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AQUATIC SCIENCES: GLOBAL CHANGES FROM THE CENTER TO THE EDGE

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Abstract Book

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Aalto, **S**., University of Jyväskylä, Jyväskylä, Finland, sanni.lh.aalto@jyu.fi
Pulkkinen, K. A., University of Jyväskylä, Jyväskylä, Finland, katja.a.pulkkinen@jyu.fi
Kaski, O., University of Jyväskylä, Jyväskylä, Finland, oulimaka@cc.jyu.fi
Salonen, K., University of Jyväskylä, Jyväskylä, Finland, arisalon@cc.jyu.fi

HOST-PATHOGEN DYNAMICS RESPONSE TO SESTON NUTRIENT ENRICHMENT– A MESOCOSM EXPERIMENT

The anthropogenic loading of carbon and nutrients has increased in lakes. This may lead to changes in nutrient-carbon ratio of producers and further into nutrient deficiency of consumers, such as zooplankton, and affect their biomass and population dynamics. Parasites take energy from their hosts and may thus decrease host reproduction and growth. Zooplankton species, such as *Daphnia*-waterfleas, are host to numerous parasites. Parasite incidence and intensity in zooplankton is governed by environmental effects such as food quality and quantity. In this experiment we studied how nutrient enrichment changes the biomass of producers and nutrient ratios in seston and whether this has an effect on prevalence and intensity of parasites infecting *Daphnia longispina*. The three enclosures receiving added N and P had significantly higher nutrient content of seston than control enclosures, but no change in biomass of the producers was detected. Of the five parasite species infecting *D. longispina*, one endoparasite had significantly higher intensity in treatment enclosures. This study is the first to connect seston nutrient content to host-parasite interactions in the natural environment.

Abbott, **R**. **L**., State University of New York College of Environmental Science and Forestry, Syracuse, USA, rlabbott@syr.edu
Schulz, K. L., State University of New York College of Environmental Science and Forestry, Syracuse, USA, kschulz@syr.edu

THE ROLE OF POLYUNSATURATED FATTY ACIDS IN THE FEEDING BEHAVIOR, FECUNDITY AND DEVELOPMENT OF A FRESHWATER CALANOID COPEPOD

Fatty acids are an important nutritional component of diets for freshwater zooplankton as precursors of many hormones and to maintain cell membrane fluidity. Food quality, specifically fatty acid content, also has effects on the fecundity of zooplankton. Nutritional quality of a food source can affect the feeding behavior of freshwater calanoid copepods as well; lower food quality may induce compensatory feeding. We will report the occurrence of compensatory feeding for a freshwater calanoid copepod by comparing the filtering rates and preferential cell selection of calanoid copepods fed *Chlamydomonas reinhardtii* cells spiked with three polyunsaturated fatty acids (PUFAs) versus those fed unsupplemented algae. In addition, we will report on the fecundity and development time on these two diets from a life table experiment to assess the effect of PUFAs and possible compensatory feeding on reproduction. These experiments attempt to elucidate the importance of fatty acids on the behavior of common zooplankton, which could affect their energy expenditures and life histories in environments with low quality food sources.

Abelho, **M**., Escola Superior Agrária, Instituto Politécnico de Coimbra, Coimbra, Portugal, abelho@esac.pt

EFFECT OF INTRODUCED EXOTIC TREE LITTER ON CONSUMPTION, BODY AND FECES NUTRIENT CONTENT OF THE ISOPOD ARMADILLIDIUM VULGARE

Consumption and growth of the woodlouse Armadillidium vulgare, the most abundant terrestrial detritivore along the Rio Grande Bosque, were measured on litters from the autochthonous Rio Grande cottonwood and New Mexico olive and the exotic Russian olive. The isopods consumed more of the exotic than of the autochthonous plant litters. Russian olive litters have higher N and P contents than litter from the autochthonous trees. Isopods fed Russian olive litters had the highest N contents, and produced N-rich feces, but the P content of the isopods and of their feces was not directly related to the P content of their food suggesting that the crustaceans differentially absorbed this nutrient from their food. Since Armadillidium vulgare processes much of the terrestrial litter in the riparian area along the Rio Grande, its altered consumption and body chemistry when feeding on Russian olive suggests that the replacement of the original vegetation by exotic vegetation such as Russian olive may alter processing of the terrestrial detritus, thus potentially affecting the linkage between the riparian and the aquatic ecosystem.

Acharya, **K**., Desert Research Institute, Las Vegas, USA, kumud.acharya@dri.edu
Yiping, L., Hohai University, Nanjing, China, yipinglihhu@gmail.com

PERILS OF ECONOMIC GROWTH AND LAND USE CHANGE: HYPEREUTROPHICATION OF LAKE TAIHU, CHINA

Rapid population and economic growth in the last few decades in China has degraded many water bodies especially in the eastern region. Lake Taihu, China's third largest lake, exemplifies the severity of the problems. Distribution of algal bloom in Lake Taihu appears to be heterogeneous and correlated with population centers and urban land use types. Using data from 32 tributaries and 26 in-lake stations, collected monthly over 6 years, we investigated spatiotemporal distributions of, and correlations between, chlorophyll-a (Chl-a), total phosphorus (TP), total nitrogen (TN) and water temperature (WT), among other variables. Results reveal strong spatiotemporal trends in all variables, with concentration decreasing from more populated north and west to center and east of regions of the lake. Spatial trends in TP and TN concentrations strongly corresponded with observed nutrient loads from the adjoining rivers in densely populated areas, demonstrating influence of watershed pollutant loads on lake water quality. Annual net retention rate of TN and TP exceeded 5,900 ton/yr and 250 ton/yr, accounting for approximately 30% of the total input flux.

Ackerman, **J**. **D**., University of Guelph, Guelph, Canada, ackerman@uoguelph.ca
Schindler, R. J., University of Guelph, Guelph, Canada, rschindl@uoguelph.ca

THE EFFECT OF BOUNDARY ROUGHNESS ON NEAR-FIELD SCALAR DISPERSION IN STREAMS

Understanding the fate and transport of scalar quantities (e.g., nutrients, pollutants, chemical cues) is important in aquatic systems. Whereas it is possible to model the transport of chemical cues under ideal circumstances, conditions are more complex in nature where roughness elements in the near-bed regions of aquatic systems can induce turbulence, which affects the three-dimensional structure of chemical plumes. We examined the effect of bed roughness on scalar dispersion in the near-bed region of small streams. The dispersion of rhodamine dye was measured spatially using fluorometers to estimate the longitudinal dispersion (K_x). k increased across sites from 2.1 ± 0.1 cm to 3.5 ± 0.2 cm, corresponding to average (u) and friction velocities (u*) ranging from u = 12.6 ± 0.2 cm/s to 58 ± 2 cm/s and u* = 0.8 ± 0.1 cm/s to 6.3 ± 0.9 cm/s. K_x increased across sites with higher k from (1.01 ± 0.06) x 10^{-2} m^2/s to (21.85 ± 0.64) x 10^{-2} m^2/s. Significant differences in K_x were found among sites ($F_{3,84}$ = 616, P < 0.001). These values, though relatively small, scale with K_x values reported previously. The results indicate that bed roughness has a significant and important affect on near field scalar transport and therefore the processes that rely on scalars.

Acuna, **V**., Catalan Institute for Water Research, Girona, Spain, vicenc.acuna@icra.cat
von Schiller, D., 2- Leibniz -Institute of Freshwater Ecology and Inland Fisheries , Berlin, Germany,
Timoner, X., 3- Institute of Aquatic Ecology, University of Girona , Girona, Spain, xtimoner@icra.cat
Marti, E., Centre for Advanced Studies of Blanes , Blanes, Spain,
Ribot, M., Centre for Advanced Studies of Blanes , Blanes, Spain,
Tockner, K., 2- Leibniz -Institute of Freshwater Ecology and Inland Fisheries , Berlin, Germany,
Sabater, S., Catalan Institute for Water Research, Girona, Spain, ssabater@icra.cat

ECOSYSTEM FUNCTIONAL RESPONSE TO INTERMITTENCY IN A MEDITERRANEAN STREAM

Recent observations and regional climate models indicate that the severity of drought in the Mediterranean region is increasing and longer no-flow periods are anticipated. Headwater streams in this region undergo a seasonal drought that often results in periods of no-flow or intermittency, but the predicted increase of the intermittency extent sets novel conditions that might profoundly influence the C, N, and P dynamics in these systems. In order to better comprehend the effects of intermittency on the C-N-P dynamics, as well as the interaction of these elements, we measured stream ecosystem metabolism and uptake of N and P during the drying and rewetting phases of a Mediterranean stream. Field results indicated different dynamics of these elements with distinct temporal patterns during both drying and rewetting phases. Indeed, the

metabolism of C reacted considerably faster than that of N or P to changes in flow. Different underlying mechanisms might explain the observed patterns, but experiments under controlled conditions are needed to find out the underlying mechanisms, as well as to predict if the extent of intermittency might decouple even more C-N-P dynamics in streams.

Adams, **C. J.**, University of Idaho, Moscow, USA, adam4707@vandals.uidaho.edu
Wilhelm, F. M., University of Idaho, Moscow, USA, fwilhelm@uidaho.edu

IMPLICATIONS OF SOLAR POWERED CIRCULATION OF AN EPILIMNION FOR CYANOBACTERIA CONTROL ON THE ZOOPLANKTON POPULATIONS WITHIN WILLOW CREEK RESERVOIR, OREGON.

Worldwide, anthropogenic activities represents significant pressure that negatively affect the availability of clean water, thus increasing lake manager's tasks to maintain or improve the quality of waterbodies through the use of an increasing arsenal of methods and chemicals. Although chemicals are tested to ensure the safety of non-target species, mechanical methods receive much less scrutiny. Solar powered circulation (SPC) is advocated for the suppression of cyanobacteria, but effects on zooplankton populations remain unknown. Given the important role of zooplankton in the clear water phase and trophic cascades in freshwater ecosystems, I am interested to examine if, and to what extent SPC affect the distribution and abundance of zooplankton populations, particularly *Daphnia*. I tested the hypothesis that SPC had no effect on the vertical and horizontal distribution of *Daphnia* in a reservoir receiving whole-lake SPC treatment. The results from this research will be discussed in the context of management strategies and their effects on zooplankton .

Adams, **L. G.**, Kennesaw State University, Kennesaw, USA, ladams@kennesaw.edu
Levin, D. R., NOAA Chesapeake Bay Office, Annapolis, USA, doug.levin@noaa.gov
Spence, L., COSEE SE, Charleston, USA, lundie.spence@scseagrant.org

ENGAGING STUDENTS IN SCIENCE WITH REAL-TIME DATA COLLECTED FROM STUDENT DESIGNED AND MONITORED BASIC OBSERVATION BUOYS (BOB)

Using real-time data (RTD) in the classroom engages students, adds relevance, and allows them to test their own predictions (Adams and Matsumoto, 2009). Most monitoring devices are cost prohibitive for classroom use. However, Basic Observation Buoy (BOB) is a low cost observation system developed in response to the need for hands-on student involvement with environmental monitoring of protected waterways. BOB, developed by Dr. Doug Levin (NOAA's Chesapeake Bay Office), was the focus of a 2009 collaborative science/outreach workshop sponsored by COSEE SE and SECOORA (Spence et al. 2009). Regional plans include an upload site on SECOORA's URL where information can be shared, thus giving students ownership of their data. My research plans include a partnership with a Beaufort County High School in SC for a phase II Tidal Creek Monitoring project that integrates BOB. The phase I study employed a DataSonde and its data have since been incorporated into a student driven middle school science activity. Phase II will directly involve high school students collecting RTD using BOB and testing their predictions about coastal processes in the tidal creek.

Adolf, **J. E.**, University of Hawaii Hilo, Hilo, USA, jadolf@hawaii.edu
Walker, J. K., University of Hawaii Hilo, Hilo, USA, jkwalker@hawaii.edu
Collins, T. P., University of Hawaii Hilo, Hilo, USA, topaz@hawaii.edu

COMPARING NUTRIENT – GROUNDWATER – PHYTOPLANKTON RELATIONSHIPS IN COASTAL WATERS OF EAST AND WEST HAWAII ISLAND

On Hawaii Island ('The Big Island'), the presence of submarine groundwater discharge (SGD) has a demonstrated impact on the physical and chemical structure of coastal marine waters. In West Hawaii, SGD is a dominant source of freshwater and nutrients to coastal waters, while extremely high rainfall in East Hawaii means both surface and ground water have significant impacts on the physical-chemical environment along the coast. Less is known about the biological impacts of SGD in waters around Hawaii Island. To begin addressing this research gap, we have been examining the relationship between SGD and coastal phytoplankton around Hawaii Island. Our research has focused on Hilo Bay (East Hawaii) and Pauoa Bay (West Hawaii). Both bays showed salinity – nutrient relationships characteristic of SGD, although groundwater nutrient levels were 2-3 fold higher at Pauoa Bay compared to Hilo Bay. Pauoa Bay phytoplankton biomass was generally low (< 1 mg m^{-3}) and dominated by picoplankton, although nuisance blooms of large Euglenoids were observed. Hilo Bay phytoplankton biomass averaged 3-4 mg m^{-3} and shifted between picoplankton, large chain-forming diatoms and dinoflagellates. In both environments, the influence of SGD on phytoplankton is likely modulated by physical conditions determining water residence time. Ongoing research using dataflow mapping and real-time continuous monitoring buoys will also be discussed.

Ahlbeck, **I.**, Stockholm University, Stockholm, Sweden, ida@ecology.su.se
Hansoon, S., Stockholm University, Stockholm, Sweden, Sture.Hansson@ecology.su.se

EVALUATING DIET ANALYSIS METHODS BY INDIVIDUAL BASED MODELING

There are many ways in which stomachs can be analyzed and opinions on preferred methods differ among experts. We have used a modeling approach to analyze how well different ways of diet analysis describe the "true" diet of fish. The aim was also to explore how characteristics of the fish and sampling methods may influences the performance of different diet analyses techniques. The methods investigated were based on the frequency of occurrence of different prey types in the stomachs and their numbers and masses (actual or recalculated measures). We also used composite indexes that combine results from two or more methods (Index of Relative Importance and the Comparative Feeding Index). The characteristics of the modeled fish, "piscivorous" or "benthivorous" and how the fish was "caught" influenced the performance of the diet analysis methods – some were more robust than others. "Simpler" methods (numeric, volumetric, point and frequency of occurrence) performed better than composite indexes. Generally, methods describing the diets from mass of different prey in the stomachs gave results most similar to the true diet of the fish.

Ahlgren, **J.**, Swedish University of Agricultural Sciences, Uppsala, Sweden, joakim.ahlgren@vatten.slu.se
Djodjic, F., Swedish University of Agricultural Sciences, Uppsala, Sweden, Faruk.Djodjic@vatten.slu.se
Wallin, M., Swedish University of Agricultural Sciences, Uppsala, Sweden, Mats.Wallin@vatten.slu.se

USING TRACE ELEMENT DISTRIBUTION TO TRACE SOURCES OF ANTHROPOGENIC NUTRIENT INPUT IN SMALL STREAMS

In most catchments anthropogenic input of nutrients to surface water is a mixture of agricultural runoff and sewage emissions. Knowledge about the relative contribution of these sources is vital for abatement purposes, and in this study we have investigated whether the distribution of trace elements in surface waters can be used to trace the nutrient source. Water from three groups of streams was analyzed: a) streams influenced only by agricultural runoff, b) streams influenced only by sewage emissions, and c) reference streams. Samples were collected at different flow regimes and times of year, and analyzed for over 70 elements using ICP-MS. Results show differences between the reference streams and anthropogenic affected streams in trace element composition, indicating that the method is well suited to trace anthropogenic affected waters. In addition, there are tendencies for the agriculturally affected waters to differ from the sewage affected, primarily in higher levels of As, Br, Sb, I and W. These results will be used to improve source apportionment models, which may subsequently be able to trace and quantify the sources of nutrients in catchments.

Aiken, **G. R.**, US Geological Survey, Boulder, CO, USA, graiken@usgs.gov
Gilmour, C. C., Smithsonian Environmental Research Center, Edgewater, MD, USA, gilmour@si.edu
Krabbenhoft, D. P., US Geological Survey, Middleton, WI, USA, dpkrabbe@usgs.gov
Orem, W., US Geological Survey, Reston, VA, USA, borem@usgs.gov

INFLUENCES OF DISSOLVED ORGANIC MATTER ON MERCURY BIOGEOCHEMISTRY

A number of biogeochemical processes that influence the fate, bioavailability, and transport of mercury (Hg) in aquatic systems are mediated by interactions of Hg with dissolved organic matter (DOM). DOM can influence the aqueous chemistry of Hg by acting as a ligand and directly binding Hg, and, in the presence of sulfide, by interacting with mercuric sulfide (HgS) such that greater concentrations of HgS are maintained in solution than would be predicted by speciation models. In this paper, the results of in-situ mesocosm experiments designed to directly measure the effects of DOM -Hg interactions on Hg biogeochemistry are described. In these experiments, mesocosms (wetland

enclosures), located in the central Everglades, were amended with isotopically enriched Hg, sulfate, and the hydrophobic organic acid (HPOA) fraction of DOM isolated from a site in the eutrophic northern Everglades. DOM additions resulted in substantially increased concentrations of dissolved Hg in surface water. Greater concentrations of methylmercury in surface water were also observed in the DOM amended mesocosms supporting the hypothesis that DOM increases Hg bioavailabilty for methylation.

Akbaripasand, **A**., University of Otago, Dunedin, New Zealand, ab_akbary@yahoo.com
Closs, G. P., University of Otago, Dunedin, New Zealand, gerry.closs@stonebow.otago.ac.nz
Lokman, M., University of Otago, Dunedin, New Zealand, mark.lokman@stonebow.otago.ac.nz

EFFECTS OF INVERTEBRATE DRIFT DENSITY ON DIET AND GROWTH OF A GALAXIID FISH IN THREE NEW ZEALAND STREAMS

The abundance of New Zealand native fish, banded kokopu (*Galaxias fasciatus* Gray), has declined over the past decades due to habitat loss through land use-changes. It is not clear that streams with land use practices have less food potential. We investigated whether (i) level of food abundance is different in streams with different type of catchment (dense native bush, lightly grazed pasture and mixed native bush-pasture), and (ii) the fish use different food types in different habitats, or (iii) the growth rate of this fish is dependent on food density and quality. To test these hypotheses we measured banded kokopu abundance and growth monthly, using spotlight and capture-recapture of tagged fish and assessed their diet and invertebrate density in three streams. Drift density were different in all three stream types with higher food in pasture. But the fish experienced better growth in bushy stream. The main diet in forested stream was mayfly which was different from the items chosen by the fish in pasture stream. The factors complicating the relationship between invertebrate drift and growth will be discussed

Albers, **S**. **J**., University of Northern British Columbia, Prince George, BC, Canada, albers@unbc.ca
Petticrew, E. L., University of Northern British Columbia, Prince George, BC, Canada, ellen@unbc.ca

MARINE DERIVED NUTRIENT TRANSFER: CHANGING BIOFILM ABUNDANCE AND COMPOSITION IN RESPONSE TO SALMON SPAWNING AND DIE-OFF.

An opportunity to utilize a regulated salmon spawning channel in the summer of 2009 allowed for quantification of both marine derived nutrients (MDN) and fine sediment trapped by benthic biofilms during both salmon spawning and die-back. Each year, millions of Pacific salmon (*Oncorhynchus spp.*) transfer valuable MDN upstream to their natal habitats, while at the same time imparting energy to the gravel bed via their spawning activity. We studied the response of streamwater conditions and biofilm abundance and composition to salmon spawners in the Horsefly River spawning channel. Biofilm abundance was monitored during salmon arrival, spawning activity and die-off. The study's objective was to examine 1) the magnitude of MDN uptake and retention by benthic biofilms via biofilm abundance and 2) the mass of fine sediment trapped by the biofilm. These results will be used to determine if MDN can stimulate primary productivity in the nearfield environment. This work identifies the importance to stream ecosystems of both the nutrient delivery and physical reworking of the gravel bed by salmon and may have consequences for both salmon and river management goals.

Albertson, **L**. **K**., UC Santa Barbara, Santa Barbara, USA, albertson@lifesci.ucsb.edu
Cardinale, B. J., UC Santa Barbara, Santa Barbara, USA, cardinale@lifesci.ucsb.edu

IMPACTS OF BIOLOGICAL DIVERSITY ON SEDIMENT TRANSPORT IN STREAMS

An increasing number of studies have shown that organisms modify physical processes by constructing biological structures (e.g. roots, biofilms). However, most of these studies have assumed all species have identical impacts. Here we ask whether we must account for variation among species that, because of niche differences, each exert a unique influence on physical processes. We use a model system to test how the diversity of benthic, net-spinning caddisfly larvae (Trichoptera) impacts sediment transport. We extend the results of previous studies showing that nets of a single caddisfly species can reduce sediment mobility by asking whether two species have a greater impact than one. In studies conducted in laboratory flumes, we found that the critical shear stress required to initiate sediment movement was significantly higher in streams containing two species. The increase in stability appeared to be due to spatial partitioning of larvae among pore spaces, with a greater area of pores covered by nets when two species were present. Our results suggest that a quantitative merger of biology and geomorphology may require that we specifically account for variation among species.

Aldridge, **T**. **M**., University of Louisiana at Monroe, Monroe, USA, aldridtm@warhawks.ulm.edu
Hill, A. M., University of Louisiana at Monroe, Monroe, USA, hill@ulm.edu

DIGITAL COMPARISON OF ANISOPTERA LARVAE MORPHOLOGY

T.M Aldridge and A.M. Hill, Department of ology, University of Louisiana at Monroe, Monroe, LA. hill@ulm.edu. Morphometrics is an approach used to distinguish among closely related species of adult Odonata. We are exploring the feasibility of using digitized images and landmark analysis to assist in identifying early instar larvae that would otherwise be difficult to process using traditional keying methods. Larvae were collected, identified to genus level, and photographed for analysis. Thus far, digital analysis of head capsule shape and, perhaps, prementum shape seem promising.

Alexander, **K**. **B**., University of Colorado, Boulder, USA, katharine.alexander@colorado.edu
Cullis, J., University of Colorado, Boulder, USA, james.cullis@colorado.edu
Pugh, E. T., University of Colorado, Boulder, USA, evanpugh@gmail.com
Turner, J., University of Colorado, Boulder, USA, hydromaiden@gmail.com
McKnight, D. M., University of Colorado, Boulder, USA, diane.mcknight@colorado.edu

EVALUATION OF NEW VIBRAM® SOLED WADING BOOTS ON THE TRANSPORT AND SURVIVABILITY OF DIDYMOSPHENIA GEMINATA

Transport by recreational users has been shown to be a significant factor in the spread of the nuisance diatom Didymosphenia geminata. Felt soled wading boots are considered to be the most efficient mechanism for the transport of live cells. This has prompted the banning of felt soled waders in some countries and fishing gear manufacturers to introduce new products such as Vibram® soled wading boots. The aim of this study was to investigate the relative ability of the new Vibram® soles to transport live D. geminata cells in relation to felt soles. The results show that the Vibram® soles carry significantly fewer cells than traditional felt soles and that the survivability is low after 36 hours even without treatment. Felt soles not only transported more cells, but the percentage of live cells actually increased after 36 hours indicating that there was continued reproduction in the favorable conditions of the felt soles. These results give further support to manufacturers and water resource managers for the phasing out of felt soled waders.

Alexander, **R**. **B**., U.S. Geological Survey, Reston, USA, ralex@usgs.gov
Smith, R. A., U.S. Geological Survey, Reston, USA, rsmith1@usgs.gov
Schwarz, G. E., U.S. Geological Survey, Reston, USA, gschwarz@usgs.gov
Boyer, E. W., Pennsylvania State University, University Park, USA, ewb100@psu.edu
Brakebill, J. W., U.S. Geological Survey, Baltimore, USA, jwbrakeb@usgs.gov

REGIONAL DIFFERENCES IN THE DOWNSTREAM FLUX OF NITROGEN IN RIVER NETWORKS

Recent legal rulings on federal Clean Water Act jurisdiction underscore the need for improved understanding of headwater influences on the physical, chemical, and biological integrity of downstream waters. Although field data and modeling have advanced knowledge of the role of headwaters and river networks in shaping downstream water quality, more systematic, integrated assessments of diverse environmental settings can refine this knowledge. Here, we use streamflow and nitrogen flux measurements from more than 1,000 U.S. monitoring sites and a spatially explicit watershed model (SPARROW) to broaden perspectives on the factors controlling nitrogen flux in river networks. The analysis accounts for the coupled interactions of land use, climate, and landscape processes (terrestrial and aquatic). We find that temporal and spatial variations in nitrogen flux can be primarily explained by scale-invariant responses to these factors. However, accounting for regional deviations in these responses as reflected by spatial differences in model parameters improves understanding of the local and cumulative effects of processes on the

downstream flux of nitrogen in river networks. Results also demonstrate the profound influence of headwater areas on downstream water quality.

Allan, **J**. **D**., University of Michigan, Ann Arbor, USA, dallan@umich.edu
McIntyre, P. B., University of Michigan, Ann Arbor, USA, pbmcinty@umich.edu
Halpern, B., National Center for Ecological Analysis and Synthesis, Santa Barbara, USA, halpern@nceas.ucsb.edu
Boyer, G., SUNY-College of Environmental Science and Forestry, Syracuse, USA, glboyer@esf.edu
Buchsbaum, A., National Wildlife Federation, Ann Arbor, USA, BUCHSBAUM@nwf.org
Burton, A., University of Michigan, Ann Arbor, USA, burtonal@umich.edu
Campbell, L., Queens University, Kingston, Canada, linda.campbell@queensu.ca
Chadderton, W. L., The Nature Conservancy, Lansing, USA, lchadderton@tnc.org
Ciborowski, J., University of Windsor, Windsor, Canada, cibor@uwindsor.ca
Doran, P., The Nature Conservancy, Lansing, USA, pdoran@TNC.ORG
Eder, T., Great Lakes Commission, Ann Arbor, USA, teder@glc.org
Hecky, R., University of Minnesota, Duluth, USA, rehecky@gmail.com
Infante, D., Michigan State University, Lansing, USA, infanted@msu.edu
Johnson, L., University of Minnesota, Duluth,USA, ljohnson@umn.edu
Lodge, D., University of Notre Dame, South Bend,USA, David.M.Lodge.1@nd.edu
Read, J., Michigan Sea Grant, Ann Arbor, USA, jenread@umich.edu
Rutherford, E., NOAA Great Lakes Environmental Research Lab, Ann Arbor, USA, edwardr@umich.edu
Sowa, S., The Nature Conservancy, Lansing, USA, ssowa@tnc.org
Steinman, A., Annis Water Resources Institute, Muskegon, USA, steinmaa@gvsu.edu
Joseph, C., University of Michigan, Ann Arbor, USA, cgeddes@umich.edu
Fenner, J., University of Michigan, Ann Arbor, USA, jacqfenn@gmail.com

PRIORITIZING RESTORATION AND CONSERVATION OPPORTUNITIES IN THE GREAT LAKES

A key lesson from terrestrial conservation science is that maps of stressors and valued resources are one important starting point for developing coherent restoration and conservation strategies. Management efforts are tied to specific places, therefore we need to know the spatial distribution of human impacts in order to guide effective actions. Moreover, numerous types of threats often affect the same location, calling for analyses that integrate multiple stressors. Here, we outline the Great Lakes Environmental Assessment and Mapping Project (GLEAM), which seeks to merge GIS layers representing every major category of threats to the Great Lakes, ranging from climate change to land-based pollution to exotic species. By synthesizing this information into a single map of cumulative threat levels across the basin, we will provide a new tool to guide management efforts. Additional comparisons between the spatial distribution of cumulative threats and priority habitats, species of concern, and ecosystem services are proceeding concurrently. This effort, modeled upon recent global threat analyses for marine waters and rivers, will facilitate prioritizing restoration and conservation actions throughout the Great Lakes region.

Alldred, **M**. **K**., Stony Brook University, Stony Brook, NY, USA, malldred@life.bio.sunysb.edu

EFFECTS OF WETLAND PLANTS ON DENITRIFICATION RATES: A META-ANALYSIS

Wetland plant communities differ in the ability to modify denitrification rates, altering the rate at which nitrogen pollution is permanently removed from ecosystems to the atmospheric sink. Thus, rapid shifts in plant community distributions resulting from land use change, climate change, species invasions, or sea level rise may alter the nitrogen-removal capacity of future landscapes. Numerous studies have estimated denitrification rates in natural and constructed wetland sediments inhabited by different plant communities. However, little effort has been made to synthesize these results across the ecological and engineering literature. I conduct a systematic review of these studies and perform a meta-analysis of their results. A comparison of average denitrification rates in vegetated and non-vegetated sediments using a log-linear response ratio reveals that wetland plants tend to have a positive effect on denitrification, relative to non-vegetated sediments. Average denitrification rates are used as a measure of effect size to test for variation within and among plant communities and the various methods used to measure denitrification. Results indicate significant variation in denitrification rates, both within and among communities, and among methods.

Allen, **D**. **C**., University of Oklahoma, Norman, USA, dallen@ou.edu
Vaughn, C. C., University of Oklahoma, Norman, USA, cvaughn@ou.edu

THE USE OF STABLE-ISOTOPE TRACERS TO TRACK NUTRIENT SUBSIDIES BY FRESHWATER MUSSELS

Freshwater mussels have been found to have positive influences on benthic primary production and standing crops of grazing benthic macroinvertebrates during the summer when nutrients are limiting. One hypothesis for this phenomenon is that mussels provide nutrient subsidies during these times through excretion and nutrient recycling. Physiological experiments show that some mussel species are stressed at high temperatures in the summer (>30°C), catabolyzing energy reserves. Thus, mussels are likely to be excreting endogenously, and may be subsidizing benthic food webs with mussel-derived nutrient subsidies. We conducted two pilot experiments to test the feasibility of using stable-isotope tracers as a means to track mussel-derived nutrient subsidies in benthic food webs. A mesocosm experiment showed that benthic algae closely track δ15N values of mussel hemolymph, and in a second experiment we were able to enrich mussel hemolymph to approximately 18 δ15N ‰. Finally, we describe how this approach will be used to quantify mussel-derived nutrient subsidies to benthic and possibly riparian food webs, and to see how freshwater mussel community structure influences the direction and magnitude of these effects.

Allums, **S**. **E**., Joseph W. Jones Ecological Research Center, Newton, USA, stephanie.allums@jonesctr.org
Opsahl, S. P., Joseph W. Jones Ecological Research Center, Newton, USA, stephen.opsahl@jonesctr.org
Golladay, S. W., Joseph W. Jones Ecological Research Center, Newton, USA, steve.golladay@jonesctr.org
Hicks, D. W., Joseph W. Jones Ecological Research Center, Newton, USA, woody.hicks@jonesctr.org
Conner, L. M., Joseph W. Jones Ecological Research Center, Newton, USA, mike.conner@jonesctr.org

LAND USE INFLUENCE AND GROUNDWATER/SURFACE INTERACTIONS ON WATER QUALITY IN THE LOWER FLINT RIVER BASIN, GEORGIA

Water Chemistry was monitored from 2001 to 2009 in four large springs and 9 river sites along the lower Flint River (Georgia, USA). Delineation of recharge areas and quantification of land cover demonstrated that land use within the four springsheds ranged from forested urban to agricultural. Analysis of 10 springs (six additional springs) for δ15N-NO3- suggested fertilizer and animal/human waste as the nitrate source in rural springs (4.8‰ to 8.4‰) and predominantly animal/human waste in urban springs (7.7‰ to 13.4‰). Nitrate-N in the springs ranged from 1.74 mg/l to 3.30 mg/l, and exceeded historical levels reported for the aquifer. Statistical analyses suggested an increasing trend in nitrate-N concentrations in groundwater discharging at the springs. Analysis of Flint River water chemistry indicated elevated nitrate-N concentrations during low-flow conditions due to greater contributions from groundwater discharge. Conversely, the Flint River exhibited lower nitrate-N concentrations during high flows which were attributed to a relatively low proportion of groundwater-derived nitrate. The overall results indicate that nitrate-N concentrations are influenced by a dynamic interaction between land use, rate of groundwater discharge, and time.

Alp, **M**., Eawag / ETH, Duebendorf, Switzerland, maria.alp@eawag.ch
Robinson, C. T., Eawag / ETH, Duebendorf, Switzerland, christopher.robinson@eawag.ch

RECRUITMENT CONSTRAINTS OF AQUATIC INSECTS: TOWARDS SOLVING THE PUZZLE

In river restoration, constraints on dispersal and recruitment are a major factor reducing or impeding colonization of newly available habitats. We present an analysis of a manipulative experimental study conducted in two Swiss lowland rivers investigating recruitment constraints of aquatic invertebrates. Our study mainly targeted insects with specific oviposition behaviours: adult winged females of these species land on protruding boulders, then attach fertilized eggs on the submersed undersides. We added artificial oviposition substrates (bricks) to the riverbed at sites strongly differing in their morphological condition and monitored oviposition, benthic species pool and presence of winged adults throughout the insect flight season. We used changes in relative oviposition rates on bricks (which generally were less preferred) versus natural stones as an indicator of constraints in substrate availability. Combining this novel approach

with detailed information on species pool and parameters determining substrate availability in each study reach during the experiment allowed us to distinguish between multiple factors influencing oviposition rates. Comparison of several insect and non-insect taxa revealed different types and extent of constraints on recruitment in the study streams.

Alvarez, **E**., Instituto Español de Oceanografía. Centro Oceanográfico de Gijón., Asturias, Spain, eva.alvarez@gi.ieo.es

González, P., Artificial Intelligence Center. University of Oviedo at Gijón., Asturias, Spain, pglez82@gmail.com

López-Urrutia, Á., Instituto Español de Oceanografía. Centro Oceanográfico de Gijón., Asturias, Spain, alop@gi.ieo.es

Díez, J., Artificial Intelligence Center. University of Oviedo at Gijón., Asturias, Spain, jdiez@aic.uniovi.es

Nogueira, E., Instituto Español de Oceanografía. Centro Oceanográfico de Gijón., Asturias, Spain, enrique.nogueira@gi.ieo.es

del Coz, J. J., Artificial Intelligence Center. University of Oviedo at Gijón., Asturias, Spain, juanjo@aic.uniovi.es

González-Quirós, R., Instituto Español de Oceanografía. Centro Oceanográfico de Gijón., Asturias, Spain, rgq@gi.ieo.es

AUTOMATED CLASSIFICATION TECHNIQUES TARGETED TO IMPROVE THE PRECISION OF BIOMASS ESTIMATES

Automated image capture devices have been developed in the last decade in order to sample plankton at high spatio-temporal resolution. In parallel, automated classification techniques have demonstrated to be necessary to handle such great quantity of information. The objective of these techniques is the accurate enumeration of the images in as many taxonomic categories as possible. One of the applications of the automated counting and classification is, however, to determine the biomass rather than the abundance within taxonomic categories. Thus, we propose to take this perspective into account when designing the classification method, prioritizing the accuracy in biovolume/biomass estimates. We use FlowCAM images of microplankton to illustrate how a size-structure-oriented classification differs from a taxonomic-enumeration-oriented classification, leading to improved biomass estimates. A higher accuracy can be achieved in two ways. First, the classification groups can be organized with the shape of each particle in mind. Second, the classification algorithm can be optimized on the basis of biomass rather than abundance and the classifier designed to minimize the error in total biomass.

Ambler, **J. W**., Millersville University, Millersville, USA, julie.ambler@millersville.edu

Aulenbach, D. L., Millersville University, Millersville, USA, dlaulenb@marauder.millersville.edu

Eichelberger, K. M., Millersville University, Millersville, USA, kmeichel@marauder.millersville.edu

Coble, J. L., Millersville University, Millersville, USA, jlcoble@millersville.edu

DOMINANCE OF TUNICATES, CLADOCERANS AND SMALL CALANOID COPEPODS DURING STRATIFIED CONDITIONS IN THE SOUTHERN MID-ATLTANTIC BIGHT

Tunicates may have different roles in food web dynamics than copepods since tunicates feed on smaller phytoplankton, grow rapidly by asexual reproduction, and produce fecal pellet that decompose more easily. However, tunicates have not been as well studied as copepods, because they are fragile. Mesozooplankton were sampled monthly with 80um mesh nets along a 25km transect off Wallops Is., VA, in the Mid-Atlantic Bight. Tunicates (Oikopleura dioica and Dolioletta gegenbauri), cladocerans (Penilia avirostris), and small copepod species (Parvocalanus crassirostris, Paracalanus parvus, and Pseudocalanus newmanni) dominated zooplankton densities during months when stratified conditions occurred, June to October 2006 and 2007. Seasonal trends for all taxa were similar with maximum densities in July, except for D. gegenbauri , which had maximum densities in October when it completely dominated zooplankton numbers and biomass. Its high population densities may have been caused by cross shelf advection coupled with favorable biological interactions. Thus, tunicates were dominant taxa during the most productive time of year, but their dominance was shared by cladocerans and copepods which have similar grazing but different fecal pellet producing capabilities.

Anderson, **A**. **M**., University of Minnesota, St. Paul, USA, ande8267@umn.edu

Ferrington, L. C., University of Minnesota, St. Paul, USA, ferri016@umn.edu

EFFICIENCY OF SORTING CHIRONOMIDAE SURFACE FLOATING PUPAL EXUVIAE SAMPLES FROM URBAN TROUT STREAMS IN NORTHEAST MINNESOTA

Collections of Chironomidae surface-floating pupal exuviae (SFPE) provide an effective means of assessing water quality in streams. Although not widely used in the US, the technique is not new and has been shown to be more cost-efficient than traditional dip-net sampling techniques in organically enriched streams. The intent of this research was to document the efficiency of sorting SFPE samples relative to dip-net samples in trout streams with catchments varying in amount of impervious surface. Samples of SFPE were collected from 17 trout streams in Duluth, MN; dip-net samples of the entire macroinvertebrate community were also collected from these streams. We quantified time needed to sort subsamples of 100 macroinvertebrates and SFPE; time to subsample up to 300 SFPE was also recorded. The average time to sort subsamples of 100 specimens was 22.5 minutes for SFPE samples, compared to 32.7 minutes for 100 macroinvertebrates in dip-net samples. Average time to sort up to 300 SFPE was 37.7 minutes. These results indicate that sorting SFPE samples is more time-efficient than traditional dip-net techniques in trout streams with varying catchment characteristics.

Anderson, **K**. **E**., University of California, Riverside, USA, kurt.anderson@ucr.edu

Nisbet, R. M., University of California, Santa Barbara, USA, nisbet@lifesci.ucsb.edu

Harrison, L. R., University of California, Santa Barbara, USA, lharrison@bren.ucsb.edu

Kolpas, A., University of Delaware, Newark, USA, kolpas@lifesci.ucsb.edu

Pecquerie, L., University of California, Santa Barbara, USA, pecquerie@lifesci.ucsb.edu

Albertson, L. K., University of California, Santa Barbara, USA, albertson@lifesci.ucsb.edu

Cardinale, B. J., University of California, Santa Barbara, USA, cardinale@lifesci.ucsb.edu

MODELING SPATIAL SCALE DEPENDENCE IN STREAM POPULATION RESPONSE TO PHYSICAL HABITAT UNDER CHANGING FLOW REGIMES

Altered flow regimes can have profound effects on the spatial structure and total availability of instream habitat. However, methods for creating explicit links between changes in the availability and distribution of physical habitat and population persistence of focal species are generally lacking. Resulting complexities include difficulties in determining the spatial scale of physical habitat variability that is most relevant to population persistence. We have introduced a metric termed the response length which characterizes the effects of the local environment as felt by distant populations. We will discuss how this length scale forms an important component of theory that predicts the distribution of organisms among different physical habitat types in streams and rivers. We will also explore the validity of the response length concept using a parameterized 2-D hydraulic model and data on benthic and drift invertebrate populations for the Merced River. We find that this simple metric can provide a useful way to characterize complex changes in physical habitat and biotic resource availability across realistic changes to the flow regime.

Anderson, **M**. **R**., Fisheries and Oceans Canada, St. John's, Canada, m.robin.anderson@dfo-mpo.gc.ca

DURATION AND EXTENT OF ELEVATED MERCURY LEVELS IN DOWNSTREAM FISH FOLLOWING RESERVOIR CREATION

While mercury accumulation in reservoir fish following impoundment is a well known phenomenon, consequences for downstream populations are less well known. In particular, the effects on downstream estuarine populations have only rarely been studied. Here I present evidence from a Northern Canadian reservoir that elevated mercury levels can be seen in fish downstream for a distance of over 200 km and into the estuary for some species. The Smallwood Reservoir in Labrador, Canada created in the mid 1970's, drains into the Churchill River and hence into Lake Melville, a large estuarine fjord. Mercury levels in most riverine species were elevated immediately following impoundment and have since declined as have the levels in estuarine smelt. For several species this effect was not noticeably attenuated with distance as would be expected if it resulted from downstream populations feeding on pieces of reservoir fish chopped up by passage through the turbines as seen in Northern Quebec reservoirs. These

findings suggest that future reservoirs planned for the Lower Churchill River will also result in elevated mercury levels of fish downstream and into the estuary.

Anderson, **T**. **J**., University of Wisconsin Oshkosh, Oshkosh, USA, andert54@uwosh.edu
Stelzer, R. S., University of Wisconsin Oshkosh, Oshkosh, USA, stelzer@uwosh.edu
Drecktrah, H. G., University of Wisconsin Oshkosh, Oshkosh, USA, drecktra@uwosh.edu
Eggert, S. L., USDA Forest Service North Central Research Station, Grand Rapids, USA, seggert@fs.fed.us

SECONDARY PRODUCTION OF CHIRONOMIDAE IN A LARGE EUTROPHIC LAKE

Secondary production of primary consumers can impact fish production and food web structure in lakes. We calculated secondary production of chironomids in Lake Winnebago, Wisconsin the first estimate of secondary production in this large, eutrophic system. Chironomids dominate benthic invertebrate biomass in the lake where previous research has shown that lake sturgeon (*Aciperser fulvescens*) rely heavily on chironomids as a food source. Benthic samples were collected with an Ekman dredge at four profundal sites on eleven dates from spring 2008 through spring 2009. Instantaneous growth rates for seven chironomid length classes at five thermal regimes were measured in the laboratory. Mean annual production of Chironomidae using the instantaneous growth rate method was 8.42 g dry mass (DM) m^{-2} yr^{-1}. The sub-family Chironominae accounted for 6.84 g DM m^{-2} yr^{-1} and Tanypodinae production was 1.59 g DM m^{-2} yr^{-1}. Mean annual density of Chironomidae was 2714 m^{-2} and mean biomass was 2.83 g DM m^{-2}. These annual production estimates are higher than many other chironomid production rates from lakes but are similar to chironomid production estimates from lotic ecosystems.

Anderson, **T**. **M**., University of Minnesota, Morris, Morris, USA, anderstm@morris.umn.edu

EVALUATING THE ROLE OF ALLOCHTHONOUS ORGANIC MATTER AS A FOOD RESOURCE FOR SHREDDERS IN A PRAIRIE POTHOLE LAKE IN WEST CENTRAL MINNESOTA

In Cottonwood Lake, a prairie pothole lake in west central Minnesota, shredders make up a significant part of the macroinvertebrate community in the littoral zone (67% abundance, 25% of all taxa). Trees occur along much of the shoreline suggesting that terrestrially derived organic matter could be an important source of CPOM for macroinvertebrates in prairie potholes, particularly in the littoral zone. Stable isotopes of carbon (^{13}C) and nitrogen (^{15}N) of the common shredders *Glyptotendipes* and *Hyalella azteca* were compared to those of the collector-gather, *Chironomus* and the predator, *Cryptochironomus*. Stable isotopes of potential sources of allochthonous (oak, American elm, cottonwood) and authochthonous (cattail) CPOM taken from the lake were also evaluated. Both $\delta^{13}C$ and $\delta^{15}N$ were significantly depleted in *Chironomus* compared to other macroinvertebrates. *H. azteca*, had significantly greater values of $\delta^{13}C$ than all other macroinvertebrates. Sources of CPOM did not show distinctive profiles for either ^{13}C or ^{15}N, highlighting the challenge of characterizing detrital food resources. Further analyses will help discern the fate of terrestrial inputs in prairie pothole lakes.

Tucker, A. J., Miami University, Oxford, USA, tuckera2@muohio.edu
Williamson, C., Miami University, Oxford, USA, willia85@muohio.edu
James Oris, Miami University, Oxford, USA, orisjt@muohio.edu
Gevertz, A., Miami University, Oxford, USA, gevertzak@muohio.edu
Mark Olson, Franklin and Marshall College, Lancaster, USA, mark.olson@fandm.edu

WATER TEMPERATURE AND ULTRAVIOLET RADIATION TRANSPARENCY INTERACT TO CONTROL INVASIVE WARM-WATER FISH ESTABLISHMENT IN NEARSHORE LAKE TAHOE, CA/NV USA.

In many systems, temperature constrains the depth of suitable spawning habitat for warm-water fishes. In transparent lakes this potentially exposes eggs and larvae in nests to high levels of ultraviolet radiation (UVR). We examined how water temperature and transparency to UVR influence the suitability of nearshore habitats for invasive warm-water fish in Lake Tahoe, a sub-alpine oligotrophic lake. We exposed larval bluegill and largemouth bass to solar UVR to establish a UVR dose-response relationship for each species. These results were combined with UVR transparency data from monthly profiles (May-Oct 2009) to predict fish survival in each nearshore site as a function of UVR exposure. Using data from the literature and from monthly temperature profiles we also predicted larval fish survival at each nearshore site as a function of temperature. UVR and temperature dependent survival estimates were combined to produce a single estimate of potential survival at each nearshore site. Model results were corroborated by in situ incubation experiments. Our results suggest that current UVR transparency and water temperature limit establishment of non-native fish in most, though not all, nearshore sites.

Angeler, **D**. **G**., Swedish University of Agricultural Sciences, Department of Aquatic Sciences and Assessment, Uppsala, Sweden, david.angeler@vatten.slu.se
Trigal, C., Swedish University of Agricultural Sciences, Department of Aquatic Sciences and Assessment, Uppsala, Sweden, cristina.trigal@vatten.slu.se
Drakare, S., Swedish University of Agricultural Sciences, Department of Aquatic Sciences and Assessment, Uppsala, Sweden, stina.drakare@vatten.slu.se
Johnson, R. K., Swedish University of Agricultural Sciences, Department of Aquatic Sciences and Assessment, Uppsala, Sweden, richard.johnson@vatten.slu.se
Goedkoop, W., Swedish University of Agricultural Sciences, Department of Aquatic Sciences and Assessment, Uppsala, Sweden, willem.goedkoop@vatten.slu.se

CROSS-SCALE RESILIENCE IN BLOOM IMPACTED PHYTOPLANKTON COMMUNITIES

The complex nature of ecological systems limits the unambiguous determination of resilience mechanisms. We studied resilience of phytoplankton communities to recurring bloom impacts of the alga *Gonyostomum semen*, Raphidophyceae. We characterized phytoplankton community dynamics in bloom lakes and reference lakes using univariate community metrics (evenness, species richness, biovolume and Simpson diversity). All metrics, except species richness, were altered and showed stronger variability in bloom lakes relative to reference lakes, suggesting that both lake types occurred in alternative states. We also assessed resilience mechanisms using multivariate time series modelling. The models captured successional dynamics of the phytoplankton communities in all lakes, whereby different groups of species were substituted sequentially over the ice-out period. The models also identified that *G. semen* impacts in bloom lakes were only manifested within a single species group but not across species groups, highlighting rapid renewal of the phytoplankton communities upon bloom collapse. These results provide support of the cross-scale resilience model. Cross-scale resilience could provide an explanation for the paradox of similar species richness in bloom lakes and reference lakes, despite both lake types occurring in alternative states.

Weekes, A., USGS FRESC, Seattle, USA, aweekes@usgs.gov
Christian Torgersen, C., USGS FRESC, Seattle, USA, ctorgersen@usgs.gov
Montgomery, D. R., University of Washington, Seattle, USA, dave@ess.washington.edu
Woodward, A., USGS FRESC, Seattle, USA, awoodward@usgs.gov
Bolton, S., University of Washington, Seattle, USA, sbolton@u.washington.edu

SPATIAL STRATIFICATION FOR MONITORING IN RELICT GLACIATED CASCADE MOUNTAIN HEADWATERS

Aquatic habitats in undisturbed headwater catchments can differ widely within a mountain region. Monitoring approaches often use streamflow measurements taken at a gage at the watershed outlet. This approach is thought to integrate physical processes occurring upstream. We first tested the hypothesis that five adjoining basins with similar physical characteristics (e.g.; slope, elevation range, drainage area, surficial and bedrock geology, and glacial history) would produce a similar hydrological response. We found that streamflow metrics over a three year period differed by an order of magnitude. To explain this variation, we investigated a systematic way to characterize the spatial distribution of intermediate-scale geohydrologic controls within the stream network using nested temperature loggers and pressure transducers. The linkage between geomorphic and hydrologic response was found to be best expressed in colluvial, alluvial and bedrock landforms found within relict glacial structures. Study results showed a strong relationship between percentages of highly permeable colluvial material and characteristic hydrologic regimes. The position of major colluvial deposits along the longitudinal profiles was also an important determinant of water temperature and streamflow response. Preliminary results suggest that a hierarchical spatial framework accounts for intermediate-scale landscape processes that may dominate variability among hydrologic regimes.

Anon Suarez, D. A., Centro Regional Universitario Bariloche (Univ. Nac. del Comahue), Bariloche, Argentina, danon46@gmail.com

Diéguez, M. C., Centro Regional Universitario Bariloche (Univ. Nac. del Comahue), Bariloche, , dieguezmc@gmail.com

Baccalá, N. B., Centro Regional Universitario Bariloche (Univ. Nac. del Comahue), Bariloche, , norabaccala@gmail.com

BENTHIC MACROINVERTEBRATES COMMUNITY STRUCTURE IN PATAGONIAN LAKES

Benthic organisms are important components of lakes' communities and represent important links in freshwater food webs. They are often the most important food source for game and commercial fisheries. We searched for patterns in the composition, distribution and abundance of the benthic invertebrates in Patagonian lakes and assessed their relationships with physical-chemical variables and trophic status. Samples were collected from thirty tree lakes belonging to the Río Negro and Chubut provinces of Argentina. The study lakes are spread along a strong environmental gradient of rainfall. The recorded taxa were mainly chironomids, annelids, amphipods, nematods, gastropods, bivalves, trichopterans and odonates. Characteristically, chironomids and oligochaetes showed high population densities. Redundancy analysis identified two major groups within the studied lakes: "steppe" lakes (n=8) and "mountain" lakes (n=25). Steppe lakes are relatively shallow, have higher Chl a, DOC and pH values and tend to exhibit higher individual densities while, mountain lakes have a richer community composition (i.e., higher number of taxa). The abundance of the most frequent taxa (chironomids, oligochaets and leeches) increased with Chl a, pH and DOC.

Appling, A. P., Program in Ecology, Duke University, Durham, NC, USA, apa3@duke.edu

Bernhardt, E. S., Program in Ecology, Duke University, Durham, NC, USA, ebernhar@duke.edu

Stanford, J. A., Flathead Lake Biological Station, University of Montana, Polson, MT, USA, jack.stanford@flbs.umt.edu

VEGETATION AND DEPTH PREDICT DENITRIFICATION IN A COARSE-SUBSTRATE FLOODPLAIN

Riparian floodplains can support rapid denitrification and may therefore reduce river N loads. Although river water passes through floodplains both aboveground and belowground, the depth distribution of denitrification is not well quantified for floodplains with high subsurface connectivity. For one such floodplain in northwest Montana, we assayed denitrification rates at multiple depths in gravel bars, grassy meadows, and tree stands. We assayed N-amended denitrification potentials (DNPs) and soil variables that might explain DNPs, including KCl-extractable NO_2^-&NO_3^- and NH_4^+, soil moisture, pH, and C&N, and the mass of roots and particulate organic matter (POM). We found that DNPs could be accurately predicted from the soil %C alone with R^2=0.82. Vegetation cover significantly affected DNPs, and at all vegetated sites DNPs were highest near the soil surface and declined precipitously with depth. Except in a buried wood deposit, denitrification near the water table could not be stimulated with nitrate and/or glucose additions. These results highlight the importance of surface soils in the riparian N cycle and provide insights into the correlated effects of vegetation cover and soil chemistry on riparian denitrification.

ARCHAIMBAULT, V., cemagerf of Lyon, Lyon, France, virginie.archaimbault@cemagref.fr

COLAS, F., University Paul Verlaine of Metz, Metz, France, fannycolas39@hotmail.fr

DEVIN, S., University Paul Verlaine of Metz, Metz, France, devin@univ-metz.fr

FAUNAL AND FUNCTIONAL STRUCTURE OF MACROINVERTEBRATE COMMUNITIES ALONG A STREAM / DAM SUCCESSION

To understand both the effect of a physical modification of a river course by dams and of a metallic contamination of sediment within dams, macrobenthic communities of an alpine stream were studied. Macroinvertebrates were sampled on five sites along the same river course: an upstream reference site, a reference storage, a site downstream this first storage, a metal-contaminated storage and a downstream site. Sampling protocol allowed us 1) to assess both faunistic and functional modifications from the habitat to the station scale and 2) to define the respective impacts upon banks and channel communities. Our results showed that bank samples are more efficient than channel ones to evidence an upstream – downstream gradient, with the contaminated dam clearly outside the general pattern, considering both faunistic and functional information. Considering the habitat scale, we showed that both erosion and sedimentation habitats allowed to evidence the existence of a contaminated site based on the faunistic composition. More surprisingly, it appeared that assemblages found in our storages did not showed particular and specific characteristics compared to stream assemblages.

Ardon, M., Duke University, Durham, USA, marcelo.ardon@duke.edu

Morse, J. L., Duke University, Durham, USA, jlm40@duke.edu

Ahrens, A., Duke University, Durham, USA, angelica.ahrens@gmail.com

Bernhardt, E. S., Duke University, Durham, USA, ebernhar@duke.edu

SALTWATER INTRUSION ALTERS THE COMPOSITION OF DISSOLVED ORGANIC MATTER AND SUPPRESSES DOM EXPORT FROM A COASTAL PLAIN WETLAND

Coastal plain wetlands will be subjected to changes in precipitation and sea level rise, increasing the frequency and duration of saltwater intrusion. Changes in salinity can alter carbon, nitrogen and sulfur cycling in unpredictable ways. Here, we focused on dissolved organic matter (DOM) export, a vital link in carbon cycling in marine and freshwater ecosystems. We examined quantity and composition of DOM export for three years in a large (440 ha) restored wetland in the coastal plain of NC. During the first two years, drought conditions and saltwater intrusion decreased DOM concentrations by 94% (average 27 mg/L DOC, range 5-74 mg/L) and export by 72% (54 kg ha^{-1} y^{-1} in 2008 compared to 194 kg ha^{-1} y^{-1} in 2009). C:N of DOM decreased during periods of high salinity (average 36, range 4-211), while $SUVA_{254}$ values varied with season (average 2.2 L mg C^{-1} m^{-1}, range 0.5-5.1). Hydrologic reconnection as part of wetland restoration facilitated drought-induced saltwater intrusion, leading to changes in DOM composition and decreased DOM export. Our results illustrate an unforeseen consequence of wetland restoration under a changing climate.

Argerich, A., Oregon State University, Corvallis, USA, argerica@geo.oregonstate.edu

Haggerty, R., Oregon State University, Corvallis, USA, haggertr@geo.oregonstate.edu

Christensen, C., Oregon State University, Corvallis, USA, christce@onid.orst.edu

González-Pinzón, R., Oregon State University, Corvallis, USA, gonzaric@geo.oregonstate.edu

VARIATION IN NUTRIENT UPTAKE RELATED TO METABOLICALLY ACTIVE TRANSIENT STORAGE

Quantification of water transient storage zones is critical to understand stream nutrient uptake, but the common method to measure transient storage parameters (based on the use of conservative solutes as hydrologic tracers) does not allow distinguishing among different transient storage compartments that contribute in different proportions to nutrient uptake. We use an alternative experimental approach, the Resazurin (Raz) "smart" tracer, which in combination with a conservative tracer gives the relation between metabolically active transient storage (MATS) versus whole transient storage. Raz is a weakly fluorescent phenoxazine dye that undergoes an irreversible reduction to highly fluorescent Resorufin (hereafter referred as Rru) in the presence of aerobic respiration. We conducted combined injections of Raz, NaCl, NH4, and PO4 in WS01 at H.J. Andrews Experimental Forest, Cascades Range, Oregon, USA. The injection was performed during 3 contrasting environmental conditions (summer, winter, and spring) at a constant flow rate until the reach arrived to plateau conditions (1-5 days). Changes in time in EC, Raz, Rru and nutrient concentrations were examined at 3 surface sampling sites and at 7 wells.

Arismendi, I. D., USGS Forestry Sciences Lab, Corvallis, OR, USA, ivanarismendi@uach.cl

Jara, C., Universidad Austral de Chile, Valdivia, Chile, cjara@uach.cl

Penaluna, B. E., Oregon State University, Corvallis, OR, USA, brooke.penaluna@oregonstate.edu

FACILITATION BY INTRODUCED BEAVER ON NON-NATIVE BROWN TROUT AND THEIR COMBINED EFFECTS IN FRESHWATER SUB-ANTARCTIC ECOSYSTEMS

Few studies are considering interactions between invaders or the combined effects of multiple invaders at the community level. In Tierra del Fuego (southern South America), we studied the interactions between brown trout and North American beaver and the combined effects on macroinvertebrate communities. We compared four different study site types, including beaver ponds with and

without trout, and stream sections (without beavers) with and without trout. We found that beavers modify physical habitat in streams which results in an increase in macroinvertebrate density providing more food availability that facilitates better trout growth and well-being. Trout in streams sections without beaver have significantly lower growth rates and well-being. Also, there is a shift in macroinvertebrate composition from shredder and scraper functional feeding groups in reference stream stretches to gatherer/collectors in beaver ponds. Based on our data, we suggest the existence of additive effects (positive or negative) by the two invaders on gatherer, shredder and scrapper functional feeding groups. Our study shows evidence that similar evolutionary histories among invaders may promote synergistic interactions between them and those interactions has the potential to disrupt ecosystems by amplifying invasions via indirect mechanisms and cause differential effects on natural food webs in the receiving ecosystems.

Armanini, **D**. **G**., Environment Canada @ Canadian Rivers Institute, Department of Biology, University of New Brunswick, Fredericton, Canada, darmanin@unb.ca

Dunbar, M. J., Centre for Ecology and Hydrology, Wallingford, United Kingdom, mdu@ceh.ac.uk

Extence, C. A., Environment Agency, Spalding, United Kingdom, chris.extence@environment-agency.gov.uk

Baird, D. J., Environment Canada @ Canadian Rivers Institute, Department of Biology, University of New Brunswick, Fredericton, Canada, djbaird@unb.ca

LONG-TERM TEMPORAL STABILITY OF FUNCTIONAL TRAITS IN RIVERINE MACROINVERTEBRATES: IMPLICATIONS FOR BIOMONITORING

High species turnover has been identified as a shortcoming of using taxonomic-based methods for river biomonitoring. While the occurrence of individual species at a site is often highly variable between years, due to e.g. local extinction, density fluctuation or rarity, the different species comprising the community may reflect similar biological traits. Due to a dearth of long-term benthic community data, this hypothesis remains largely untested. Here we compare inter-annual variability in the macroinvertebrate community expressed as taxonomic identity and as functional traits. We used data from 200 biomonitoring samples, collected at 10 river sites in the East Midlands (United Kingdom) between 1987 and 2008, a period with considerable interannual flow variation. Dissimilarities in functional composition were consistently lower than for taxonomic entities, suggesting temporal stability in ecosystem function. Multivariate ordination indicated that functional trait turnover was lower than for taxonomic units, and that functional composition had a higher signal-to-noise ratio. Thus traits-based approaches can reduce inter-annual variability and increase the reliability and statistical power of biomonitoring studies.

Arnett, **H**. **A**., University of Maine School of Biology and Ecology/Climate Change Institute, Orono, USA, heather.arnett@umit.maine.edu

Saros, J. E., University of Maine School of Biology and Ecology/Climate Change Institute, Orono, USA, jasmine.saros@umit.maine.edu

Mast, M. A., United States Geological Survey, Denver, USA, mamast@usgs.gov

QUANTIFYING SURFACE WATER NITRATE CONCENTRATIONS THAT ELICIT DIATOM COMMUNITY CHANGES IN LAKES ACROSS THE ROCKY MOUNTAINS

Nitrogen (N) limited alpine lakes have been receiving enhanced atmospheric N deposition over the last century. This increase has elicited dramatic changes in the diatom community structure, but the surface water concentrations of nitrate that cause this shift remain unclear. To better understand this relationship, we developed a diatom calibration set from surface sediment samples in 46 lakes across the U.S. Rocky Mountain Range. Out of the sixteen measured environmental variables, ordination analysis identified nitrate, conductivity, total phosphorus, and temperature as significant environmental variables. A transfer function was developed for nitrate and applied to a suite of sedimentary diatom profiles from lakes across the Rockies. Bootstrapping validation of the model showed strong potential for lakewater nitrate reconstructions over time. The model's predictive power, however, was decreased by the dominant presence of a ubiquitous species causing inaccurate reconstructions compared to past monitoring data. Despite these complications, this model is a first step towards quantifying the strong effects of nitrate on these sensitive systems, as well as the complications in using calibrations sets and the importance of indicator species.

Arnold, **J**. **L**., Yellowstone National Park, Yellowstone Center for Resources, Yellowstone Park, USA, jeff_arnold@nps.gov

Clements, W. H., Department of Fish, Wildlife and Conservation Biology, Colorado State University, Fort Collins, USA, willc@warnercnr.colostate.edu

Koel, T. M., Yellowstone National Park, Yellowstone Center for Resources, Yellowstone Park, USA, todd_koel@nps.gov

Jean, C., Greater Yellowstone Network, Bozeman, USA, cathie_jean@nps.gov

Daley, R., Greater Yellowstone Network, Bozeman, USA, rob_daley@nps.gov

USING A MULTIMETRIC INDEX TO EVALUATE BENTHIC COMMUNITIES IN YELLOWSTONE NATIONAL PARK

We developed a multimetric index that accounted for the effects of geothermal discharges on benthic communities in streams in Yellowstone National Park. These metrics will be useful to assess long-term changes in water quality conditions brought about by climate change and other anthropogenic disturbances such as increased sedimentation from road construction activities and piscicide application for removal of non-native fishes. Piecewise linear regression was used to identify potential threshold relationships between stream conductivity and index values. A model selection technique based on Akaike Information Criteria (AIC) was used to choose the best model from a list of a priori models of increasing complexity. Using the best model identified by AIC analysis, we estimated index values for all stations and compared these to measured values. We were especially interested in the responses from sites that were subject to multiple piscicide (CFT legumine) applications. In general, sites subjected to the application of a piscicide fell outside of the 95% prediction intervals. We will use these indices in the future to monitor recovery of stream health in areas affected by fish restoration activities.

Arnosti, **C**., Department of Marine Sciences, Univ. North Carolina-Chapel Hill, Chapel Hill, USA, arnosti@email.unc.edu

Steen, A. D., Department of Marine Sciences, Univ. North Carolina-Chapel Hill, Chapel Hill, USA, andrew.steen@biology.au.dk

Ziervogel, K., Department of Marine Sciences, Univ. North Carolina-Chapel Hill, Chapel Hill, USA, ziervoge@email.unc.edu

Ghobrial, S., Department of Marine Sciences, Univ. North Carolina-Chapel Hill, Chapel Hill, USA, reef@email.unc.edu

Jeffrey, W. H., Univ. West Florida, Pensacola, USA, wjeffrey@uwf.edu

LATITUDINAL GRADIENTS IN DEGRADATION OF MARINE DISSOLVED ORGANIC CARBON

Degradation of high molecular weight dissolved organic carbon (DOC) in the ocean is initiated by the activities of microbial extracellular enzymes. The structural specificities of these enzymes thus determine which substrates are available for microbial metabolism. Very little is known, however, about the extracellular enzymatic capabilities of marine heterotrophic bacteria, since the vast majority of marine bacteria have not been isolated in culture and most experimental methods currently used provide little information about enzyme structural specificity. We used a suite of 6 fluorescently labeled polysaccharides to measure extracellular enzymatic activities in surface waters at 32 stations spanning a latitudinal gradient from 76°S to 79°N. Our data show that temperate and tropical microbial communities can access a wider spectrum of dissolved organic macromolecules than high-latitude microbial communities. This pattern parallels latitudinal gradients in bacterial species richness, which decrease towards the poles. As changing climate increasingly affects the marine environment, changes in hydrolysis rates and potentially in the spectrum of substrates accessible by microbial communities may lead to major shifts in the location and rate at which marine DOC is respired.

Arscott, **D**. **B**., Stroud Water Research Center, Avondale, USA, darscott@stroudcenter.org

Larned, S., National Institute for Water and Atmospheric Research, Christchurch, New Zealand, s.larned@niwa.co.nz

AQUATIC INVERTEBRATE COMMUNITY STRUCTURE IN FLOODPLAIN PONDS ALONG AN INTERMITTENT-PERENNIAL NEW ZEALAND RIVER

In intermittent/ephemeral rivers floodplain ponds are often an important aquatic refuge during dry periods and support a diverse and distinct array of aquatic invertebrate taxa compared to main channels and other fluvial habitats. Individual ponds along an intermittent river have distinct hydroperiods and hydrological connectivity with the main channel. We quantified the spatial and temporal configuration of pond habitats from a time series of five aerial

photo-runs taken along a 55 km section of the Selwyn River, New Zealand under different flow conditions. A study comparing invertebrate communities in riffles, runs, and floodplain ponds resulted in similar taxon richness among habitat units but distinct communities in ponds compared to riffles and runs. A second study quantified the temporal dynamics (7 dates between October 2006 – February 2008) of invertebrate communities associated with mineral, wood debris, and open water column in 18 ponds and related spatial and temporal variation to hydrological, chemical, and physical factors. Invertebrate community variability among ponds was related to pond hydroperiod and position along the longitudinal continuum. Mineral, organic debris, and water column habitats supported distinct invertebrate communities.

Arsuffi, **T**. **L**., Texas Tech University - Llano River Field Station, Junction, USA, tom.arsuffi@ttu.edu

Dominguez-Brazil, M., Texas Tech University - Llano River Field Station, Junction, USA, Texas Tech University - Llano River Field Station

Thomas, Z., Texas Tech University - Llano River Field Station, Junction, USA,

Strovas, J., Texas Tech University - Llano River Field Station, Junction, USA,

TEXAS TECH UNIVERSITY'S LLANO RIVER FIELD STATION: ENGAGED SCHOLARSHIP & EDUCATION ON WATER & WATERSHEDS USING MULTIPLE APPROACHES, SCALES & STAKEHOLDERS

Llano River Field Station (LRFS) is the largest (> 400 acres) inland field station in Texas located in the vast (30+ counties) biologically diverse Texas Hill Country. Here, we describe multidisciplinary strategic initiatives involving: 1) local, state and national grants (Communities Foundation of Texas, U.S. Department of Education, National Science Foundation), 2) hosting and networking through professional scientific/educational conferences to showcase the station, educational programs, facilities and research opportunities, 3) organizing research and educational symposia (Ecological Society of America, Texas Academy of Science, OBFS), 4) developing innovative partnerships, land and watershed workshops, educational and research efforts (Texas Public Radio, land and watershed stewardship training, state/national parks, local school districts, legislation), 5) participating as a member of scientific, educational, NGO professional organizations and 5) serving on scientific & advisory committees. With Texas more than 85% urban and 97% private property, LRFS use of engaged education to improve academic performance of diverse demographic K-12 students and foster increased interest in science, environmental literacy and ecology for a K-20+ urbanized society serves many interests and stakeholders in areas of watershed and range management in Texas.

Artigas, J., ICRA, Girona, Spain, jartigas@icra.cat

Gómez, N., Institute of Limnology Dr. RA Ringuelet , Florencio Varela, Argentina,

Donato, M. I., Universidad Nacional de Colombia, Bogotá, Colombia,

Giorgi, A., Universidad Nacional de Luján, Luján, Argentina,

Elosegi, A., University of the Basque Country, Bilbao, Spain, arturo.elosegi@ehu.es

Feijóo, C., Universidad Nacional de Luján, Luján, Argentina,

Muñoz, I., University of Barcelona, Barcelona, Spain, imunoz@ub.edu

Rodrigues-Capitulo, A., Institute of Limnology Dr. RA Ringuelet , Florencio Varela, Argentina,

Romaní, A. M., University of Girona, Girona, Spain, anna.romani@udg.edu

Sabater, **S**., ICRA, Girona, Spain, ssabater@icra.cat

GLOBAL PRESSURES, SPECIFIC RESPONSES. THE EFFECT OF NUTRIENT ENRICHMENT IN CONTRASTING STREAMS

The effects of environmental conditions on the response of stream communities to nutrient enrichment were experimentally assessed in three streams of different biomes (a Mediterranean stream in Spain, a Pampean stream in Argentina, and an Andean stream in Colombia). The moderate N and P enrichment produced remarkable biomass increase in bacteria and algae, moderate changes in invertebrates, and none in fish. These trends were consistent among the three systems, but the magnitude and seasonality of the biomass responses were highly site-specific. The Mediterranean stream had a relevant phosphorus limitation and communities showed the highest biomass responses. In this system, limiting light conditions in summer and fluctuant water flow in spring and autumn produced variable responses. The Andean stream had mostly nitrogen limitation and showed intermediate responses, related to the stability of light and temperature. The lowest response to nutrient enrichment was in the Pampean stream, where the high basal nutrient concentration and the food web complexity attenuated the potential effect of nutrient enrichment. The enrichment mostly favoured the increase of grazers in the three systems, evidencing bottom-up regulation. The study evidenced that the response of stream biological communities to the nutrient enrichment depend on ecosystem specificities, mostly the previous nutrient status and the variability in environmental conditions.

Ashkenas, **L**. **R**., Oregon State University, Corvallis, USA, linda.ashkenas@oregonstate.edu

Johnson, S. L., PNW Research Station, US Forest Service, Corvallis, USA, sherrijohnson@fs.fed.us

SPATIAL PATTERNS OF ECOSYSTEM METABOLISM IN FORESTED HEADWATER STREAMS: PRELIMINARY RESULTS FROM THE TRASK WATERSHED STUDY, OREGON

The Trask River Watershed Study in the Oregon Coast Range focuses on quantifying impacts of whole basin forest treatments on small, headwater streams and the extent to which these impacts are transmitted downstream. Streamside forests are dominated by a mixture of coniferous and deciduous vegetation. Sample sites include 11 first-order basins (slopes 5-15%) and 4 downstream, third-order sites (slopes 2-6%). As part of annual pre-treatment baseline data sampling, we measure ecosystem metabolism (gross primary production and ecosystem respiration) using one- and two-station methods. We use salt and propane tracers to estimate re-aeration rates and hydrodynamic variables. We measure standing stocks of auto- and heterotrophs, periphyton chlorophyll A, substrate composition, and riparian shading. All streams were strongly heterotrophic, with GPP ranging from 0.5 – 6.5 mg O2/m2/d and ER 1.5 – 12.5 mg O2/m2/d, for P:R ratios <0.02. We hypothesize that with removal of riparian vegetation during timber harvest in 2012, these systems will show a short-term increase in heterotrophy due to increases in detrital inputs. Subsequently, streams will be dominated by autotrophic processes until riparian shading recovers.

Atkinson, **C**. **L**., Univeristy of Oklahoma, Norman, USA, carlalatkinson@gmail.com

Golladay, S. W., J.W. Jones Ecological Research Center, Newton, USA, steve.golladay@jonesctr.org

First , M. R., Woods Hole Oceanographic Institute, Woods Hole, USA, mfirst@whoi.edu

DIFFERENCES IN WATER COLUMN HETEROTROPHS ATTRIBUTED TO WATER CHEMISTRY ACROSS A GRADIENT OF AGRICULTURAL IMPACTS

Depressional wetlands are a distinctive feature of the southeastern USA. Intermittently inundated wetlands provide important ecosystem services and values such as water quality enhancement, food chain support, and carbon sequestration. Unfortunately, these intermittent depressions have received less protection than other types of wetlands under the Clean Water Act and have been intensively altered by agriculture practices. We investigated differences in water chemistry and heterotroph (bacteria, nanoeukaryotes) community structure between reference wetlands and wetlands impacted by agriculture in the Gulf Coastal Plain of southwestern Georgia. Wetlands were sampled 3 times: February, April, and June 2009. Dry mass, ash-free dry mass, pH, alkalinity, dissolved organic carbon, dissolved inorganic carbon, ammonia, nitrate, and soluble reactive phosphorus were determined for each of the samples. Flow cytometry was used to characterize the heterotroph community. Overall, impacted wetlands had higher numbers of heterotrophs and this pattern was correlated with higher phosphorus, inorganic carbon, and dry mass. Depressional wetlands are an important habitat for southeastern biota, and we hope this information can be applied as an assessment tool for resource managers.

Atwood, **T**. **B**., University of British Columbia, Vancouver, Canada, trishaa@interchange.ubc.ca

Kang, M., University of British Columbia, Vancouver, Canada, kang_misun@hotmail.com

Kominoski, J. S., University of British Columbia, Athens, USA, jkominoski@gmail.com

Richardson, J. S., University of British Columbia, Vancouver, Canada, john.richardson@ubc.ca

INFLUENCES OF LEAF LITTER QUALITY ON ISOTOPIC FRACTIONATION OF CARBON AND NITROGEN BY THE LARVAL STONEFLY, ZAPADA CINCTIPES

The use of literature-based isotopic fractionation and the assumption that fractionation is constant across diets and species, can lead to inaccurate

conclusions about consumer trophic levels and food webs. This study looked at diet-specific variation in isotopic fractionation within a given consumer species. Isotopic fractionation of leaf litter C and N within consumer tissues were quantified and compared for larval stoneflies (Zapada cinctipes) fed either a higher-quality (low C:N) diet of Alnus rubra or a lower-quality (higher C:N) diet of Tsuga heterophylla. The isotopic fractionation for C was lower (~-0.5 ‰) for Z. cinctipes fed T. heterophylla compared to those fed A. rubra (~1 ‰). Conversely, the isotopic fractionation for N was higher in the T. heterophylla diet (~5‰) compared to the A. rubra diet (~2‰). These results suggest that quality of a detritus-based diet can cause variation in isotopic fractionation within a consumer. As a result, dietary constraints on consumer isotopic fractionation should be taken into account when using stable C and N isotopes to determine consumer diets.

Aubeneau, **A**. **F**., Northwestern University, Evanston, USA, aubeneau@gmail.com
Stonedahl, S. H., Northwestern University, Evanston, USA, susacat@gmail.com
Harvey, J. W., U.S. Geological Survey, Reston, USA, jwharvey@usgs.gov
Packman, A. I., Northwestern University, Evanston, USA, a-packman@northwestern.edu

IMPROVED MODELING OF HYPORHEIC EXCHANGE USING CTRW: FIRST APPLICATION TO FIELD DATA.

Hyporheic exchange is crucial for benthic processes. Exchange between flowing surface water and streambed porewater is driven by head gradients over fractal topography. Here, we relate the distribution of flow conditions and topographic features in a Midwestern stream to the observed exchange of a non-reactive tracer. We combined a physically based porewater flow model for the residence time distribution of solutes in the bed with a continuous time random walk (CTRW) framework to predict the in-stream tracer breakthrough curve. The CTRW approach is a generalization of the well known transient storage model (TSM) that does not require a fixed storage area and can account for any residence time distribution in the bed. Here, we compare results from both models for an in-stream tracer experiment. We show that simple measurable inputs (streamflow and bed characteristics) can be used to accurately predict transport processes and hyporheic exchange in streams.

Auber, **A**., INRA, Ecotoxicology and Quality of Aquatic Environments, UMR 985 Ecology and Ecosystem Health, Rennes, France, Arnaud.Auber@rennes.inra.fr
Roucaute, M., INRA, Ecotoxicology and Quality of Aquatic Environments, UMR 985 Ecology and Ecosystem Health, Rennes, France, Marc.Roucaute@rennes.inra.fr
Caquet, T., INRA, Ecotoxicology and Quality of Aquatic Environments, UMR 985 Ecology and Ecosystem Health, Rennes, France, Thierry.Caquet@rennes.inra.fr

USING TRAITS TO CHARACTERIZE THE EFFECTS OF PESTICIDES ON AQUATIC MACROINVERTEBRATES AND TO PREDICT LITTER BREAKDOWN

One of the current challenges in ecological risk assessment is a better understanding and forecasting of the effects of toxicant mixtures on taxonomic and functional attributes of communities and on associated ecological processes. In this study, outdoor pond mesocosms were used to assess the impacts of four realistic pesticide exposure scenarios exhibiting different qualitative (e.g., identity of active ingredient) and quantitative characteristics (e.g., level and frequency of treatment) on macroinvertebrate communities. Treatments induced strong changes in the abundance of taxonomic and feeding groups and a decrease of alder leaf breakdown rate. Application of Principal Response Curve to a subset of biological and ecological traits (extracted from the database of Usseglio-Polatera et al., 2000) showed that the mode of respiration had the highest influence on the response of macroinvertebrates. Negatively affected organisms were gill breathers whereas favoured groups were tegument breathers. In addition to this approach based on literature-derived affinity values for traits, an index combining abundance data and a quantitative measurement of a performance trait (shredding efficiency) proved to be a powerful predictor of leaf breakdown rate.

Auerbach, **D**. **A**., Colorado State University, GDPE, Fort Collins, USA, daa@colostate.edu
Poff, N. L., Colorado State University, GDPE, Fort Collins, USA,
Niemann, J. D., Colorado State University, CEE, Fort Collins, USA,

BIODIVERSITY EFFECTS OF DRAINAGE NETWORK TOPOLOGY

Recent work at the intersection of hydrology, fluvial geomorphology and stream ecology has begun to ask how the scaling properties characteristic of the branching topology of river networks may influence biological processes such as the maintenance of species diversity. River network morphology could serve as a useful landscape-scale predictor of stream ecosystem function because channel configuration directly mediates local environmental factors and helps determine the presence and strength of between-site linkages. Using DEM-derived drainage networks and existing regional survey data to generate topological predictors and ecological responses, I test hypotheses indicating how, for example, the ratio of average path length to maximum path length affects species richness. The results provide insight into how rivers and streams operate at landscape scales, and represent a potentially significant tool for targeting monitoring and protection efforts, especially in low-infrastructure areas where it may be appropriate to supplement critical but resource-intensive ground work with remote-sensed network data. Finally, the nature of these relationships also has important implications for the necessity of managing rivers to maintain regional connectivity.

Austin, **B**. **J**., University of Arkansas, Fayetteville, USA, bjaustin@uark.edu
Jackson, A., University of Arkansas, Fayetteville, USA,
Evans-White, M. A., University of Arkansas, Fayetteville, USA,
Entrekin, S., University of Central Arkansas, Conway, USA,

PERIPHYTON ACROSS A GRADIENT OF NATURAL GAS WELL DENSITY IN HEADWATER STREAMS IN NORTH CENTRAL ARKANSAS

The recovery of natural gas has increased markedly over the past ten years due to technological advances in horizontal drilling and the push for the United States to become energy independent. The process of gas well construction increases the potential for sediment erosion into streams, which could increase turbidity, shade benthic algae, and decrease primary production. Eight streams with varying densities of natural gas wells in their watershed (1.13-12.09 wells/1000 hectares) were sampled to determine whether natural gas wells reduce primary production. Within each stream, two cobbles from three riffles and pools were collected to quantify chlorophyll *a* (chl *a*) abundance, ash-free dry mass (AFDM), ash mass, and autotrophic index in spring and summer 2009. Turbidity increased with well density in the spring (R^2=0.52, p=0.026), but not in the summer. There were no significant correlations between well densities and chl *a* abundance AFDM, ash mass or autotrophic index. Further research examining periphyton biomass and production across seasons and well densities are needed to gain a better understanding of how these processes are affected by well development throughout the year.

Austin, **J**. **A**., U. Minnesota Duluth, Large Lakes Observatory, Duluth, USA, jaustin@d.umn.edu

RESOLVING A PERSISTENT OFFSHORE TEMPERATURE MAXIMUM USING AN AUTONOMOUS UNDERWATER GLIDER

In November 2009, we deployed a Webb Research Autonomous Underwater Glider in western Lake Superior. It continuously occupied a 12-km long cross-shelf section of the Wisconsin shelf for 12 days, making 26 full surveys of the section. The shelf waters were cooling off steadily during this period. We observed a persistent offshore temperature maximum on the order of 0.5C above the coastal or offshore surface temperature. This appears to be due to the competing effects of more rapid cooling in shallow, onshore water, and the mixing of deep cold water into offshore surface waters. While this temperature maximum may not be of fundamental importance in and of itself, it represents a phenomenon that would be difficult to resolve through more familiar sampling schemes, such as shipboard CTD surveys or moored instrumentation.

Auvenshine, **S**. **J**., Michigan State University Fisheries and Wildlife, East Lansing, USA, auvensh4@msu.edu
Kramer, D. B., Michigan State University, James Madison College, East Lansing, USA, dbk@msu.edu
Cheruvelil, K. S., Michigan State University, Lyman Briggs College, East Lansing, USA, spencek1@gmail.com

EFFECTS OF LOCAL ENVIRONMENTAL POLICY ON MICHIGAN'S INLAND LAKE WATER QUALITY

With 11,037 inland lakes, 3,288 miles of Great Lakes shoreline, and 36,000 miles of streams (DEQ 2009), Michigan's aquatic resources require diligent management to preserve and protect both their quality and quantity. Although local governments (county, township, city, village), through their land use planning and zoning, play a large role in determining water quality, few have studied the impacts of local policy on water quality. Therefore, our research

evaluates the impacts of these policies on lake water quality (quantified as remotely sensed and ground-truthed Secchi disk depth) across the state of Michigan using a spatial database (GIS) and statistical models. We evaluated the effectiveness of current local policy strength, while accounting for natural landscape characteristics, on water quality. Our spatial model demonstrates relationships between strong policy implementation and good inland lake water quality within jurisdictions. This model will provide policymakers with an evaluative assessment of their policies, therefore providing an important component of adaptive management.

Ayoub, **L**. **M**., University of South Florida, Tampa, USA, lmayoub@mail.usf.edu
Coble, P. G., University of South Florida, Saint Petersburg, USA, pcoble@marine.usf.edu
Bell, S., University of South Florida, Tampa, USA, sbell@cas.usf.edu

SOURCES OF CDOM TO CORAL REEFS ARE IDENTIFIED: INFORMATION FROM SPECTRAL FLUORESCENCE AND EEMS

High energy, short wavelength radiation (280 - 490 nm) is damaging to corals and other benthic organisms. In aquatic systems, colored dissolved organic matter (CDOM) preferentially absorbs these shorter wavelengths, potentially providing photoprotection for benthic organisms. To characterize sources of CDOM in waters over coral reefs, we measured 3D spectra of CDOM fluorescence (Excitation – Emission Matrix, EEMs) from inshore reefs at incoming and outgoing tide, as well as nearby mangrove and seagrass sites, in the middle and lower Florida Keys. Results were compiled using parallel factor analysis (PARAFAC). Four components were determined: components 1 and 3 were similar to UV humic-like and protein-like peaks, respectively, found in mangrove pore waters and decomposed seagrass. These results provide the first information to link sources of CDOM from coastal vegetation to that found over coral reefs. This connectivity of CDOM from mangrove and seagrass to coral reefs has implications for coastal management.

Bachiller, **E**., Azti Foundation, Pasaia, Spain, ebachiller@azti.es
Fernandes, J., Azti Foundation, Pasaia, Spain, jfernandes@azti.es
Irigoien, X., Azti Foundation, Spain, Spain, xirigoien@azti.es

A COMPARISON BETWEEN DIGITAL CAMERA AND SCANNER AS IMAGING DEVICES FOR SEMI-AUTOMATED ZOOPLANKTON CLASSIFICATION USING MICROSCOPE CLASSIFICATION AS CONTROL

Rapid development of semi-automatic zooplankton counting and classification methods has carried out new chances when defining objectives for plankton distribution studies. Image analysis allows processing many more samples than under microscope classification but with lower taxonomical resolution. The laboratory image capture in this field of research has recently focused in scanning devices. However, there are different image capturing devises such as photographic cameras that can offer alternative utilities. In this study, a comparison between results from images taken by scanner and digital camera is made for two resolutions, while microscope counting results are used as control.

Back, **J**. **A**., Baylor University, Waco, USA, jeff_back@baylor.edu
Taylor, J. M., Baylor University, Waco, USA, jason_taylor1@baylor.edu
King, R. S., Baylor University, Waco, USA, ryan_s_king@baylor.edu

PHOSPHORUS CONTENT IN MAYFLIES: WHY SEX AND ONTOGENY MATTER

The elemental content of organisms changes across their ontogeny. The typical pattern reported for phosphorus is a monotonic decline in phosphorus content with increasing organism size. We investigated the role of size and sex on phosphorus content of mayflies. Mayfly nymphs were collected from seven central Texas streams which represent a nutrient gradient. Nymphs of each mayfly species were sorted into size classes, sexed, and then analyzed to determine phosphorus content for individual nymphs. Three general patterns were evident: 1) small nymphs from nutrient rich sites were enriched in phosphorus compared to nymphs of the same size and species from unenriched sites. 2) mature female nymphs were more phosphorus rich than smaller female nymphs of the same species from the same site. 3) male nymphs were less phosphorus rich than females of the same species and from the same site. Observed patterns were species and sex specific and showed high fidelity within a species across sites. Mayfly phosphorus content is highly dependent upon ontogeny and sex, and both should be explicitly considered in stoichiometric studies.

Bacon, **P**. **A**., University of Arkansas - Department of Biological Sciences, Fayetteville, USA, pbacon@uark.edu
Longing, S. D., University of Arkansas - Arkansas Cooperative Fish and Wildlife Research Unit , Fayetteville, USA, slonging@uark.edu
Dowling, A. P., University of Arkansas - Department of Entomology, Fayetteville, USA, adowling@uark.edu
Huxel, G. R., University of Arkansas - Department of Biological Sciences, Fayetteville, USA, ghuxel@uark.edu

POPULATION STRUCTURE AND DISPERSAL CAPACITY OF HETEROSTERNUTA SULPHURIA (COLEOPTERA: DYTISCIDAE: HYDROPORINAE) IN OZARK STREAMS

Heterosternuta sulphuria is an Ozark-endemic species of concern found along protected margins of small groundwater-dominated streams. A preliminary conservation status (S3 and G3) has been assigned based on new records, yet important information related to dispersal capacity and vulnerability to habitat fragmentation is currently unknown. Current information suggests weak dispersal capacity and extirpation from streams in a region experiencing widespread urbanization. We are currently determining population structures of *H. sulphuria* across 38 sites spanning 10 counties to determine its dispersal capacity and isolation as well as to develop conservation actions for existing populations. Using the mitochondrial cytochrome oxidase I (COI) gene and the less conservative region of the 16S ribosomal RNA sub-unit, population and phylogeographic structure can be evaluated across watersheds in both protected (e.g. wilderness and conservation areas) and unprotected sites. Determining relationships of potential core and fragmented populations with land-use and riparian extents will provide information to support habitat preservation and restoration strategies. Furthermore, the history and succession of geology and associated aquatic environments will be investigated to further elucidate the evolution and contemporary biogeography of *H. sulphuria*.

Bade, **D**. **L**., Kent State University, Kent, USA, dbade@kent.edu

SIGNALS OF AUTUMNAL MIXING EVENTS ASSESSED USING A VERTICAL ARRAY OF SENSORS

One component in the underlying model of diel-oxygen metabolism calculations, the advection or mixing of water and oxygen, is usually ignored. To assess the potential impact of mixing or advection on dynamics of oxygen and other constituents, a vertical array of sondes was placed in East Twin Lake (OH) during the onset of autumnal mixing. East Twin Lake is a small, deep lake (27 ha; 12 m) that stratifies strongly in the summer and is anoxic most of the season below 5-6 m. If mixing is critical to understanding the underlying metabolism model, then large mixing events into the anoxic layer should provide a test of this assumption. Although the oxygen was undersaturated (70 – 80 %) at the surface for the duration of the observations, no large excursions from the biological component of the metabolism model were noted. Besides evidence for mixing based on temperature, a strong signal for mixing could be observed from oxidation – reduction potential (ORP) measured at the surface. Analysis of ORP may aid in determining when important mixing events occur that could influence other biogeochemical processes.

Baer, **N**. **A**., Colby-Sawyer College, New London, USA, nbaer@colby-sawyer.edu
Richardson, D. C., SUNY New Paltz, New Paltz, USA, richardsond@newpaltz.edu
Weathers, K. C., Cary Institute of Ecosystem Studies, Millbrook, USA, weathersk@caryinstitute.org
Ewing, H. A., Bates College, Lewiston, USA, hewing@bates.edu
Roebuck, H. J., Bates College, Lewiston, USA, hroebuck@bates.edu

SEASONAL TRENDS, WATERSHED DRIVERS, AND BIOAVAILABILITY OF DISSOLVED ORGANIC CARBON (DOC) IN TRIBUTARIES OF LAKE SUNAPEE, NEW HAMPSHIRE

Dissolved organic carbon (DOC) can feed aquatic food webs by providing an energetic source for bacteria in small streams, rivers, and lakes. From 2004-2009, water samples for DOC were collected from tributaries to oligotrophic Lake Sunapee, New Hampshire, United States, and we conducted three lab incubations in 2009 to determine bioavailable DOC (BDOC). Mean DOC concentrations from 13 tributaries varied 8-fold, from 2 mg DOC L-1 to 16 mg DOC L-1. Tributary DOC concentrations were positively correlated with the percent of organic soils in each sub-watershed (r2 = 0.44), but were not correlated with any other land cover characteristic. Among six focal sites, the highest DOC concentrations and the

greatest differences across sites occurred in the summer and fall. BDOC ranged from 5% up to 25% over all three experiments, but BDOC concentrations from two summer experiments were less variable when compared to an experiment during peak leaf fall. Temporal and seasonal patterns of DOC fluxes affect DOC inputs to the Lake Sunapee lake food web and may influence the transport of heavy metals from the watershed to the lake.

Bailey, **J**. **L**., J.Bailey Consulting, Whitehorse, Canada, jbailey@northwestel.net
Reynoldson, T. B., Acadia University, Wolfville, Canada, trefor.reynoldson@gmail.com

EVALUATING THE EFFECTS OF DEVELOPMENT ACTIVITIES AND CLIMATE CHANGE ON WETLANDS USING REFERENCE CONDITION APPROACH BIOASSESSMENTS

Wetlands are important components of healthy ecosystems and support a vast array of aquatic, terrestrial and avian biodiversity. There has been much focus to date on the classification of wetland areas, though more recently, there is increased interest in developing techniques to assess the effects of development activities and changing climate on wetlands. As development pressures increase and the effects of climate change become more evident, several resource management agencies and non-government organizations in Yukon, Canada wished to develop sampling and data analysis techniques to assist in assessing the effects of these stressors. Through collaboration among aquatic scientists, botanists and other biologists, we developed a reference condition approach sampling and data analysis protocol that uses invertebrate and vegetation communities as indicator variables and site and landscape scale habitat descriptors. A pilot study to evaluate sampling methods and the development of Reference Condition Approach predictive models for the plant and two invertebrate communities will be undertaken in summer, 2010. This will be followed by developing methods for integrating assessment outputs from three different community assemblages.

Bailey, **R**. **C**., Cape Breton University, Sydney, Canada, robert_bailey@cbu.ca

SIMULATING ECOSYSTEM HEALTH AND SICKNESS: THE ONLY WAY TO KNOW THE TRUTH IS TO MAKE IT UP.

When we assess freshwater ecosystems using benthic invertebrates, we choose sites in the ecosystem, and points within the sites, to characterize the invertebrate community. Judgement about the status of an ecosystem is based on either an absolute measure of health, or more commonly, comparison to a reference condition. Regardless of our sampling effort, we sample rather than census the community and its environment, and thus never know the true state of the ecosystems we assess. I will explore a variety of methods used to simulate (i) making a healthy ecosystem sick (degradation), (ii) making a sick ecosystem healthy (remediation), and (iii) maintaining a healthy ecosystem (conservation). I will then compare the ability of the techniques that have been used for decades to detect change in ecosystems, challenging them with data where we know the truth about the health of the ecosystem.

Baines, **S**. **B**., Stony Brook University, Stony Brook, NY, USA, sbaines@ms.cc.sunysb.edu

ECOSYSTEM EFFECTS OF DISSOLVED ORGANIC SUBSIDIES TO ZEBRA MUSSELS

Through their filter-feeding, zebra mussels have kept phytoplankton biomass in the Hudson River below 20% of values observed prior to the 1991 invasion. Bioenergetic models and ecosystem energy budgets indicate that phytoplankton biomass is currently insufficient to explain the robust growth and reproduction of zebra mussels. Past work has shown that zebra mussels can maintain their weight under a starvation food ration by taking up dissolved organic carbon (DOC) directly. A model of zebra mussel population dynamics in the Hudson River that accounts for yearly variations in phytoplankton abundance, suspended particulate matter and DOC concentrations indicates that without a subsidy of organic matter from the terrestrial environment, zebra mussel populations would have vacillated around a much lower density than currently observed and phytoplankton biomass would be at least double the current value. The subsidy cannot be explained by use of bacteria or terrestrial detritus as food resources, and so likley results from DOC uptake. The ecosystem and community level consequences of direct terrestrial subsidies to consumers needs to be better studied, especially given recent changes in DOC in surface waters.

Baird, **D**. **J**., Environment Canada, Canadian Rivers Institute, University of New Brunswick, Fredericton, Canada, djbaird@unb.ca
Geraci, C. J., National Museum of Natural History, Smithsonian Museum, Washington, USA, geracic@si.edu
Pilgrim, E. M., US Environmental Protection Agency, Cincinnati, USA, Pilgrim.Erik@epamail.epa.gov

BUILDING NATURE'S LIBRARY: A STRATEGY FOR DNA BARCODING THE MACROINVERTEBRATE FAUNA OF NORTH AMERICA - PANEL DISCUSSION (1 OF 2)

DNA barcoding offers unique opportunities to revolutionize our understanding of natural ecosystems through the development of techniques for rapid and accurate identification of biological specimens and samples. However, in order to realize their full transformative potential, it is necessary to formulate a strategy for developing a DNA barcode library of taxonomically-verified specimens which will form the foundation of a new public tool for the rapid identification of unknown material. Our knowledge of the limitations of specimen suitability for DNA extraction, the availability of resources for curation of voucher specimens, and our understanding of the composition and distribution of different faunal groups will form the building blocks of our strategy to achieve this objective. Structured as a panel discussion with contributions from the floor, here we aim to develop a path forward for this initiative through active and participatory engagement with the NABS and ASLO membership. We invite all of you to come and make your voice heard in this exciting new challenge.

Baker, **D**. **M**., SUNY, College of Environmental Science and Forestry, Syracuse, USA, dmbake01@syr.edu
Schulz, K. L., SUNY, College of Environmental Science and Forestry, Syracuse, USA, kschulz@syr.edu
Mitchell, M. J., SUNY, College of Environmental Science and Forestry, Syracuse, USA, mitchell@syr.edu

THE EFFECTS OF CHANGING QUANTITY AND FORM OF NITROGEN LOADING ON THE PHYTOPLANKTON ASSEMBLAGE OF A RECOVERING POLLUTED URBAN LAKE.

As a result of changing fertilizer use and domestic wastewater treatment, worldwide the concentration of ammonium (NH4+) in water bodies has been decreasing while the proportion of both nitrate (NO3-) and urea have been increasing. Changes in the form of nitrogen (N) in an aquatic system can affect phytoplankton assemblages, because phytoplankton species often have markedly different preferences for the various N forms. Improved wastewater treatment has decreased the ratio of NH4+:NO3- in the epilimnion of Onondaga Lake by 90% since 1988. This study examines the effect of this shift in NH4+:NO3- on the phytoplankton community when compared with other changes resulting from decreased nutrient loads, including lower lake concentrations of total nitrogen (TN) and phosphorous (TP) and also a lower N:P. Specifically we describe a long-term analysis (1988-2008) of phytoplankton assemblages in relation to the changing nutrients loads. Additionally, we report on informed laboratory experiments of selected phytoplankton species designed to determine which nutrient variables (NH4+:NO3-, N:P, TN and TP) yield changes in growth and dominance similar to those observed in Onondaga Lake.

Baker, **M**. **A**., Utah State University, Logan, USA, michelle.baker@usu.edu

THE TAO OF ATOM 'Y' – FLUVIAL TRANSPORT AND TRANSFORMATION IN THE 21ST CENTURY

Leopold's odyssey of atom X is an important metaphor underlying much of the recent progress in understanding the transport and transformation of globally important biogeochemicals. In recent decades, a large body of work has documented the important role of headwater streams in retaining nutrients such as N and P during transport from the land to the sea. Atom Y in Leopold's story follows a different path- one that is heavily influenced by anthropogenic activities and one that considers transport through different ecosystems – including engineered ones. Biogeochemicals in the 21st century are under human influence and important connectivities among aquatic ecosystems drive transport and transformations; yet are poorly described and understood. Here I will present data from hydrologically connected streams, lakes and hyporheic zones, focusing on residence times and loss rates. Not only do catchments with more complicated plumbing retain nutrients longer, the impacts of hydrologic connectivities between ecosystems persist for many kilometers, and may be enhanced or disrupted by anthropogenic activity.

Baker, **M**. **E**., UMBC, Baltimore, USA, mbaker@umbc.edu
King, R. S., Baylor Univeristy, Waco, USA, Ryan_S_King@baylor.edu
Kazyak, P. F., Maryland Dept Natural Resources, Annapolis, USA, PKAZYAK@dnr.state.md.us

STRIKINGLY CONSISTENT BIODIVERSITY LOSSES TO WATERSHED IMPERVIOUS COVER ACROSS TAXONOMIC GROUPS REVEALED BY THRESHOLD INDICATOR TAXA ANALYSIS (TITAN)

Rapid loss of stream biodiversity to encroaching urban development is of significant concern world wide, yet efforts to characterize effects of watershed urbanization often rely on aggregate community responses or indices. We used Threshold Indicator Taxa Analysis (TITAN) to decompose community response to impervious cover from more than 1900 watersheds from Maryland, USA. Despite significant effects of watershed physiography and biogeography across invertebrate, fish, amphibian, and reptile samples, we show unprecedented and remarkably consistent patterns of biodiversity loss at levels of imperviousness previously considered benign. The ability to assess taxon-specific responses is critical for linking species loss to individual life-history characteristics and causal mechanisms, and for understanding the behavior of community metrics. Our results highlight the importance of conservation strategies that integrate protection for watersheds currently below impervious surface threshold levels.

Bakker, **E**. **S**., Netherlands Institute of Ecology (NIOO-KNAW), Nieuwersluis, Netherlands, l.bakker@nioo.knaw.nl

MACROPHYTE TRAITS ALONG A TROPHIC GRADIENT: STOICHIOMETRY, ANTI-HERBIVORE DEFENSE AND PALATABILITY

Species of freshwater macrophytes may differ strongly in palatability for aquatic herbivores as shown in feeding trials. Analysis of field exclosure studies shows that the impact of vertebrate herbivores on freshwater macrophyte abundance increases significantly over a trophic gradient. This may be due to a shift in macrophyte species composition towards more palatable species. However, many macrophyte species can occur over a wide range of nutrient conditions which may affect intra-specific macrophyte traits. Environmental nutrient conditions may affect plant stoichiometry and investment in defenses, which in turn may affect plant palatability. In this study, I test the relationship between plant stoichiometry, phenolic concentrations and palatability in freshwater macrophytes both inter- and intraspecifically. Furthermore I determined the range of stoichiometry, phenolic and palatability values for macrophyte species collected from 62 field sites. I found that macrophytes are very plastic and can differ more than ten-fold in nutrient concentration intraspecifically. Finally I related macrophyte stoichiometry and phenolic concentrations to the nutrient concentrations in the environment.

Balint, **M**., Research Institute Senckenberg, Gelnhausen, Germany, balint.miki@gmail.com
Nowak, C., Research Institute Senckenberg, Gelnhausen, Germany, Carsten.Nowak@senckenberg.de
Pauls, S. U., University of Minnesota, Entomology, St Paul, USA, pauls497@umn.edu

QUANTIFYING LOSSES IN GENETIC BIODIVERSITY UNDER DIFFERENT SCENARIOS OF CLIMATE CHANGE

Communities of cold-adapted biota are vulnerable to climate warming. Numerous studies examine effects of climate change on biodiversity in general, but no study has examined such effects on intraspecific genetic diversity. Here we study and compare range-wide genetic data of 9 cold-adapted highland aquatic insects from Europe in combination with species distribution modeling (SDM) to evaluate the effects of projected climatic changes on the genetic structure and diversity of montane aquatic communities. We estimated the potential loss of genetic diversity by quantifying the projected loss of haplotypes in shrinking distribution ranges of each species. Special attention was paid to the loss of diverged haplogroups (>2% sequence divergence), as these may represent cryptic taxa or populations undergoing speciation. The modeled climate scenarios for 2080 suggest that large areas of current distribution ranges will not be suitable, especially in central Europe and the Balkan Peninsula. The SDMs project that climatically suitable areas will completely disappear for 2 species. 7 or 12 of 22 haplogroups from other species will be lost, while an average of 50% and 79% of the observed haplotypes are at risk of extinction under the moderate and worst-case scenario, respectively. Projected suitable habitats will be restricted to patches in higher mountains, and larger areas in the Alps and Fennoscandia. These regions will be key for conservation of European montane aquatic diversity.

Ball, **J**. **E**., University of California Berkeley, Berkeley, USA, jball@berkeley.edu
Cover, M. R., University of California Berkeley, Berkeley, USA, mcover@biology.csustan.edu
Resh, V. H., University of California Berkeley, Berkeley, USA, resh@berkeley.edu

COBBLE-DWELLING MACROINVERTEBRATES AS INDICATORS OF SEDIMENTATION

A variety of interacting environmental attributes influence the composition and abundance of stream communities, making it difficult to identify the ecological effects of individual factors. We addressed this problem by using a microhabitat sampling approach to isolate the effects of sedimentation on macroinvertebrates beneath 66 individual cobbles in Walker Creek (Klamath National Forest, Northern California). We tested whether increased cobble embeddedness was associated with changes in macroinvertebrate metrics and taxonomic composition. Linear regression analyses indicated that several metrics had a significant negative relationship with cobble embeddedness, including taxa richness, % EPT individuals, % collector-filterers, and % scrapers. The only metric that significantly increased with increasing embeddedness was % burrowing taxa. The mayflies Baetis and Epeorus were the only taxa that exhibited a negative relationship with embeddedness. By focusing on a microhabitat scale, where biotic responses to sedimentation are the least complicated by other factors, our study identified several sediment-sensitive indicators. The development of biological indicators that specifically represent a loss of refuge underneath cobbles is particularly significant, because this habitat is also important for salmonid spawning and juvenile rearing.

Balthasar, **A**. **R**., Trent University, Peterborough, Canada, rbalthasar@gmail.com
Xenopoulos, M. A., Trent University, Peterborough, Canada,
Spooner, D. E., Trent University, Peterborough, Canada,
Evans, R. D., Trent University, Peterborough, Canada,

CONCENTRATION AND ISOTOPE RATIOS OF ZINC IN STREAMS ALONG A GRADIENT OF AGRICULTURAL LAND USE.

Recent advances in mass spectrometry have improved our ability to trace contaminants in the environment and foodwebs via isotopic ratios of metals. As an example, zinc isotopic ratios have been used to track contaminants derived from mining practices, but less is known about how fertilizers and pesticides can affect metal ratios and fractionation in the environment and organisms. We used high precision MC-ICP-MS to quantify Zn concentration and isotope ratios in 12 streams along a gradient of agricultural land-use in southern Ontario. We also measured the potential accumulation and isotope ratio variation in freshwater mussels (Family: Unionoida). Preliminary analyses show that water column zinc is variable across sites compared to other metals (cadmium and chromium); and some metals where correlated to particular land use characteristics. For example, water concentrations of molybdenum ranged from 0.02 µg/L to 0.16 µg/L with increasing monoculture. Since streams have high seasonal variability, we plan to use mussel tissue as a long-term indicator of metal concentrations. The study will contribute to understanding how land use influences metal leaching rates from soils into streams and how agriculture practices may be affecting water quality. In addition, the techniques used in this project will also contribute to understanding how metal accumulation in aquatic organisms may be facilitated by nutrient loading and landscape changes associated with agriculture.

Banas, **N**. **S**., Univ of Washington Applied Physics Laboratory, Seattle, USA, neil@apl.washington.edu

ADDING RICH TROPHIC INTERACTIONS TO A SIZE-SPECTRAL PLANKTON MODEL: DIVERSITY PATTERNS AND PREDICTABILITY

A variety of recent models have suggested ways to incorporate phytoplankton diversity into biogeochemical ocean models, either through allometric/size-spectral or optimization/natural selection-based methods. Still, grazing has generally been represented very simply in these models. This study adds complex, realistic variation in grazer prey preferences to a simple size-spectral nutrient-phytoplankton-zooplankton (NPZ) model with 40 size classes, to explore the effect of complex top-down controls on ecosystem structure and function. Diverse prey preferences of two types are considered: first, a smooth, empirical, finite-width allometric pattern, representing an idealization of taxa-based preferences; and second, a variant which adds intense, stochastic noise to that pattern, representing species-specific interactions. In both cases, as nutrient supply is varied, a parabolic relationship between diversity and biomass appears. When a smooth seasonal cycle of nutrient supply is imposed, chaotic trophic interactions add factor-of-two variation in biomass from year to year. Thus

in contrast to existing models which, by allowing for phytoplankton diversity, produce ecosystems which smoothly optimize themselves to local nutrient and light conditions, allowing for zooplankton grazing diversity appears to interfere with bottom-up predictive controls.

Bang, **H.**, Seoul National University, Seoul, Republic Of Korea, ramza21@snu.ac.kr
Yan, G., Seoul National University, Seoul, China, yange@snu.ac.kr
Kim, G., Seoul National University, Seoul, Republic Of Korea, gkim@snu.ac.kr

DESORPTION OF PHOSPHORUS FROM MARINE SEDIMENTS BY ENHANCED SILICATE LEVELS IN SUBTERRANEAN ESTUARIES: IMPLICATIONS FOR GLOBAL PHOSPHORUS CYCLING

It is well known that desorption of phosphorus from marine sediments occurs owing to enhanced silicate concentrations following spring diatom blooms. We hypothesize that such desorption processes can occur in subterranean estuaries since silicate concentrations in groundwater are generally much higher than those in seawater. We evaluated the magnitude of phosphorus desorption by monitoring the changes of phosphate concentrations in seeping brackish groundwater in response to the changes of silicate concentrations in feeding groundwater using a sediment column in the laboratory. The concentrations of phosphate increased sharply as silicate concentrations increased, although there was no appreciable phosphate increase in control experiments. From this sediment column, we observed 2.5-fold increase in phosphate concentrations as silicate concentrations are doubled up (~ 200 μM). We found that this desorption was almost completed within about 5 days, which accounts for about 5% of the labile phosphorus in the sediment column. Our study suggests that submarine groundwater discharge can convey a significant amount of phosphorus to the ocean through this desorption process, in addition to direct inputs from terrestrial sources.

Barker, **R. E.**, University of Dayton, Dayton, USA, barkerre@notes.udayton.edu
Benbow, M. E., University of Dayton, Dayton, USA, benbowme@notes.udayton.edu
McEwan, R. W., University of Dayton, Dayton, USA, ryan.mcewan@notes.udayton.edu
Blair, T. B., University of Dayton, Dayton, USA, blairtb@notes.udayton.edu

LINKAGES BETWEEN TERRESTRIAL AND AQUATIC COMMUNITIES: THE INVASIVE SHRUB LONICERA MAACKII INFLUENCES LEAF BREAKDOWN RATES AND MACROINVERTEBRATE COLONIZATION

Lonicera maackii , a dominant invasive shrub in riparian zones may have significant impacts on the structure and function of aquatic systems. We investigated linkages between this terrestrial invader and the function and macroinvertebrate richness of the aquatic system via a leaf-pack breakdown experiment including invasive, native and mixed leaf packs. We assessed leaf loss and macroinvertebrate colonization over 43 days in two streams. Leaf breakdown rates for the invasive was up to one order of magnitude faster than other treatments, but depended on stream. Chironomidae were the dominant colonizers of invasive leaves in contrast to other leaf packs. By day 7 gathering-collector densities were greater in invasive compared to other treatments. Shredders were dominant by days 14 and 43, and in higher densities within the invasive compared to native and mixed leaf treatments by day 43. These preliminary results demonstrate *L. maackii* leaves significantly break-down more rapidly compared to native leaves but also affect macroinvertebrate densities and functional feeding group colonization, supporting the hypothesis that *L. maackii* can have direct impact on stream biological communities mediated through organic matter resources.

Barnes, **R. T.**, US Geological Survey, Boulder, USA, becca.barnes@gmail.com
Smith, R. L., US Geological Survey, Boulder, USA, rlsmith@usgs.gov
Aiken, G. R., US Geological Survey, Boulder, USA, graiken@usgs.gov

DENITRIFICATION AND DOM REACTIVITY: A COMPARISON BETWEEN EXPERIMENTAL AND MODELING RESULTS

Dissolved organic matter (DOM) dominates the material and energy fluxes within aquatic ecosystems, fueling the majority of microbial processes, including those that regulate in-stream nitrogen constituents. Sources and in situ transformations determine DOM's chemical nature and lability within aquatic systems. The relationship between DOM composition, nitrogen cycling, and nitrogen-loads was investigated in the Boulder Creek watershed. Located in the Colorado Front Range, Boulder Creek spans an ecosystem gradient from the alpine to the plains and receives excess atmospheric nitrogen deposition. Short-term laboratory incubations were conducted to assess denitrification potential and bulk sediment respiration across this ecosystem gradient. Results strongly suggest that the quality of available DOM is an important control on denitrification, thereby regulating the in-stream nitrogen cycle within Boulder Creek. Furthermore, spectral properties of DOM (absorbance and fluorescence) can be utilized to improve process predictions. In light of these results we constructed mass balance and stream transport models to assess the amount of nitrogen lost throughout the year to in-stream processes and compared these results to predictions based on experimental data.

Barnum, **T. R.**, Odum School of Ecology, University of Georgia, Athens, USA, barnutr@uga.edu
Pringle, C. M., Odum School of Ecology, University of Georgia, Athens, USA,
Kilham, S. S., Department of Biosciences and Biotechnology, Drexel University, Philadelphia, USA,
Lips, K. R., Department of Biology, University of Maryland, Baltimore, USA,
Colón-Gaud, C., Institute for Tropical Ecosystem Studies, University of Puerto Rico, Carbondale, USA,
Frauendorf, T. C., Department of Zoology and Center for Ecology, Southern Illinois Univeristy, Carbondale, USA,
Whiles, M. R., Department of Zoology and Center for Ecology, Southern Illinois Univeristy, Carbondale, USA,

STRUCTURE OF AN ALGAL-BASED FOOD WEB IN A NEOTROPICAL STREAM BEFORE AND AFTER AMPHIBIAN EXTIRPATION

The consequences of amphibian declines could be significant in Neotropical streams where tadpoles are important components of stream ecosystem structure and function. We examined the effects of tadpole extirpations on the topology of an algal-based food web characteristic of stream pools in a headwater Panamanian stream. Topological food webs are composed of nodes representing taxa and links representing who-eats-whom. Links in our food web were identified through gut content analysis of two grazing tadpole species (*Lithobates warszewitschii* and *Hyloscirtus colymba*) and the ten most abundant insect taxa. We then developed topological webs illustrating food web linkages for pre- and post- extirpation conditions and estimated a connectance value for each food web. The connectance value decreased from 0.084 pre-extirpation to 0.050 post-extirpation. We attribute the decrease to the loss of 29 linkages between tadpoles and other taxa in the community, including the loss of linkages to large-bodied diatom taxa (e.g., *Terpsinoe musica*). Furthermore, grazing insects do not consume larger-bodied diatoms, suggesting they are not functionally redundant with grazing tadpoles with respect to their consumptive effects on algal communities.

Barron, **M. G.**, U.S. EPA, Gulf Breeze, USA, barron.mace@epa.gov
Courtney, L. A., U.S. EPA, Gulf Breeze, USA, courtney.lee@epa.gov
Marcovich, D., U.S. EPA, Gulf Breeze, USA, marcovich.dragoslav@epa.gov
McGill, C., U.S. EPA, Gulf Breeze, USA, mcgill.cheryl@epa.gov
Kell, S., FL DEP, Pensacola, USA, sarah.kell@dep.state.fl.us

RELATIONSHIP BETWEEN SHORT TERM BLEACHING MEASURES AND LONGER TERM GROWTH IN EXPERIMENTALLY BLEACHED MONTASTREA FAVEOLATA

Species in the genus Montastrea are dominant scleractinian corals on Caribbean reefs that have been shown to bleach during exposure to elevated temperature and solar radiation. We investigated the sensitivity and responses of M. faveolata specimens to elevated temperature and solar radiation, both individually and in combination. Measures of coral bleaching, including photosystem II yield, and changes in pigment concentrations and zooxanthellae density were monitored prior to experimental stress, following 5 or 18 days of temperature and solar radiation exposures, and following 69 or 109 days recovery under culture conditions. Growth was assessed during experimental bleaching and recovery using two dimensional photogrammetry. Significant growth reductions were observed after elevated temperature and solar radiation treatments that were significantly correlated with bleaching endpoints. Longer-term growth trends were not consistently associated with alterations in photosystem II yield, pigment concentrations, or zooxanthellae density. These results indicate that bleaching events cause transient reductions in coral growth but have variable impacts on longer term growth of scleractinian corals.

Barry, **C**. **D**., Queens University Belfast, Belfast, United Kingdom, c.barry@qub.ac.uk

Anderson, N. J., Loughborough University, Loughborough, United Kingdom, N.J.Anderson@lboro.ac.uk

CATCHMENT AND CLIMATE CONTROLS ON PCO_2 IN SW GREENLAND LAKES

In SW Greenland oligo-trophic lakes occupy ≈ 15% of the landscape. Variable effective precipitation results in conductivity and dissolved organic carbon (DOC) gradients (10-150mg L^{-1}), but the region is characterised by fresh lakes overall. We measured pCO_2 & O_2 in 15 lakes along a DOC gradient and deployed dissolved oxygen sondes in one fresh and one oligo-saline lake. No relationship existed between DOC and pCO_2. Oligo-saline lakes were weakly oversaturated with CO_2 throughout the year, while several fresh lakes shifted to undersaturation during the ice-free season. Excluding a sole humic lake, lakes were always oversaturated with O_2. Net Ecosystem Production estimates for the ice-free season were positive for the fresh and oligo-saline lake (250 & 80mg m^{-2} day^{-1} respectively). Results suggest that gross primary production exceeds respiration in clear-water lakes in this region and that the large pools of DOC present are highly refractory. The observation that many lakes are probably autotrophic coupled with high rates of organic carbon burial (≈ 5g m^{-2} yr^{-1}) implies these lakes are important sites of carbon sequestration at the landscape scale.

Bartsch, **L**. **A**., USGS, La Crosse, USA, lbartsch@usgs.gov

Klein, S. J., University of Minnesota Duluth, Duluth, USA, klein328@d.umn.edu

Franz, J. L., Winona State University, Winona, USA, jfranz@winona.edu

Knights, B. C., USGS, La Crosse, USA, bknights@usgs.gov

Houser, J. H., USGS, La Crosse, USA, jhouser@usgs.gov

Decker, J. K., Fordham University, Armonk, USA, jismith@fordham.edu

Richardson, W. B., USGS, La Crosse, USA, wrichardson@usgs.gov

NITROGEN FIXATION, IT'S NOT JUST FOR NITROGEN POOR SYSTEMS: SPATIAL AND TEMPORAL PATTERNS OF N-FIXATION IN THE UPPER MISSISSIPPI RIVER (UMR)

Nitrogen distribution within the UMR is both spatially and temporally heterogeneous. Sites with high hydrological connectivity to the river's main channel have higher late summer dissolved inorganic nitrogen (DIN), while less connected sites have lower DIN and low nitrogen to phosphorus (N:P) ratios. Biweekly acetylene reduction assays, were conducted at 6 sites, from May to September, 2008, to determine the temporal and spatial extent of N-fixation. In late July, the least connected site had N-fixation rates tenfold higher than observed in the main channel. The onset of fixation coincided with declining N:P ratios and a cyanobacteria bloom, primarily *Aphanizomenon flos-aquae* or *Aphanocapsa sp*. The site with the highest N-fixation rates also exhibited the lightest ^{15}N signatures in seston and fish indicating that atmospherically derived nitrogen may be an important N source. N-fixation was an early spring and late-summer phenomenon, when DIN and N:P ratio are low favoring the cyanobacteria bloom. Ironically, a reach of the UMR that transports ≈ 80,000 tons of nitrogen per year can exhibit nitrogen limitation favoring autotrophs capable of N-fixation.

Bartsch, **M**. **R**., U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, USA, mbartsch@usgs.gov

Richardson, W. B., U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, USA, wrichardson@usgs.gov

Bartsch, L. A., U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, USA, lbartsch@usgs.gov

Vallazza, J. M., U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, USA, jvallazza@usgs.gov

Moraska Lafrancois, B. M., National Park Service, St. Croix Watershed Research Station, Marine on St. Croix, USA, brenda_moraska_lafrancois@nps.gov

EFFECTS OF FOOD QUALITY ON JUVENILE UNIONID MUSSEL SURVIVAL AND GROWTH IN THE ST. CROIX NATIONAL SCENIC RIVERWAY

Recent increases in nutrient and sediment loading have caused observable shifts in algal composition and have potentially altered the quality of mussel food in the St. Croix National Scenic Riverway. Juvenile *Lampsilis cardium* and *L. siliquoidea* were deployed in cages for 28 d at four riverine and four lacustrine sites. Mussel tissue and food resources (seston fractions: whole water, <63, <32 and <10 µm and surficial sediment) were analyzed for total lipids (TL) and quantitative fatty acid (FA) composition. Riverine sites were dominated by Chlorophyta, whereas Cyanophyta generally dominated lacustrine sites. Overall mussel survival was 95% and mean growth rates for both species were higher at riverine (3 and 23 µm/d) than lacustrine sites (-10 and 6 µm/d) for *L. cardium* and *L. siliquiodea*, respectively. Total lipids were similar between mussel species and sites (averaged 10.5 ± 1.1%); however, seston TL ranged from 5.6 to 11.0% at riverine and 11.7 to 14.3% at lacustrine sites. Sediment TL averaged 0.031% at riverine and 0.047% at lacustrine sites. Mussel growth may be more dependent on dietary FA quality than quantity.

Bastien, **J**., Environnement Illimite Inc, Montreal, Canada, julie.bastien@envill.com

Demarty, M., Environnement Illimite Inc, Montreal, Canada, maud.demarty@envill.com

Tremblay, A., Hydro-Quebec, Montreal, Canada, tremblay.alain@hydro.qc.ca

GHG FLUXES (CO2, CH4, N2O) AND PCO2 MONITORING BEFORE AND DURING THE FIRST FOUR YEARS AFTER FLOODING OF THE EASTMAIN-1 RESERVOIR (QUEBEC, CANADA)

The recent flooding (November 2005) of Eastmain-1 (EM-1) reservoir is currently being monitored within a joint study (Hydro-Québec, Université du Québec à Montréal, McGill University, Environnement Illimité inc.). The main goal is to determine the GHG fluxes from various terrestrial and aquatic environments before and after flooding in order to establish the impacts, in terms of net GHG emissions, of creating reservoirs in northern environments. The results of GHG (CO2, CH4 and N2O) fluxes and dissolved gases measurement campaigns carried out during the open-water period and under-ice in this newly created reservoir are presented, and compared to those obtained in the natural aquatic environments present before flooding. CO2 fluxes measured in the EM-1 reservoir increased rapidly the first year after impoundment (2006) to reach values between 4 to 10 times higher, respectively, than those measured in the aquatic environments before flooding. EM-1 CO2 fluxes decreased from 2006 to 2008 and are comparable to values of natural lakes 3 years after flooding. CH4 fluxes have returned to natural values 2 years after flooding. N2O fluxes did not vary significantly between the pre- and post-flooding period.

Batta-Lona, **P**. **G**., University of Connecticut, Groton, USA, paola.batta_lona@uconn.edu

O'Neill, R., University of Connecticut, Storrs, USA, rachel.oneill@uconn.edu

Obergfell, C., University of Connecticut, Storrs, USA, craig.o@uconn.edu

Bucklin, A., University of Connecticut, Groton, USA, ann.bucklin@uconn.edu

MOLECULAR INDICATORS OF ADAPTATION IN A CHANGING ANTARCTIC ENVIRONMENT: TRANSCRIPTOMICS OF THE SOUTHERN OCEAN SALP, *SALPA THOMPSONI*.

Genomic-scale analysis of emerging model organisms will allow examination of important biological questions using species for which little genetic or genomic information is available. Next-generation sequencing can be effectively used for gene discovery in such cases. The Southern Ocean *Salpa thompsoni* is subject to severe environmental (temperature) and biological conditions (food availability, energetic constraints, timing of reproduction), as well as the marked seasonal variability and long-term climate change. There is an urgent need to understand the potential for Salps to adapt to climate change, yet few molecular resources are available for this species or its close relatives. An ongoing study is using 454 pyrosequencing of the salp genome to identify genes associated with key biochemical and physiological processes that underly adaptation to environmental conditions. S.thompsoni was collected during a January 2009 cruise of the Japanese research vessel Umitaka-Maru in the Pacific sector of the Southern Ocean. 454 sequencing runs of genomic DNA generated 38,740 contigs, which were assembled and annotated by gene ontology to sort genes by molecular function, biological process, and cellular component. To facilitate genomic studies in pelagic tunicates and other non-model marine systems, we describe methods for transcriptome sequencing, as well as strategies for assembling a useful catalog of genes for ecological and environmental studies of S. thompsoni.

Battin, **T**. **J**., University of Vienna, Vienna, Austria, tom.battin@unviie.ac.at
Hödl, I., University of Vienna, Vienna, Austria,
Augspurger, C., University of Vienna, Vienna, ,
Wörman, A., The Royal Institute of Technology, Stockholm, Sweden,
Taherzadeh, D., TU München, München, Germany,
SInger, G., University of Vienna, Vienna, Austria,
Besemer, K., University of Vienna, Vienna, Austria,

TOWARDS AN ORDERLY LIFE IN A TURBULENT WORLD

Biofilms dominate microbial life in most streams and rivers. Single microbes, initially suspended in the water column, can attach to surfaces where they form microcolonies and ultimately produce an extracellular matrix — the major scaffold of the biofilm. Both structure and function of biofilms are influenced by hydrodynamics, and vice versa, biofilms can shape their hydrodynamic environment. In this talk, I will discuss examples showing how the flow environment may control the transition of single cells to multicellularity. First, I will show how primary cells, depending on the hydrodynamic environment, cluster immediately after their adhesion to a surface — a phenomenon that may be advantageous in harsh environments, such as streams. Next, based on two experimental approaches, I will show how the interplay between hydrodynamics and biofilm surface topography may influence the dispersal of microbial cells and their colonization of native biofilms. Detailed understanding of the biophysical mechanisms underlying an orderly life in streams and rivers is essential to advance our knowledge on microbial biodiversity and ecosystem functioning.

Bauer, **B**., University of Potsdam, Potdam, Germany, bauerb@uni-potsdam.de
Gaedke, U., University of Potsdam, Potsdam, Germany, gaedke@uni-potsdam.de
Vos, M., University of Potsdam, Potsdam, Germany, mattvos@uni-potsdam.de

DIVERSITY INFLUENCES ECOSYSTEM FUNCTION THROUGH SYNCHRONIZATION AND COMPENSATORY DYNAMICS

Diversity is thought to stabilize ecosystem function by promoting compensatory dynamics where increases in some species' biomass makes up for decreases in others. Compensation is thought to arise when a sufficient number of functionally different species coexist and compete with each other. Therefore, discerning the effects of species richness from those of functional diversity is an important challenge. We addressed it by extending a previously described two-trophic-level plankton model. We varied species diversity and functional differences between species. Our aim was the exploration of the conditions for compensation and synchronization among predator and prey species which affect the biodiversity-ecosystem function relationship. At low species numbers we encountered compensatory dynamics even at low functional diversity. Increasing species numbers increases their trophic similarity. This enhances the chance of synchrony by causing the predators' biomasses to track the oscillations of increasingly similar sets of prey species. Overall, we found that different ranges of species diversity have contrasting effects on the reliability of ecosystem function by inducing either synchronization, compensatory dynamics or stasis.

Baxter, **A**. **M**., Kent State University, Department of Biological Sciences, Kent, OH, USA, lyss222@yahoo.com
Johnson, L. T., Indiana University- Bloomington, School of Public and Evironmental Affairs, Bloomington, IN, USA, latjohn@indiana.edu
Edgerton, J. M., Kent State University, Department of Biological Sciences, Kent, OH, USA, jedgerto@kent.edu
Leff, L. G., Kent State University, Department of Biological Sciences, Kent, OH, USA, lleff@kent.edu
Royer, T. V., Indiana University- Bloomington, School of Public and Environmental Affairs, Bloomington, IN, USA, troyer@indiana.edu

RELATING PATTERNS IN BIOTIC, CHEMICAL AND PHYSICAL VARIABLES TO DENITRIFICATION IN AGRICULTURAL AND FORESTED STREAMS IN INDIANA AND OHIO

Land use is a key factor determining conditions in streams. In particular, application of fertilizers leads to excess nitrogen in affected waterways; the microbial process of denitrification can remove this N. This study examined how bacterial abundance, denitrification rates, algal biomass, and benthic invertebrates vary longitudinally in agricultural and mixed-use streams, and how observed patterns correlate with physical and chemical factors, such as nutrient and DOC concentrations. Three streams from intensive agricultural areas and three with mixed land uses in Indiana and Ohio were sampled under base flow in summer and fall (2009). Denitrification rates (using acetylene block method) varied greatly with surrounding land use and season, ranging from 1 to 14575 µg N/m2/h. Similar variation was found in chemical factors such as nitrate concentration, which ranged from 0.03 to 6.30 mg/L, and community factors such as bacterial abundance (using DAPI staining) which ranged from 1.6 x 106 to 6.95 x 107 cells/g DM. Intra-stream variation was lower than inter-stream, and although agricultural impacts explained many patterns, in some cases denitrification rates were lower than predicted based on environmental conditions.

Beakes, **M**. **P**., University of California, Santa Cruz, Santa Cruz, USA, michael.beakes@noaa.gov
Cois, C., University of California, Santa Cruz, Santa Cruz, USA, cristinakicks@gmail.com
Retford, N., University of California, Santa Cruz, Santa Cruz, USA, nretford@gmail.com
Twardochleb, L. A., University of California, Santa Cruz, Santa Cruz, USA, lauratwardochleb@yahoo.com
Moore, J. W., University of California, Santa Cruz, Santa Cruz, USA, jwmoore@biology.ucsc.edu

INCIPIENT IMPACTS OF WILDFIRE ON A CALIFORNIA STREAM

The frequency and severity of wildfire in North America has increased substantially in recent years, with relatively poorly understood impacts on aquatic systems. Here we examine the incipient impacts of a wildfire that burned forty percent of the Scott Creek watershed in coastal California, August 2009. With extensive pre-fire data from study sites in both burned and unburned regions we are provided a "natural experiment" to investigate wildfire impacts on stream ecosystem processes and imperiled salmonids. We examined the short-term impacts of fire on abiotic conditions such as stream temperature, ecosystem processes such as algal accrual and leaf litter breakdown, and aquatic and riparian community dynamics. While fire did impact some of these response variables (e.g., stream temperature, terrestrial in-fall), other potential responses (e.g., trout population numbers) appeared resilient to this disturbance. Heavy winter rain may exacerbate the disturbance from wildfire. Given ongoing global change, it is increasingly imperative to understand how large-scale perturbations alter stream ecosystem and community dynamics.

Beaulieu, **J**. **J**., US EPA, Cincinnati, USA, beaulieu.jake@epa.gov
Rebholz, J., Thomas More College, Crestview Hills, USA, rebholz.jacob@epa.gov
Shuster, W. D., US EPA, Cincinnati, USA, shuster.william@epa.gov

NITROUS OXIDE PRODUCTION AND EVASION FROM THE MARKLAND POOL OF THE OHIO RIVER

We measured the production and evasion of nitrous oxide (N_2O), a potent greenhouse gas, from the Markland pool of the Ohio River near Cincinnati, OH. Emission rates measured biweekly at one site for a year were seasonally variable with the highest rates occurring during late summer and lowest during winter (4–34 &microg N_2O-N/m^2/h). Pool-wide surveys conducted during the summers of 2008 and 2009 showed the entire 150 km length of the pool to be a source of N_2O with the highest emission rate (630 &microg N_2O-N/m^2/h) occurring immediately downstream of Cincinnati. Sediments were a source of N_2O and production rates were positively correlated with sediment organic matter content. The water column produced N_2O at 5 of 11 sampling sites and the highest production rates were associated with effluent from the city's waste water treatment plant (WWTP). The water column, sediments, and WWTP effluent accounted for ≈20%, 10%, and 5% of the N_2O evading from the pool during the late summer with the balance likely originating from tributaries, groundwater inputs, other point sources, and biogeochemical hotspots.

Beaver, **J**. **R**., BSA Environmental Services, Inc., Beachwood OH, USA, j.beaver@bsaenv.com

Blasius-Wert, B. J., U.S. Bureau of Reclamation, Boulder City NV, USA, BBlasius@usbr.gov

Kirsch, J. E., U.S. Bureau of Reclamation, Boulder City NV, USA, JKirsch@usbr.gov

Hickman, G. J., U.S. Bureau of Reclamation, Boulder City NV, USA, GHickman@usbr.gov

Teacher, C. E., BSA Environmental Services, Inc., Beachwood OH, USA, c.teacher@bsaenv.com

Rosati, T. C., BSA Environmental Services, Inc., Beachwood OH, USA, t.rosati@bsaenv.com

Scotese, K. C., BSA Environmental Services, Inc., Beachwood OH, USA, k.scotese@bsaenv.com

PHYTOPLANKTON AND ZOOPLANKTON COMMUNITIES OF RESERVOIRS OF THE COLORADO RIVER: IMPACTS OF DREISSENID MUSSELS AND DROUGHT

Reservoirs of the Colorado River have experienced drought conditions since 2000 and the introduction of invasive quagga mussels ca.¬¬ 2004. Habitat partitioning and the thermal regime of Lake Mead result in spatial separation of populations of Daphnia and quagga mussels. Quagga mussel veligers were most numerous in open water areas with maximum depth, greater clarity, low chlorophyll a concentrations and abundant hard structures for adult mussel attachment. Daphnia were most numerous in shallower areas strongly influenced by nutrient inputs, with decreased clarity, high chlorophyll a concentrations and more sediment. Daphnia populations continue to increase in mid to late winter and early spring prior to the spawning of gamefish populations and rapidly decrease with increasing predation pressure, water temperature and cyanobacteria populations. Phytoplankton biovolume has decreased in all basins of Lake Mead since 2007. In the Colorado River and Overton Arm, August peak biovolume has shifted from diatom dominance to an increase in Pyrrophyta and Chrysophyta. Cyanophyta and specifically Microcystis aeruginosa biovolumes have increased in 10 of 12 sampling locations. On-going plankton studies from other systems less impacted by dreissenid mussels (Rocky Mountain National Park area, Lake Powell, Lake Havasu) will be discussed.

Bechtold, **H**. **A**., Idaho State University, Pocatello, USA, bechheat@isu.edu

Baxter, C. V., Idaho State University, Pocatello, USA, baxtcold@isu.edu

Marcarelli, A. M., Michigan Technological University, Houghton, USA, ammarcar@mtu.edu

Inouye, R. S., National Science Foundation, Arlington, USA, inourich@isu.edu

ARE NUTRIENT LOADING EFFECTS ON STREAM NUTRIENT PROCESSING DRIVEN BY SHIFTS IN BIOFILM COMMUNITY DYNAMICS?

Stream biofilm community composition may be influenced by nutrient stoichiometry, and in turn, may affect the storage, processing and export of nutrients. We experimentally tested the responses of autotroph and heterotroph components of biofilm communities to nutrient concentrations by adding variable amounts of nitrogen (NO3-, 0.8 –490 µg/L-N), phosphorus (PO4-3, 1.2-35 µg/L-P) and/or dissolved organic carbon (DOC-glucose, 1.2 –7.1 mg/L), in replicated laboratory mesocosms. We hypothesized that increased DOC concentrations would shift biofilm composition toward heterotrophs, and that decreased DOC relative to NO3- or PO4-3 concentrations would increase the relative dominance of autotrophs. Biofilm chlorophyll a concentrations did not respond to DOC or PO4-3 addition, but increased with NO3- addition, which suggested an increase in the N-limited algal assemblage. In contrast to our expectation, fungal ergosterol concentrations decreased with DOC addition, and did not respond to NO3- or PO4-3. Shifts in heterotroph compared to autotroph dominance in response to resource availability suggest that biofilm community interactions may be an important mechanism controlling nutrient uptake. Understanding these complex interactions may help explain patterns of accumulation and downstream export of nutrients.

Becker, **J**. **C**., Texas State University - San Marcos, San Marcos, TX, USA, jcbecker@txstate.edu

Nowlin, W. H., Texas State University - San Marcos, San Marcos, TX, USA, whnowlin@txstate.edu

Rodibaugh, K. J., Texas State University - San Marcos, San Marcos, TX, USA, kr1209@txstate.edu

Labay, B. J., Texas State University - San Marcos, San Marcos, TX, USA, benlabay@gmail.com

SPATIAL PATTERNS OF NUTRIENT CONCENTRATION AND ECOSYSTEM FUNCTION IN A WESTERN GULF SLOPE RIVER SYSTEM

Riverine ecosystems are a critical link between terrestrial landscapes and the world's oceans. Landscape development often occurs without an understanding of the impact on riverine systems, and the ecological integrity and function of many river systems is increasingly threatened. Here we present the results of a study examining the relationship between patterns of land use, nutrient concentrations, and ecosystem function in the Brazos River, TX, USA. Aquatic nutrient and ecosystem function data was collected three times at 37 sites from March 2008 - February 2009 in the central and lower Brazos River watershed. Sites were located across a mix of main-stem river, small tributaries, and four large sub-watersheds. GIS techniques were used to assess land-use/land-cover parameters in the watershed and tributary sub-basins. Dissolved organic carbon concentrations generally increased longitudinally upstream in larger sub-watersheds, while total nitrogen and total phosphorous were more closely related to percent urban and agricultural land use in watersheds. Understanding the spatial patterns and scaling of nutrient dynamics and ecosystem function is an important component in improving our ability to manage and restore large river systems.

Beebe, **K**. **M**., University of Alabama, Tuscaloosa, USA, kmbeebe@crimson.ua.edu

Findlay, R. H., University of Alabama, Tuscaloosa, USA, rfindlay@as.ua.edu

SEASONAL DYNAMICS OF THE SEDIMENT MICROBIAL COMMUNITY IN WEEKS BAY, ALABAMA

To determine the seasonal variation in estuarine microbial communities we collected sediments from Weeks Bay, Alabama over a 13-month period. Water column temperature, dissolved oxygen, salinity and turbidity were measured and surface sediments collected. Total microbial biomass, phytoplankton biomass and community structure were determined by phospholipid phosphate, chlorophyll and phospholipid fatty acid analyses, respectively. Temperatures ranged from 31°C to 16°C (summer to winter). Salinity showed the same trend with winter minimums (0.2-4 ppm) and summer maximums (16.5 ppm). Reduced dissolved O_2 concentrations in bottom water (2-45% saturation) indicated water column stratification during summer. Total benthic microbial and algal biomass showed no significant differences among sites or months. However, microbial community structure varied with greater relative abundance of aerobic bacteria and eukaryotic algae during cold-water months and greater relative abundance of sulfate-reducing bacteria during warm-water months when salinities were higher and the water column tended to stratify. Weeks Bay offers unique opportunities to study a small estuary hydrologically connected to Mobile Bay and our efforts in determining seasonal variation in benthic microbial communities should aid in the management of both watersheds.

Beganyi, **S**. **R**., University of Georgia Entomology, Athens, USA, Sbeganyi@uga.edu

Batzer, D. P., University of Georgia Entomology, Athens, USA, Dbatzer@uga.edu

EFFECTS OF WILDFIRE ON THE COMMUNITY COMPOSITION AND TOTAL MERCURY CONCENTRATIONS OF AQUATIC MACROINVERTEBRATES IN THE OKEFENOKEE SWAMP

Fire is an important disturbance in the Okefenokee Swamp. From April –June 2007, wildfire burned through most (75%) of the wetland area. With the existence of extensive pre-fire data sets on community structure and total mercury of invertebrates, the fire presented an opportunity to rigorously assess impacts of wildfire on invertebrates from the Okefenokee. Post-fire collection of samples occurred in September, December, and May, 2007–2009. Sample sites included 13 burned and 8 non-burned (reference) sites. Comparisons of data among pre-fire, post-fire reference, and post-fire burned sites permitted assessment of wildfire effects on the community composition of invertebrates and total mercury of select organisms (amphipods, crayfish, odonates, mosquitofish). NMS ordinations and ANOSIM tests suggested that habitat was an important factor; communities in burned cypress differed from reference

cypress, and certain indicator organisms (*Sigara*, *Ischnura*, and *Oecetis*) were driving that change. Unexpectedly, mercury concentrations in odonates and crayfish declined in burned sites, with variation again being greatest in cypress stands. Results suggest that impacts of fire on invertebrates are significant and may be most pronounced in cypress stands of the Okefenokee.

Behn, **K**. **E**., University of Wyoming, Laramie, USA, kbehn@uwyo.edu
Kennedy, T. A., United States Geological Survey, Flagstaff, USA, tkennedy@usgs.gov
Hall, R. O., University of Wyoming, Laramie, USA, bhall@uwyo.edu

FLUCTUATING FLOWS IN A LARGE, REGULATED RIVER MAY REDUCE PRODUCTION IN BACKWATER HABITATS

Backwaters (stagnant flow in the lee of return-current channel sand bars) of the Colorado River in Grand Canyon may be critical rearing habitat for juvenile native fishes because high quality food resources (algae and invertebrates) are abundant there. We compared food resource measures between backwaters and sandy main-channel habitats across four seasons and two flow regimes (daily fluctuations from hydropeaking, and steady discharge intended to stabilize near-shore rearing habitats). Additionally, we compared backwater water residence time between the flow regimes. Benthic organic matter and chlorophyll were higher in backwaters than the main-channel, however gross primary production and water column resources were similar between habitats. Invertebrate biomass in backwaters was higher than sandy main-channel habitats but lower than productive cobble habitats. All resource measures were unaffected by flow regime. Backwater water residence time was higher during steady discharge relative to daily fluctuations (~10 hours vs. ~3 hours). Backwaters may retain transported organic matter from the main-channel, and steady discharge likely promotes retention by increasing residence time. However, tributary-derived sediment/turbidity during our steady discharge sampling may have offset these effects.

Beisel, **J**. **N**., Univ Metz - LIEBE Lab., Metz, France, beisel@univ-metz.fr
Sornom, P., Univ Metz - LIEBE Lab., Metz, France, pascal.sornom@umail.univ-metz.fr

THE IMPORTANCE AND USEFULNESS OF BEHAVIOURAL TRAITS IN BASIC AND APPLIED ECOLOGICAL STUDIES

We reviewed the importance of behavioural traits both in basic and applied freshwater ecology. Their usefulness is particularly demonstrated in gammarid studies thanks to the major advantages of this taxonomic group. The consequences of behavioural characteristics and their potential modifications can be reported at different organisation scales. From predator-prey to host-parasite relationships, we illustrate how behavioural traits influence the individual fitness and ecological processes. For example, the use of refuges, the activity level of organisms, the swimming speed or the aggregation with congeners have rarely been regarded together as a mean to reduce predation risk in macroinvertebrates. We observed that a selective pressure by predators may have shaped the evolution of trade off in gammarids between refuge use, aggregation and displacement abilities. Behavioural traits can rapidly be shaped by natural selection because they evolve at faster rates than morphological life history traits. In bioassessment method, a growing number of studies have used behavioural responses as tools for ecotoxicity testing and water quality monitoring. The development of such tests is of interest because in addition to being sensitive, fast, simple to perform, cheap, and non-invasive, they also could allow to link toxic effects obtained at biochemical/cellular levels to impacts observed on populations and communities.

Beisner, **B**. **E**., University of Quebec at Montreal, Montreal, Canada, beisner.beatrix@uqam.ca
Cantin, A., University of Quebec at Montreal, Montreal, Canada, ariane28@hotmail.com
Gunn, J. M., Laurentian University, Sudbury, Canada, jgunn@laurentian.ca
Prairie, Y. T., University of Quebec at Montreal, Montreal, Canada, prairie.yves@uqam.ca
Winter, J. G., Ontario Ministry of the Environment , Montreal, Canada, Jennifer.Winter@ontario.ca

DIFFERENTIAL EFFECTS OF THERMOCLINE DEEPENING AND MIXING ON LAKE PLANKTON COMMUNITIES

Lake thermocline depth is expected to change under climate change with repercussions for the spatial distribution and composition of plankton communities. However, responses of the plankton to thermocline depth has not been investigated at the whole-basin scale and in the absence of mixing. We mixed one basin of a lake, lowering its thermocline. In a second basin, the thermocline was lowered without mixing, while a third basin served as a control. The vertical distribution and composition of plankton were monitored. Greater chlorophyll occurred with thermocline deepening, attributable to increases in the spectral groups: chlorophytes, cryptophyes and browns, while mainly chlorophytes increased with turbulent mixing. Total chlorophyll declined at very deep thermoclines because of light limitation. Zooplankton biomass was unaffected by thermocline depth, but turbulent mixing homogenized their distributions. In the unmixed basins their biomass concentrated around the thermocline, irrespective of depth. Zooplankton composition was most affected by mixing, which strongly favoured taxa commonly found in turbulent environments. Overall, phytoplankton communities responded more to the thermal structure of their habitat, while zooplankton responded more to the level of turbulence present.

Bekchonova, **M**., Urgench State University, Urgench, Uzbekistan, marhabo84@inbox.ru
Mullabaev, N., Institute of Water Problems, Uzbekistan Academy of Sciences, Tashkent, Uzbekistan, nodirbek76@mail.ru
Chandra, S., University of Nevada Reno, Reno, USA, sudeep@cabnr.unr.edu
Shermetova, D., Urgench State University, Urgench, Uzbekistan, dianasher@yahoo.com
Ginatullina, E., Institute of Water Problems, Uzbekistan Academy of Sciences, Tashkent, Uzbekistan, e-ginatullina@yandex.ru
Shanafield, M., Desert Research Institute, Reno, USA, mshanafield@yahoo.com
Saito, L., University of Nevada Reno, Reno, USA, lsaito@cabnr.unr.edu
Fayzieva, D., Institute of Water Problems, Uzbekistan Academy of Sciences, Tashkent, Uzbekistan, dfayzieva@gmail.com
Lamers, J., ZEF-UNESCO German-Uzbek Khorezm Project, Urgench, Uzbekistan, j.lamers@zef.uzpak.uz

FISH COMMUNITIES IN SHALLOW LAKES IN KHOREZM, UZBEKISTAN

The Uzbekistan fishery has been affected by water use for the cotton monoculture, The loss of the Aral Sea fishery has made it difficult to provide people with fish products of high quality in Uzbekistan. To develop new fisheries and satisfy the fish consumption demand of the Uzbek population, we studied small lakes in Uzbekistan that contain agricultural drainage and collector water for their potential for aquaculture. We investigated catch, diet, age, and body condition of Cypriniformes in 4 lakes of Khorezm Region from 2006-2008 because they are fish that are likely to survive in the ecosystems of Khorezm. We found 15 species of Cypriniformes in the four lakes, including crucian carp (Carassius auratius gibelio), European carp (Cyprinus carpio), and bream (Abramis brama orientalis) of ages 1 to 4. Rapid growth occurred for age classes 1 to 2, and was slower for other ages. Age and growth were also found to depend on body condition of fish, and biotic and abiotic factors in the lakes. Crucian carp and European carp were considered to be dominant Cypriniformes species.

Beketov, **M**. **A**., UFZ - Helmholtz Centre for Environmental Research, Leipzig, Germany, mikhail.beketov@ufz.de

MACROECOLOGICAL LESSONS FROM SIBERIAN MAYFLIES – THE RAPOPORT EFFECT AND WHY SPECIES WITH WIDER ALTITUDINAL RANGES HAVE NARROWER GEOGRAPHICAL DISTRIBUTION?

Three hypotheses were tested: (i) patterns of cross-Eurasian longitudinal distribution of lotic mayflies are determined by species' ecological requirements and the presence of the West Siberian Lowland (WSL), (ii) the Rapoport effect is valid for the altitudinal distribution of mayflies over the large-scale river continuum, and (iii) the observed Rapoport effect is based on high nestedness of the meta-assemblage, implying the presence of a common species pool and species-thinned nested subsets. The results showed that (i) for most of the East Palaearctic (but not Transpalaearctic) species WSL can be an environmental barrier preventing their westward dispersal and therefore precluding mixing of the East and West Palaearctic rheophilic faunas. (ii) The Rapoport effect was demonstrated: species altitudinal ranges expanded with increase in the ranges' midpoints and average per-altitude ranges increased with increase in altitude and concurrent decrease in species richness. (iii) Nestedness analysis revealed that the observed Rapoport effect is based on nested organization: a common species pool at low (but not the lowest) altitudes and nested subsets of this pool at higher altitudes.

Bell, **T**. **A**., INSTAAR - University of Colorado, Boulder, USA, Tisza.Bell@colorado.edu
McKnight, D. M., INSTAAR - University of Colorado, Boulder, USA, diane.mcknight@colorado.edu
Heathcote, A., Iowa State University, Ames, USA, aheathco@iastate.edu

A SHIFT IN DIATOM COMPOSITION DUE TO INCREASED WEATHERING AND NITROGEN DEPOSITION

Green Lake 4 is an oligotrophic alpine lake that is part of the Niwot Ridge Long Term Ecolocial Research (LTER) site in Colorado. Nitrogen has been shown to be increasing in alpine lake systems of the Rocky Mountain Front Range due to atmospheric deposition, doubling in some cases over a twenty-year period. Additionally, warming events associated with climate change have also been shown to introduce other nutrients into the system through chemical weathering. Many Rocky Mountain alpine lakes similar in productivity and elevation to Green Lake 4 have shown a recent shift in diatom species as a result of these nutrient additions. As a result, diatom species associated with oligotrophic systems are being replaced with more common species that are tolerant of higher nutrient concentrations. Data from a sediment core supports that Green Lake 4, like other high alpine Rocky Mountain lakes, has undergone a diatom species shift due nutrient increases associated with atmospheric deposition, climate change, and chemical weathering processes.

Bell, **T**. **A**., INSTAAR - University of Colorado, Boulder, USA, Tisza.Bell@colorado.edu
McKnight, D. M., INSTAAR - University of Colorado, Boulder, USA, diane.mcknight@colorado.edu
Heathcote, A., Iowa State University, Ames, USA, aheathco@iastate.edu

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Bellmore, **J**. **R**., Idaho State University, Pocatello, USA, belljame@isu.edu
Baxter, C. V., Idaho State University, Pocatello, USA, baxtcold@isu.edu

A PRODUCTION BUDGET ANALYSIS OF FLOODPLAIN RESTORATION POTENTIAL IN THE SALMON RIVER BASIN, IDAHO

In the Pacific Northwest, river-floodplain segments have been targeted for habitat restoration efforts, partly because they are considered to provide an elevated food base for rearing anadromous fishes. In this study, we assessed the potential for floodplain restoration to fuel salmon recovery in a dredge-mined river-floodplain segment in the Yankee Fork Salmon River (Idaho), via a multi-trophic level assessment of the food base that supports rearing fish. By comparing the dredged segment to five reference-condition floodplain segments we found that the dredged segment had comparable levels of aquatic primary producers (chl-a), allochthonous inputs, and aquatic invertebrate production to reference segments. Comparing these measures of food base production to the food demand of the fish assemblage, we found no evidence that fish are food limited in the dredged or reference segments. Thus, we found no evidence that floodplain restoration would fuel recovery of anadromous fish populations by increasing food. This study illustrates how ecosystem approaches can be used to evaluate the potential success of alternative recovery strategies utilized in the management of endangered populations.

Benbow, **M**. **E**., University of Dayton, Dayton, USA, benbowme@notes.udayton.edu
Gorbach, K. R., University of Dayton, Dayton, USA, jenninkr@notes.udayton.edu
Shoda, M. E., University of Dayton, Dayton, , megan.shoda@gmail.com
Vonderhaar, D., University of Dayton, Dayton, USA, doug.vonderhaar@gmail.com
Burky, A. J., University of Dayton, Dayton, USA, Albert.Burky@notes.udayton.edu

THE IMPORTANCE OF HABITAT SELECTION FOR BIOMONITORING OF HAWAIIAN STREAM ECOSYSTEMS

The mountain streams of Hawaii are home to many endemic and several introduced and invasive insect species. These streams also have extreme ranges in size, gradient, hydrology and permanence, providing a diversity of habitats that change dramatically within the life span of most species, and respond to changes in watershed condition, including flow management. The objectives of this study were to understand differential native and non-native responses to stream flow withdrawal among four watersheds of Maui. Non-native Trichoptera (*Cheumatopsyche analis* and *Hydroptila potosina*) have become dominant (> 95% by density) and ubiquitous in Hawaiian stream riffle habitats compared to native species often restricted to cascades and splash zone habitats. Introduced Trichoptera response to changes in stream flow is often variable, scale dependent and unique to individual watersheds. Native insect assemblages (e.g., *Telmatogeton* sp. and *Procanace* sp.) recolonize cascade habitat quickly after natural spates but are significantly impacted by long-term anthropogenic water removal. Native species are most often found in habitats rarely studied for Hawaiian insect ecology and watershed management, but provide an innovative opportunity for stream biomonitoring and assessment development.

Bencala, **K**. **E**., USGS, Menlo Park, CA, USA, kbencala@usgs.gov
Kimball, B. A., USGS, West Valley City, CA, USA, bkimball@usgs.gov
Gooseff, M. N., Pennsylvania State University, University Park, PA, USA, mgooseff@engr.psu.edu

CHALLENGES IN THINKING FROM TRANSIENT STORAGE AND HYPORHEIC FLOW TO STREAM-CATCHMENT CONNECTIONS

Although surface- and ground-water are increasingly talked about as 'one resource', there remains environmental and ecosystem need to study the 10-100m reach scale as 'one hydrologic system'. Streams gain and lose water over a range of spatial and temporal scales. Large scales (kilometers) have traditionally been recognized and studied as river-aquifer connections. Over the last 25 years hyporheic (1 - 10m) exchange flows have been studied extensively. Often a Transient Storage Model (TSM) has been used to quantify the physical solute transport setting in which biogeochemical processes occur. At longer 10 -100m scales, the interpretation of seemingly straightforward questions about water, contaminant, and nutrient fluxes into and along a stream can be confounded by flow losses which are too small to be apparent in stream gauging and along flow paths too long to be detected in tracer experiments. Extending the simple exchange concept of the TSM presents challenges in determining field estimates of solute residence time and water source connectivity in the catchment, as well as the stream-catchment water balance.

Benjamin, **J**. **R**., Idaho State University, Pocatello, USA, benjjose@isu.edu
Baxter, C. V., Idaho State University, Pocatello, USA, baxtcold@isu.edu
Fausch, K. D., Colorado State University, Fort Collins, USA, kurtf@warnercnr.colostate.edu
Lepori, F., Université Claude Bernard – Lyon 1, Villeurbanne, France, FABIO.LEPORI@adm.univ-lyon1.fr

REPLACEMENT OF A NATIVE BY NONNATIVE SALMONID: CHANGES IN TROUT PRODUCTION AND CONSQUENCES FOR STREAM-RIPARIAN FOOD WEBS

Nonnative brook trout are replacing native cutthroat trout throughout western North America. We assessed how this replacement might affect trout production and stream-riparian food webs via a combination of comparative and experimental studies. Through a comparison of ten paired streams, we found brook trout exhibited 2.5 times greater production than cutthroat trout they replace. We observed similar patterns via analysis of existing data across the west. In a comparative study of twenty paired streams, those invaded by brook trout had a 24% lower flux of emerging insects, but only 3% fewer riparian spiders, which rely on emerging insects as prey, compared to streams with cutthroat trout. Similarly, in a large-scale experiment, brook trout reduced the flux of emerging insects by 58%. However, we did not observe an overall effect of

brook trout on benthic insects, periphyton, or riparian spiders. In these studies, the strength of the multi-trophic effects varied between or within streams. We argue that life history of the insect prey and spatio-temporal context may mediate the effects of brook trout on stream-riparian food webs.

Benke, **A. C.**, University of Alabama, Tuscaloosa, AL, USA, abenke@as.ua.edu
Whiles, M. R., Southern Illinois University, Carbondale, IL, , mwhiles@zoology.siu.edu

LIFE TABLES VS. SECONDARY PRODUCTION ANALYSES - RELATIONSHIPS AND USAGE IN ECOLOGY

The life table is a well-known conceptual and analytical approach for understanding populations. Animal secondary production is a process associated with the concept of energy flow. We illustrate the relatedness of these approaches using a pond-breeding salamander and show that secondary production not only incorporates age- or stage-specific survivorship as in life tables, but also age- or stage-specific biomass growth rates. Production measures of success (biomass turnover rates and flows) have been used to address many ecological questions, just as life table measures (R_0, r, and lambda), sufficient to dispel the notion that production is solely an ecosystem concept. Examination of Web-of-Science abstracts over 12 years demonstrated there were 78% more papers using life tables (698) than secondary production (393) overall, but 50% more papers using secondary production (353) than life tables (236) in basic research. Production was primarily studied in aquatic environments (98%) and life tables in terrestrial environments (65%). These findings suggest that broader recognition of secondary production as a conceptual/analytical approach is warranted and may help bridge the divide between aquatic and terrestrial ecologists.

Benoy, **G.**, Env Cda and Agric & Agri-Food Cda, Fredericton, Canada, glenn.benoy@ec.gc.ca
Culp, J., Env Cda and Cdn Rivers Institute @ U New Brunswick, Fredericton, Canada, joseph.culp@ec.gc.ca
Chambers, P., Env Cda, Burlington, Canada, patricia.chambers@ec.gc.ca
Chow, T. L., Agric & Agri-Food Cda, Fredericton, Canada, lien.chow@agr.gc.ca
Sutherland, A., Env Cda and Cdn Rivers Institute @ U New Brunswick, Fredericton, Canada,
Krishnappan, B., Env Cda, Burlington, Canada,

SOURCE, FATE AND EFFECTS OF SEDIMENTS IN STREAMS THAT DRAIN AGRICULTURAL WATERSHEDS

Elevated sediment loads in streams can impair ecological functions, degrade aquatic habitats and alter aquatic communities. Potato production regions of Maritime Canada are prone to severe soil erosion due to rolling topography, high intensity rainstorms and the practice of conventional tillage. The objectives of this research were to 1) characterize streambed environments across a gradient of agricultural intensity, and 2) ascertain sediment sources. Geomorphological assessments in two series of watersheds showed a progressive "fining" of the streambed environment across the gradient. Physical thresholds for deposited sediments were developed and validated using biotic assessments. Change-point analysis of benthic macroinvertebrate indices and metrics indicated that physical thresholds were protective of good ecological condition. To ascertain sources, deposited sediments were cross-referenced with soils from cultivated fields, forests and riparian floodplains using radioisotopes. Cs-137 levels revealed that the sources of material to the bedded environment included a mix of cultivated soils, eroded riparian soils and resuspended deposited sediments. This research contributes to larger integrated watershed management initiatives to understand the impacts of sediments and contaminants on riverine and estuarine habitats and aquatic communities.

Benstead, **J. P.**, University of Alabama, Tuscaloosa, USA, jbenstead@bama.ua.edu
Heffernan, J. B., Florida International University, Miami, USA, jheffer@fiu.edu
Olafsson, J. S., Institute of Freshwater Fisheries, Reykjavik, Iceland, jsol@veidimal.is
Huryn, A. D., University of Alabama, Tuscaloosa, USA, huryn@bama.ua.edu

SPRING-FED STREAMS AS MODEL ECOSYSTEMS FOR TESTING ECOLOGICAL THEORY AND GLOBAL CHANGE PREDICTIONS: INTRODUCTION TO A SPECIAL SESSION

Spring-fed streams represent unique natural laboratories because of their thermal, hydrologic and chemical stability, and because of the absence of contributions (in terms of biota and organic material) from upstream surface waters. These attributes together offer significant advantages to ecological studies by allowing isolation of important drivers of ecosystem-level processes. Moreover, a considerable diversity of spring types is found on Earth, from cold subterranean seeps to hot springs. A global richness of thermal regime, chemical composition and discharge is reflected in the distinctive biota typical of spring-fed systems. The stability and isolation (energetically and biotically) of individual springs, diversity of spring types across landscapes, and distinctive communities together make spring-fed ecosystems increasingly relevant and useful for empirical tests of ecological theory, as well as for predictions of future global change. To introduce this special session, we illustrate the use of springs as powerful model systems with examples from diverse spring-fed ecosystems, ranging from low-temperature Arctic springs, to subtropical cave systems and warm geothermal springs in Iceland.

Bergdale, A., US EPA, Region 3, Wheeling, WV, USA, bergdale.amy@epa.gov
Rodriguez, N., US EPA, Region 3, Philadelphia, PA, USA, rodriguez.norman@epa.gov
Schofield, K., US EPA, ORD, Washington, DC, USA, schofield.kate@epa.gov
Pollard, A. I., US EPA, ORD, Washington, DC, USA, pollard.amina@epa.gov
Alexander, **L. C.**, US EPA, ORD, Washington, DC, USA, alexander.laurie@epa.gov

POTENTIAL EFFECTS OF NATURAL GAS DRILLING: A CASE STUDY OF THE MARCELLUS SHALE

We present a hydraulic fracturing conceptual diagram (HFCD) of the activities and stressors associated with natural gas development, emphasizing the Marcellus Shale, an organically-rich rock formation covering 246,00 square kilometers in the northeastern United States. The conceptual diagram is a visual representation of the extraction process, and illustrates hypothesized relationships between this activity, the stressors it creates, and the biotic responses of aquatic ecosystems to those stressors. We explore disposal options for hydraulic fracturing wastes characterized by high concentrations of total dissolved solids (TDS), chloride, metals, and radionuclides, and present a preliminary analysis of the risks to aquatic life. The HFCD allows for a more thorough understanding of the potential environmental impacts and risks associated with hydraulic fracturing within the Marcellus Shale, and can be used to frame assessments of management alternatives to address the protection of human health and the biological-physical-chemical integrity of our waters.

Berger, **S. A.**, University of Bergen, Bergen, Norway, Stella.Berger@bio.uib.no
Diehl, S., Umeå University, Umeå, Sweden, sebastian.diehl@emg.umu.se
Bauchrowitz, F., University of Munich (LMU), Munich, Germany, f.bauchrowitz@bgc-muenchen.de
Weiss, P., University of Munich (LMU), Munich, Germany, Padmal@web.de
Stibor, H., University of Munich (LMU), Munich, Germany, Stibor@zi.biologie.uni-muenchen.de

EXPERIMENTAL WARMING CAN CAUSE A REGIME SHIFT IN SPRING SUCCESSION OF FRESHWATER PLANKTON

Global warming may lead to accelerated spring events and even to regime shifts in lake plankton. Since direct temperature effects on one food web component will indirectly affect other components, we manipulated independently the influence of temperature and zooplankton trophic structure on the spring succession in a mesocosm experiment. Phytoplankton responded immediately to warmer (+3.6° C) temperatures and grew more than three times faster than in 'ambient' treatments. In the 'warm' treatments ciliate and Daphnia populations peaked earlier, but no clearwater phase occurred, instead phytoplankton biomass increased throughout the entire experiment to extreme concentrations > 250 µg chl a L-1 accompanied by extreme seston carbon to phosphorus ratios exceeding

molar values of >1800. When Daphnia were the only predator in 'warm' treatments they were unable to establish a larger population in spite of very abundant food, indicating poor food quality. This shows that a few centigrades in crease in late winter/early spring could produce completely divergent seasonal dynamics of the plankton – providing experimental support for the hypothesis that global warming may lead to regime shifts.

Berkeley, **C. L.**, University of North Carolina - Greensboro, Greensboro, USA, clberkel@uncg.edu
O'Brien, W. J., University of North Carolina - Greensboro, Greensboro, USA,
Hershey, A. E., University of North Carolina - Greensboro, Greensboro, USA, aehershe@uncg.edu

POTENTIAL ROLE OF METHANE-DERIVED CARBON AS A FOOD SOURCE FOR DAPHNIA IN A NORTH CAROLINA RESERVOIR

Herbivorous zooplankton feed on seston, including algal, detrital, and bacterial components. However, many studies have found that Daphnia del 13C is lighter than seston del 13C, and selective feeding on seston algal components has been hypothesized. We hypothesized that low zooplankton del 13C is due to utilization of methane-derived carbon (MDC) obtained through ingestion of methanotrophic bacteria. We conducted an experiment to assess utilization of MDC as a possible mechanism of depleted Daphnia del 13C. At high methane concentration, methane del 13C was lighter than at low concentrations, indicating isotopic fractionation by methanotrophs. At low methane concentration, Daphnia del 13C was slightly enriched compared to seston, but was very depleted compared to seston at high methane concentration, consistent with incorporation of MDC. An antibiotic appeared to limit methanotrophs in the water column resulting in enriched Daphnia del 13C. Our study provides strong evidence that ingestion of methanotrophic bacteria resulted in depleted Daphnia del 13C relative to seston. We suggest that this phenomenon is widespread in freshwater ecosystems, explaining the consistently light del 13C of grazing zooplankton relative to bulk seston.

Bernhardt, **E. S.**, Duke University, Durham, USA, emily.bernhardt@duke.edu
Colman, B. P., Duke University, Durham, USA, bpc8@duke.edu
Arnaout, C., Duke University, Durham, USA, Christina.arnaout@duke.edu
Gunsch, C., Duke Univeristy, Durham, USA, claudia.gunsch@duke.edu
McGill, B., Duke University, Durham, USA, bonnie.mcgill@duke.edu
Richardson, C., Duke University, Durham, USA, curtr@duke.edu
Wright, J. P., Duke University, Durham, USA, jw67@duke.edu
Yin, L., Duke University, Durham, USA, lyyin@163.com

NANOMATERIALS IN THE ENVIRONMENT: THE EFFECT OF REALISTIC SILVER NANOPARTICLE EXPOSURES ON WETLAND ECOSYSTEM DYNAMICS

Silver nanoparticles are increasingly being incorporated into consumer products and water treatment membranes for their antimicrobial properties – and recent risk assessment scenarios suggest that a significant fraction of these ENPs will enter the environment through biosolid disposal. We examined the ecological effects of silver ENPs by comparing plant, microbial and biogeochemical dynamics between wetland mesocosms that received no treatment (True Control), were amended with biosolids (Biosolid Control), amended with biosolids containing 10nm nanosilver (Nanosilver Treatment), or biosolids amended with ionic Ag (Positive Control). Biosolids were added at rates recommended by the US EPA. In both silver treatments, Ag was added to increase biosolid Ag content by 57 &microg/g. We found a significant reduction in plant productivity and alterations in microbial composition and soil enzyme activities as a result of realistic nanosilver exposures. We compare these results to a series of laboratory high dose exposure experiments for which we measured similar plant responses but were unable to detect microbial responses.

Bertani, **I.**, University of Parma, Parma, Italy, isabella.bertani@nemo.unipr.it
Anzalone, M. T., University of Parma, Parma, Italy,
Rossetti, G., University of Parma, Parma, Italy,
Ferrari, I., University of Parma, Parma, Italy,

LIFE IN THE FAST LANE: WHAT IS REGULATING THE ZOOPLANKTON COMMUNITY IN THE PO RIVER (NORTHERN ITALY)?

The major driving forces involved in regulating zooplankton abundance and composition in the potamal reach of the Po River are investigated since 1970s through long- and short-term limnological surveys. This approach enables to focus on various factors (hydrological, hydrochemical and biological) that may affect the zooplankton community at different temporal scales. In particular, the uncoupling between seasonality and hydrology might contribute to the interannual variability in the temporal patterns of zooplankton abundance. Flooding events seem to promote community diversity up to a catastrophic threshold, over which destructive effects prevail. On the other hand, at reduced flow rates biotic interactions, such as predation, have a significant effect on density, diversity and evenness of the zooplankton assemblage, although even a modest increase in discharge may induce rapid and marked changes in the composition and dominance of the community. In spite of the commonly held view that lotic environments are intrinsically instable, the zooplankton community shows regular successional patterns and a remarkable resilience even after extreme hydrological conditions.

Besemer, **K.**, University of Vienna, Vienna, Austria, katharina.besemer@univie.ac.at
Singer, G. A., University of Vienna, Vienna, Austria, gabriel.singer@univie.ac.at
Hödl, I. A., University of Vienna, Vienna, Austria, iris.hoedl@univie.ac.at
Battin, T. J., University of Vienna, Vienna, Austria, tom.battin@univie.ac.at

BACTERIAL COMMUNITY COMPOSITION OF STREAM BIOFILMS IN SPATIALLY VARIABLE-FLOW ENVIRONMENTS

Streams are highly heterogeneous ecosystems, in terms of both geomorphology and hydrodynamics. While flow is recognized to shape the physical architecture of benthic biofilms, we do not yet understand what drives community assembly and biodiversity of benthic biofilms in the heterogeneous flow landscapes of streams. Within a metacommunity ecology framework, we experimented with streambed landscapes constructed from bedforms in large-scale flumes to estimate the impact of spatial flow heterogeneity on the biodiversity and community composition of stream biofilms. Hydrodynamics explained a remarkable percentage of the variation in community composition along bedforms, which suggests species sorting as a candidate model of metacommunity dynamics in stream biofilms. The spatial variation induced by the hydrodynamics along the bedforms resulted in a gradient of bacterial beta diversity, measured by a range of diversity and similarity indices, that increased with bedform height and hence with spatial flow heterogeneity at the flume level. Our results underscore the necessity to maintain small-scale physical heterogeneity for community composition and biodiversity of biofilms in stream ecosystems.

Beversdorf, **L. J.**, University of Wisconsin-Madison, Madison, USA, lbeversdorf@wisc.edu
Miller, T. R., University of Wisconsin-Madison, Madison, USA, trmiller3@wisc.edu
Mouw, C. B., University of Wisconsin-Madison, Madison, USA, colleen.mouw@ssec.wisc.edu
McMahon, K. D., University of Wisconsin-Madison, Madison, USA, tmcmahon@cae.wisc.edu

MONITORING TOXIC CYANOBACTERIA: INTEGRATING DIVERSE DISCIPLINES FOR THE DEVELOPMENT OF PREDICTIVE WATER QUALITY TOOLS

Cyanobacterial blooms degrade water quality, impairing recreation and potentially creating health concerns related to cyanotoxin production. They are spatially and temporally stochastic events that have proven difficult to predict and monitor at time scales relevant to protecting public health. We integrated diverse types of observations derived from lab experiments, high-resolution buoy data, satellite imagery, and computational water quality modeling to gain perspective on the drivers of blooms and toxin production. Each approach is rooted in different disciplines, and each has its strengths and weaknesses. Our sensor network provides one-minute resolution of biological, chemical, and physical characteristics but is limited spatially. Conversely, satellite imagery and manual sampling provide spatial coverage but represent only a snapshot of lake dynamics. Furthermore, in situ data suggests that toxin production may precede "observable blooms" by more than one week. This has been examined in cyanobacteria cultures grown under varying light conditions and substrate availability. We emphasize the need to develop explicit processes for integrating diverse data sources from multiple disciplines, with the ultimate goal of developing predictive tools for managing water quality.

Bierwagen, **B**. **G**., U.S. Environmental Protection Agency, Washington, DC, USA, bierwagen.britta@epa.gov
Hamilton, A., Tetra Tech, Santa Fe, USA, anna.hamilton@tetratech.com
Julius, S., U.S. Environmental Protection Agency, Washington, DC, USA, julius.susan@epa.gov
Barbour, M., Tetra Tech, Owings Mills, USA, michael.barbour@tetratech.com

A FRAMEWORK FOR A CLIMATE CHANGE MONITORING NETWORK IN RIVERS AND STREAMS

A multitude of studies document the responses of ecosystems and their components to changes in climate. However, predicting these and other future responses of ecosystems to continued changes in climate is currently not possible. Therefore, ecosystems and their component species, populations, communities, functions, and services need to be monitored over a sufficient amount of time to detect effects. The monitoring information needs to be useful to resource managers. This requires a design that considers management goals and uses an appropriate sampling scheme to answer questions that relate to how climate change affects these management goals. Most broadly, the monitoring network should detect changes to aquatic resources comprehensively to partition effects due to climate change from other environmental stressors. A framework to design such a monitoring network must also consider the appropriate indicators, site selection criteria, and sampling design, and needs to consider monitoring across the range of conditions found in aquatic ecosystems. We provide such a framework and discuss what elements currently exist and which require further research.

Bingham, Q. G., Utah State University, Logan, USA, q.b@aggiemail.usu.edu
Neilson, **B**. **T**., Utah State University, Logan, USA, bethany.neilson@usu.edu
Neale, C. M., Utah State University, Logan, USA, christopher.neale@usu.edu
Cardenas, M. B., University of Texas at Austin, Austin, USA, cardenas@jsg.utexas.edu

DELINEATION OF DEAD ZONES IN RIVERS USING REMOTELY-SENSED DATA AND THEIR UTILITY IN IMPROVING TWO-ZONE TEMPERATURE AND SOLUTE TRANSPORT MODEL PERFORMANCE

The analysis of high resolution thermal infrared (TIR) and multispectral imagery from airborne remote sensing was found to provide the necessary information to delineate surface areas associated with dead zones (DZ) from the main channel (MC) flow in the Virgin River, UT. Accurate instream temperature predictions had been provided by a previous two-zone temperature and solute (TZTS) modeling effort; however, the number of and ranges of parameters were large. In addition to the data types previously required to populate and calibrate this model, information from TIR and multispectral imagery were used to physically estimate average total channel width (*BTOT*) and the fraction of the channel width associated with the DZ (β). Instream temperature distributions allowed for the calculation of temperature thresholds between the MC and DZ and the estimation of β at various spatial scales. Multispectral and TIR imagery provided for the high resolution estimates of *BTOT*. We found that an increase in the resolution and frequency at which *BTOT* and β were physically estimated resulted in similar temperature predictions, but the uncertainty in calibrated parameters decreased.

Bishara, **R**. **K**., University of New Mexico, Albuquerque, USA, rbishara@unm.edu
Burdett, A. S., University of New Mexico, Albuquerque, USA, aburdett@unm.edu
Turner, T. F., University of New Mexico, Albuquerque, USA, turnert@unm.edu

COMPARISON OF COMMUNITY STRUCTURE IN A CONTROLLED MESOCOSM EXPERIMENT AND NATURAL FRESHWATER SYSTEMS IN THE MIDDLE RIO GRANDE, NEW MEXICO

Community structure in the Rio Grande may be heavily influenced by seasonal drydown, which affects abiotic conditions and biotic interactions of aquatic organisms, and diminishes available aquatic habitat. During the process of drydown, abiotic factors such as water chemistry (e.g., conductivity, oxygen concentration, pH, temperature, turbidity) change dramatically within and among river habitats and these changes are hypothesized to affect community composition. We conducted a six-week mesocosm experiment to mimic community dynamics and succession of arid-river pools. To verify that conditions in mesocosms were similar to natural pools, we compared water chemistry and aquatic organism abundances in mesocosms to survey results from the Rio Grande and neighboring wetlands. Invertebrate and fish communities will be described in terms of abundance, diversity and community structure in relation to abiotic variables. Preliminary results suggest that water chemistry of mesocosms matches natural pools, which indicates that our experiment mimics natural environmental variation. Semi-natural mesocosms can lead to a better understanding of abiotic and biotic drivers of aquatic communities, but only to the extent that they reflect natural environments.

Bixby, **R**. **J**., University of New Mexico, Albuquerque, USA, bbixby@unm.edu
Burdett, A. S., University of New Mexico, Albuquerque, USA, aburdett@unm.edu

NON-UNIFORM INPUTS FROM TRIBUTARIES SHAPE PERIPHYTON PATCHINESS IN AN ARIDLAND RIVER

The Network Dynamics Hypothesis examines watershed disturbances and hierarchical stream networks as shapers of heterogeneity in lotic systems. In aridland rivers, tributary inputs affect main channel flows by the delivery of suspended solids which influence biological components of the river. In this study, the effect of increased turbidity, related to tributary flows, on algal biomass and assemblages in aridland rivers was investigated. We predicted that tributary flows would create spatially and temporally variable patterns that were amplified at confluences and dissipated downstream. Seasonal surveys were conducted along a longitudinal gradient of the Middle Rio Grande (2007-2010, five sites). Physiochemical and algal parameters (chlorophyll a and species assemblages) were analyzed. Directly downstream from tributaries, turbidity regularly exceeded 4000 NTU; above tributaries, measurements were as low as 10 NTU. Turbidity and chlorophyll a were negatively correlated and differed significantly among sites ($P < 0.001$) and seasons ($P < 0.001$). Diatom assemblages reflect turbidity changes, with shifts in taxa associated with low light environments. Insight into drivers of periphyton dynamics is crucial to understanding stochasticity of watershed influences on aridland riverine ecosystems.

Black, **A**. **R**., Eastern Washington University, Cheney, USA, rblack@ewu.edu
Wold, L. A., Eastern Washington University, Cheney, USA,
Lewis, S. J., Eastern Washington University, Cheney, USA,

PREDATOR-INDUCED PHENOTYPIC PLASTICITY IN DAPHNIA: LIFE HISTORY RESPONSES OF DAPHNIA PULEX TO SEVERAL VISUAL PREDATORS

We examined the life histories of Daphnia pulex exposed to kairomones released from each of four large-size-selective predators. The predators included one vertebrate (larval Ambystoma) and three invertebrates (dragonfly larvae [genus Anax], larval diving beetles [genus Graphoderus], and adult backswimmers [genus Notonecta]). Exposure to predators was accomplished by generating predator conditioned water and exposing Daphnia to the conditioned water for three generations. Life history measures were collected from the third generation and compared to life history measures collected from unexposed control individuals. Statistical results suggest all predators induce significant shifts in major life history characters. Most noticeably, Daphnia in kairomone present treatments produced 25-76% more offspring in the first five broods and possessed r-values 10-44% higher when compared to the controls. Further, we examined the effects of simulated predation on each life history by superimposing increased mortality on the life history matrix produced from each treatment , then calculating a revised r-value for the life history. In all cases r-values of the predator-induced life histories declined less under simulated predation than did the r-values of the controls.

Black, **J**. **E**., Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, USA, eva.black@msu.montana.edu
Poole, G. C., Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, USA, gpoole@montana.edu

NEEDS ASSESSMENT: A PREREQUISITE FOR IN-STREAM FISH HABITAT ENHANCEMENT

In-stream fisheries habitat enhancement comprises 17% of all riverine restoration projects nationally. These enhancements overwhelmingly consist of installed logs, boulder clusters, and more highly engineered structures generally designed to create eddies and pools. Such interventions are broadly assumed to be a "cure-all" without first questioning whether the lack of eddies or deep pools are primary limiting factors to fish populations. Although, the science and practice of restoration places immense emphasis upon post-project

monitoring and evaluation, few enhancement projects ask a fundamental question prior to implementation: "Are habitat factors currently limiting fish populations, and if so, which factors are limiting?" We review the literature to build a case for assessment of habitat needs as a necessary precursor for goal-oriented enhancement of in-stream fish habitat. Many factors may threaten a fish population, but until the primary limiting factors are identified, in-stream habitat enhancement may simply attract existing fish to enhancement structures, resulting in merely the appearance of "successful" enhancement. Thus, implementing enhancement without first assessing habitat needs may yield misappropriation of limited time and resources.

Black, **R**. **W**., U.S. Geological Survey, Tacoma, WA, USA, rwblack@usgs.gov
Moran, P., U.S. Geological Survey, Tacoma, WA, USA,
Aluru, N., University of Waterloo, Waterloo, ON, Canada,
Vijayan, M., University of Waterloo, Waterloo, ON, Canada,

TRANSCRIPTIONAL RESPONSE IN TROUT COLLECTED ACROSS A GRADIENT OF URBANIZATION AROUND THE PUGET SOUND REGION, WASHINGTON

As a part of the US Geological Survey's National Water Quality Assessment Program, a study was undertaken to evaluate the effects of urbanization on stream ecosystems around the Puget Sound region. Sites were selected that spanned a range of urbanization (13-82%); defined largely by population density and impervious surfaces. The study included the collection and analysis of multiple physical, chemical, and biological endpoints relevant to stream ecosystem structure and function. At each site, 5 juvenile cutthroat trout were sampled and liver and brain tissues quickly frozen for transcriptome analysis. Gene expression pattern was assessed using a custom-made low-density trout cDNA microarray. Select genes that were consistently different between groups were confirmed by real-time quantitative PCR. Gene response of individuals were consistent by site, but were correlated with levels of urbanizations. Genes associated with PAH exposure were highly activated in those fish found in urbanized streams. Conversely, genes associated with growth were deactivated in these urbanized streams suggesting a cost of contamination tolerance. The method used in this study represents an alternative approach for characterizing stream conditions.

Blair, **T**. **B**., University of Dayton, Dayton, USA, blairtib@notes.udayton
Shoda, M. E., University of Dayton, Dayton, USA, megan.shoda@gmail.com
Barker, R. E., University of Dayton, Dayton, USA, galadriel.elanes@gmail.com
McEwan, R. W., University of Dayton, Dayton, USA, ryan.mcewan@notes.udayton
Benbow, M. E., University of Dayton, Dayton, USA, benbowme@notes.udayton.edu

DIFFERENTIAL EFFECTS OF INTRODUCED AND NATIVE TREE SPECIES LEACHATE ON STREAM INSECTS

The impact of invasive *Lonicera maackii* (Amur honeysuckle) in riparian forests is unknown, specifically the effects of senesced honeysuckle leaves and leaf leachate on stream macroinvertebrate communities and ecosystem function. The objective of this study was to evaluate lethal and non-lethal effects of honeysuckle leaching on Hydropsychidae Trichoptera in laboratory microcosms. The effects of two treatments of honeysuckle leaves were compared to a native treatment of ash/sycamore and a control incubated in Midwestern autumn stream water (15°C) for 7 days. Insect mortality, individual mass and behavior were measured at 24 hour intervals. At 96 hours, control Trichoptera experienced no mortality, while mean total mortality was 8.3%, 50% and 75% for native, low honeysuckle and high honeysuckle treatments, respectively. Standardized observations indicated insects in control microcosms were active and responsive while insects in treatment microcosms became less responsive over time, with the highest degree of negative change in low honeysuckle treatments. These results indicate lethal and non-lethal effects of introduced *L. maackii* on one dominant taxa and suggest a potential for impacts on entire stream communities.

Blanco, **J**. **F**., Universidad de Antioquia, Medellín, Colombia, blanco@exactas.udea.edu.co
Longo-Sánchez, M. C., Universidad de Antioquia, Medellín, Colombia,
Gómez-Aguirre, A. M., Universidad de Antioquia, Medellín, Colombia,
Valencia, S. M., Universidad de Antioquia, Medellín, Colombia,
Perez, G. A., Universidad de Antioquia, Medellin, Colombia,
Lizarazo, P. X., Universidad de Antioquia, Medellin, Colombia,

COASTAL STREAMS IN THE BIOGEOGRAPHIC CHOCO (COLOMBIA): THE PREVALENCE OF KEYSTONE SPECIES WITHIN A BIODIVERSITY HOTSPOT

The biogeographic Chocó region (Colombia) is a megadiverse area, however streams in the Pacific drainage remain poorly explored. We here studied insular streams in Gorgona National Natural Park (Tropical Eastern Pacific, off Colombian coast), and tested for dominance by a few species within species-rich aquatic macroinvertebrate and riparian plant communities. These streams are short (<5 km), running over basaltic and intrusive lithology, and are influenced by a maritime wet climate similarly to insular and coastal streams elsewhere in the neotropics. Fifty five aquatic insect genera were present due to the island's proximity (<35 km) to the continent but detritivore (*Potimirin glabrata*) and predatory (*Macrobrachium* spp.) shrimps dominated over aquatic insects in terms of abundance and biomass as observed in oceanic islands. More than a hundred species of riparian trees contributed leaflitter in these closed-canopy and low-order streams. However, *Cespedesia macrophylla* contributed 35% of leaflitter biomass. Despite of its poor chemical quality, its broad leaves may help to retain small-leaf species. Due to a few functionally important species of plants and shrimps, these streams are highly vulnerable to invasions by exotic species.

Blodau, **C**., University of Guelph, Guelph, Canada, cblodau@uoguelph.ca
Minderlein, S., University of Bayreuth, Bayreuth, Germany,
Kopp, B., University of Bayreuth, Bayreuth, Germany,
Siems, M., University of Bayreuth, Bayreuth, Germany,
Roulet, N.,
Fortin, D., University of Ottawa, Ottawa, Canada,
Humphreys, E., Carleton University, Ottawa, Canada,

IMPACT OF 90 YEARS OF DRAINAGE ON THE HYDROLOGY AND SUBSURFACE BIOGEOCHEMISTRY OF A NORTHERN PEATLAND

Climate in the northern temperate and boreal zone will undergo significant changes in the 21st century and in some areas become drier and warmer. We investigated the impact of a century of drainage on hydrogeological and biogeochemical process patterns in the Mer Bleue Bog, Ontario, Canada. Depending on hinterland area, either a bog system was maintained or trees invaded. Changed evapotranspiration and hydraulic characteristics, driven by increased decomposition of the soils, lead to distinct changes in hydrogeologic flow paths with recharging conditions in bog and discharging in treed areas, arguing that stability point exist for ecohydrological response. Altered vegetation and flow patterns corresponded to biogeochemical process patterns; under forest DOC concentration was increased, sulphate reduction dominated against methane production, syntrophic anaerobic microbial processes appeared to be partly disconnected according to thermodynamic analyses, and methane production was strongly reduced. A laboratory based analysis of these patterns demonstrated that humic substance enrichment may lead to suppression of methane production in such soils. In summary, a century of dry conditions allowed for very different hydrological and biogeochemical systems and potential to produce methane.

Boeckman, **C**. **J**., Oklahoma State University, Stillwater, USA, chadjb@okstate.edu
Bidwell, J. R., Oklahoma State University, Stillwater, USA, joe.bidwell@okstate.edu

POPULATION CHARACTERICS AND THERMAL TOLERANCE OF ZEBRA MUSSELS (DREISSENA POLYMORPHA) IN TWO OKLAHOMA RESERVOIRS

Zebra mussel monitoring surveys were initiated in Oologah Lake, OK beginning in 2003 and Sooner Lake, OK in 2006. Veliger densities increased in both lakes from near 30/L to 500/L in three years, with adult densities peaking at 150,000/m2. In 2006, a significant dieoff occurred in Oologah Lake, perhaps brought about by high water temperatures and high densities. Populations there have remained low, however are slowing increasing again. Sooner Lake is used as a cooling reservoir for a coal fired electricity generating facility, and consequently receives a warm thermal discharge in part of the lake. Zebra mussel densities in

the warmest region routinely decline as water temperature increases above 30˚C. Upper thermal tolerance trials are being conducted using various populations from the region, with preliminary results indicating mussels collected during the summer having greater time-to-death than those collected during the winter (2344 minutes vs. 356 minutes, respectively). Mussels exposed in druses had time-to-death less than half of those generated for the individual treatment (338 minutes vs. 1203 minutes, respectively). Warm summer water temperatures appear to negatively affect zebra mussel populations which may limit effects on other native biota.

Boeing, **W**. **J**., New Mexico State University, Department of Fish, Wildlife and Conservation Ecology, Las Cruces, USA, wboeing@nmsu.edu

Swaim, K. M., New Mexico State University, Department of Fish, Wildlife and Conservation Ecology, Las Cruces, USA, kswaim@nmsu.edu

INFLUENCES OF BIOTIC VERSUS ABIOTIC VARIABLES ON VARIOUS TROPHIC LEVELS IN AN AQUATIC DESERT ECOSYSTEM

Numerous studies have utilized a multiple-lake approach to evaluate the importance of biotic versus abiotic factors on shaping the aquatic community. However, information on desert warmwater communities is lacking due to the rarity of multiple lakes within a confined geographic region. We studied 40 desert sinkholes, located within a few square kilometers on Bitter Lake National Wildlife Refuge in New Mexico, over four years. About half of them are fishless while the rest contain fish. Physical and chemical variables cover an extreme range. For example, total depth varies between 0.5 and 15 m, Secchi depth lies between 0.1 and 5 m, and salinity between 4 and 120 ppt. We measured abundance and condition for Pecos pupfish (*Cyprinodon pecosensis*) and Pecos gambusia ((*Gambusia nobilis*), abundance of zooplankton species, and chlorophyll a. We hypothesized that the extreme range of environmental factors will dominate the food web. We found that pupfish are mainly influenced by the presence of competitors, Pecos gambusia by salinity, zooplankton by a combination of abiotic and biotic factors and phytoplankton mainly by abiotic factors.

Boersma, **K**. **S**., Oregon State University, Corvallis, USA, kate.boersma@science.oregonstate.edu

Lytle, D. A., Oregon State University, Corvallis, USA, lytleda@oregonstate.edu

OVERLAND DISPERSAL IN A FLIGHTLESS AQUATIC INSECT: A SYNTHESIS OF GENETIC, OBSERVATIONAL AND EXPERIMENTAL DATA

The combined effects of anthropogenic water use and climate change are causing perennial desert streams to dry, and this effect is predicted to intensify over the next century. The ability of aquatic organisms to survive periods of intermittency is determined in part by species-specific dispersal capacities, as dispersal may allow taxa to seek refuge from stream drying. Aquatic inhabitants of desert streams display a wide range of dispersal capacity, from fish that require perennial water to aquatic insects with a terrestrial adult stage. Giant water bugs, *Abedus herberti*, are intermediate dispersers between these extremes because they are flightless but breathe air, and molecular evidence suggests that they may be able to crawl significant distances over land before desiccating. Here I describe behavioral experiments suggesting that all ages and reproductive categories of *A. herberti* respond to drying as a dispersal cue. Then, combining recent field and laboratory data, I review empirical support for the existence of overland dispersal in *A. herberti* and discuss the potential ecological and evolutionary consequences of dispersal tendency in fragmented systems.

Bogan, **M**. **T**., Oregon State University, Corvallis, USA, boganmi@science.oregonstate.edu

Boersma, K. S., Oregon State University, Corvallis, USA, boersmak@science.oregonstate.edu

MODE OF INVERTEBRATE COLONIZATION DRIVES COMMUNITY ASSEMBLY IN NOVEL HABITATS ALONG ARID-LAND STREAMS

Many streams in arid western North America are transitioning from perennial to ephemeral flow because of extreme droughts and anthropogenic water withdrawals. Understanding dispersal and colonization potential of aquatic organisms is essential in order to predict changes in local community structure as a result of this increased aridity. We examined aquatic invertebrate colonization dynamics using replicate mesocosms placed at three distances (5m, 75m 250m) from two arid-land streams over a 6-week period. Over 60 species of aquatic invertebrates colonized the mesocosms. Individual species varied widely in their abundances, tendencies to colonize mesocosms closer to or further from the stream channels, and likelihood of dispersing following rainfall events. Using these data, we identified at least five modes of colonization in arid-land streams: (1) widespread opportunistic, (2) range-restricted opportunistic, (3) cue-limited opportunistic, (4) widespread haphazard, and (5) infrequent. Given the wide range of species-specific colonization potential demonstrated in our study, we expect that increased spatial and temporal rarity of wetted habitat will greatly alter community structure in arid-land streams.

Bogard, **M**. **J**., University of Regina, Regina, Canada, bogard2m@uregina.ca

Donald, D. B., University of Regina, Regina, Canada,

Waiser, M. J., Water Sciences and Technology Directorate, Environment Canada, Saskatoon, Canada,

Tumber, V. P., Water Sciences and Technology Directorate, Environment Canada, Saskatoon, Canada,

Finlay, K., University of Regina, Regina, Canada,

Leavitt, P. R., University of Regina, Regina, Canada,

DIFFERENTIAL EFFECTS OF UREA FERTILIZATION ON ALGAL AND BACTERIAL PRODUCTION IN EUTROPHIC LAKES

Agricultural use of urea ($(NH_2)_2CO$) as a fertilizer has increased at near-exponential rates since 1970, yet relatively little is known of its potential effects on aquatic ecosystems. To quantify effects of urea fertilization on both algal and bacterial production, we conducted three 21-day long mesocosm (3000 L) experiments in hypereutrophic Wascana Lake during the summer of 2009. Urea was added weekly at 5 concentrations (0, 1, 3, 8, and 18 mg N L^{-1}) with 3 replicates each. Both algal and bacterial production varied through time, and with urea additions. Within the first 4 days of each experiment, algal biomass and production (Chlorophyll, ^{14}C fixation) increased with urea concentrations to a plateau at 3-5 mg N L^{-1}. Yet bacterial production (^{3}H-thymidine uptake, heterotrophic plate counts) remained at background levels until day 7, and thereafter responded in a linear manner to urea additions. At the 8 and 18 mg N L^{-1} treatment levels, bacterial production was sufficient to deplete oxygen by day 21. We conclude that, in P- rich lakes, urea pollution at concentrations < 3 mg L^{-1} may enhance net autotrophy of a lake, while urea additions > 3 mg L^{-1} may increasingly favor net heterotrophy.

Bogatov, **V**. **V**., Institute of Biology and Soil Science, Vladivostok, Russian Federation, bogatov@ibss.dvo.ru

Astakhov, M. V., Institute of Biology and Soil Science, Vladivostok, Russian Federation,

VERTICAL DISTRIBUTION OF DRIFT DENSITY AND DRIFT RATE OF BOTTOM INVERTEBRATES IN A RIFFLE OF KEDROVAYA RIVER (PRIMORSKY TERRITORY, RUSSIA)

For drift collection we used a sampler, consisting of three located one on top of each other drift nets, which were established on riffle on depth of 0.3 m (mesh opening 220 microns). Research was conducted on Kedrovaya River (Primorsky Territory, Russia) from June, 2006 till May, 2007. Samples were collected once a month within 24 hours: every half an hour (in June) or one hour at night (other months) and every 2 hours in a day. Exposition time of a sampler took 5 minutes. As water velocity increases from the bottom to the surface, reduction in the year's average of invertebrates' drift density is observed in unit volume of water (numbers/m3). This has defined practically identical average for the year drift rate of stream organisms on a vertical of the water column (numbers/per net per 5 minutes). However, the largest individuals drifted in superficial layer more often. During a day drifting organisms did not show precise preference to the certain layer of water strata. For example, in June there was a constant redistribution of invertebrates between top and bottom horizons of the stream, approximately with a of ½ - 1 ½ hr. interval.

Bonada, **N**., University of Barcelona, Barcelona, Spain, bonada@ub.edu

Múrria, C., Natural History Museum, London, United Kingdom, cmurria@gmail.com

Zamora-Muñoz, C., University of Granada, Granada, Spain, czamora@ugr.es

Sáinz-Cantero, C. E., University of Granada, Granada, Spain, celisa@ugr.es

Garrido, J., University of Vigo, Vigo, Spain, jgarrido@uvigo.es

Acosta, R., University of Barcelona, Barcelona, Spain, racosta@ub.edu

Vogler, A. P., Natural History Museum, London, United Kingdom, A.Vogler@nhm.ac.uk

Alba-Tercedor, J., University of Granada, Granada, Spain, jalba@ugr.es

ECOLOGICAL BASIS OF THE SPECIES-ABUNDANCE DISTRIBUTIONS OF AQUATIC INVERTEBRATES ALONG A LARGE LATITUDINAL GRADIENT

One of the universal regularities in ecology is that relative species-abundance distributions (SADs) follow a hollow-curve shape. Important theoretical advances have been made in explaining the underlying mechanisms of this correlation and several models have been fitted (e.g. geometric, lognormal). However, although community ecologists often collect data for SAD analysis, empirical development of SAD has received much less attention and little information exist on the ecological explanations of SADs. We examined SAD of aquatic invertebrates along a large latitudinal gradient and related it to several environmental descriptors that can a priori influence SADs. Biological and environmental data were collected in 60 permanent headwater sites from Morocco to Sweden. SADs were analyzed and related to environmental variables and total abundance and richness. Results showed that regions along the latitudinal gradient differed in total abundance, richness and SADs. Regions with higher available instream energy had higher abundances but this did not necessarily result in higher richness. Other factors such as seasonal stability, historical factors, or trait characteristics appeared related to differences in SADs across latitude.

Bond, **N**. **R**., Monash University, Melbourne, Australia, nick.bond@sci.monash.edu.au

Bond, N. R., Arthur Rylah Institute, DSE, Melbourne, Australia, Paul.Reich@dse.vic.gov.au

Thomson, J., Monash University, Melbourne, Australia, Jim.Thomson@sci.monash.edu.au

Giling, D., Monash University, Melbourne, Australia, Darren.Giling@sci.monash.edu.au

Stein, J., Australian National University, Canberra, Australia, janet.stein@anu.edu.au

PREDICTING THE IMPACTS OF DROUGHT AND CLIMATE CHANGE ON FRESHWATER FISH DISTRIBUTIONS IN SOUTHEASTERN AUSTRALIA USING STATISTICAL MODELLING APPROACHES

In south eastern Australia, the predicted increase in temperature and decrease in rainfall associated with climate change will likely reduce and change patterns of runoff, altering flood frequency and increasing the duration of cease to flow periods. Together with climatic influences, such changes in hydrology have the potential to impact strongly on the distribution and abundance of aquatic biota. We used statistical modelling approaches (boosted regression trees) to link existing datasets on the distribution of freshwater fish to a suite of climatic, hydrologic and catchment physiographic variables, and then used these models to explore the potential impacts of several climate change scenarios. Results forecast widespread distributional shifts and some species losses at landscape and regional scales. Evaluation of a scenario based on recent severe drought conditions also forecast widespread species deletions. Validation of the drought scenario against recent empirical datasets from sites across Victoria supports predictions for several, but not all species. Improvements in model predictions would likely benefit from inclusion of additional predictor, especially groundwater and geomorphic influences. Here we summarise this work, discuss our approach and present future directions.

Bonet, **B**., University of Girona, Girona, Spain, berta.bonet@udg.edu

Corcoll, N., University of Girona, Girona, Spain, natalia.corcoll@udg.edu

Morin, S., Cemagref, Bordeaux, France, Soizic.Morin@cemagref.fr

Tlili, A., Cemagref, Lyon, France, ahmed.tlili@cemagref.fr

Guasch, H., University of Girona, Girona, Spain, helena.guasch@udg.edu

ANTIOXIDANT ENZYME ACTIVITIES IN PERIPHYTON AS NEW BIOMARKERS OF LOW METAL POLLUTION IN STREAMS

The goal of this study was to assess the use of antioxidant enzyme activities (AEA) in periphyton communities as biomarkers of low metal pollution under multiple stress field conditions. With this purpose, the effects of metal exposure were investigated "in situ" in a low order stream, located in a former mining area. Translocation experiments were performed along a gradient of metal pollution including a control and five polluted sites. Physical and chemical parameters, metal bioaccumulation, AEA and diatom species composition in periphyton were followed over the five weeks of translocation. Dissolved Zn concentration was <5 in the less polluted sites, 2200 in the mining source, and 250 µg/L downstream. Iron ranged between 70-1200 µg/L. AEA responses increased over time. At the end of the translocation, GST was inhibited while CAT and APX were stimulated. These changes were observed even in the less polluted sites in agreement with the diatom species composition patterns. Our results indicate that AEA can be use to assess low and chronic metal exposure under field conditions, completing the information of other classic biondicators.

Booker, **J**. **D**., Michigan State University, East Lansing, USA, bookerj85@gmail.com

Cheruvelil, K. S., Michigan State University, East Lansing, USA, ksc@msu.edu

THE SPATIAL DISTRIBUTION OF DAPHNIA RESOURCES IN SHALLOW LAKES: IS FOOD QUALITY FOR ZOOPLANKTON DETERMINED BY AQUATIC PLANTS?

Many studies of shallow lake ecology have demonstrated that phytoplankton biomass decreases with increased submersed macrophyte density. These results have been attributed to competition for nutrients and light, allelopathy, and reduced sediment resuspension. However, it is not clear what impact this macrophyte-phytoplankton interaction has on herbivorous zooplankton that migrate in and out of the littoral zone. This study investigated the potential differences in zooplankton food quantity and quality between the pelagic and littoral zones. Growth and reproduction experiments with *Daphnia* showed that plants have an impact on the food quantity and quality. A field survey of multiple shallow lakes in southern Michigan examined the horizontal distribution of *Daphnia* resources and also found significant food quality patterns in terms of phytoplankton taxa and elementary stoichiometry. However, the pattern of food quality differed greatly among similar lakes. This finding may help explain why *Daphnia* horizontal migration occurs in some shallow lakes and not others.

Boomer, **K**. **B**., Smithsonian Environmental Research Center, Edgewater, MD, USA, boomerk@si.edu

Weller, D. E., Smithsonian Environmental Research Center, Edgewater, MD, USA, wellerd@si.edu

Li, X., Smithsonian Environmental Research Center, Edgewater, MD, USA, lix@si.edu

Kalin, L., Auburn University, Auburn, AL, USA,

THE ROLE OF WATERSHED MODELS IN MUNICIPAL LAND PLANNING AND PROTECTING AQUATIC ECOSYSTEMS

Mandates to regulate nutrient and sediment discharges are leading local governments to develop watershed-based comprehensive plans that target new development to areas where it is predicted to have lower impacts on surface water quality. We used a suite watershed models, including GWLF, SWAT, and the CBP-HSPF5, to predict the water quality impacts of alternate future land use scenarios near a small town in the Chesapeake Bay watershed. For any single model, the difference among scenarios in predicted sediment loads was small (less than 10%), but the difference among the models for any single scenario exceeded 100%, highlighting the uncertainty in the model predictions. Although the alternate land cover scenarios had very different amounts of new development (0 to 20% increase), they had similar predicted sediment loads. Therefore, the water quality impact had little influence on the town's adoption of a growth plan. Integrating watershed science into decision making remains difficult, particularly because we have an incomplete understanding of the landscape processes controlling stream sediment loads.

Booth, **M**. **T**., Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, USA, mike.booth@cornell.edu

Hairston, N. G., Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, USA, ngh1@cornell.edu

Flecker, A. S., Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, USA, asf3@cornell.edu

MOVEMENT DYNAMICS DRIVE ECOSYSTEM STRUCTURE: SUCKERS AS ECOSYSTEM ENGINEERS

Fish control important characteristics of many stream systems, but their effects may be modified by movement dynamics. The timing and spatial scale of movement patterns of organisms can modulate the strength and distribution of ecosystem processes. This study investigated importance of movement dynamics in the ecosystem role of an abundant sucker species, *Catostomus insignis*, in the Gila River, NM. Suckers are patchily distributed throughout the river over space and time due to frequent movement among habitat patches. *C. insignis* creates feeding depressions in mobile sediments (e.g. sand) as it feeds on invertebrates and detritus; depressions can cover 100% of the benthic surface area within 48 hours. The timing and intensity of feeding depression formation is highly

variable, creating a "wandering mosaic" of disturbance over time. Individual movements of PIT-tagged (passive integrated transponder) C. insignis were recorded using a telemetry system to understand daily movement patterns and home ranges, and link movement activity to measured ecosystem effects, such as sediment disturbance and export. Our data suggest that timing and location of movements fundamentally change how and when fish structure ecosystems.

Boothroyd, **I**. **K**., Golder Associates (NZ) Limited, Auckland, New Zealand, iboothroyd@golder.co.nz

DIVERSITY AND COMMUNITY ORGANISATION OF GEOTHERMALLY INFLUENCED SPRING-FED ECOSYSTEMS

Geothermal systems and features are of economic, scientific and cultural importance both within New Zealand and internationally. The Taupo Volcanic Zone of the North island represents a highly significant geothermal resource on an international scale and is an important area in which to study aquatic geothermal biota, both for its intrinsic value and for its potential application to geothermal waters generally. The composition and value of biological communities within geothermal waters is poorly understood. As part of studies investigating the uniqueness and biodiversity of geothermal ecosystems, the structural components of the biota associated with various levels of organisation was investigated: at the ecosystem, community and population levels. Overall, two broad but distinct types of geothermal ecosystem were identified, each with a characteristic associated biological community. Furthermore, genetic studies on a common geothermal inhabitant, Chironomus novae-zelandiae (Insecta: Diptera) suggest an apparent genetic distinction between larvae from geothermal and non-geothermal areas, but not within geothermal areas. Implications for the use of geothermal areas in the context of these finding will be discussed.

Borde, **A**. **B**., Pacific Northwest National Lab, Sequim, WA, USA, amy.borde@pnl.gov

Diefenderfer, H. L., Pacific Northwest National Lab, Sequim, WA, USA, heida.diefenderfer@pnl.gov

Zimmerman, S. A., Pacific Northwest National Lab, Sequim, WA, USA, shon.zimmerman@pnl.gov

Thom, R. M., Pacific Northwest National Lab, Sequim, WA, USA, ron.thom@pnl.gov

WETLAND VEGETATION COMMUNITY DISTRIBUTION AND INUNDATION PATTERNS IN THE TIDALLY INFLUENCED COLUMBIA RIVER, USA

Our research quantifies the hydrologic conditions necessary for development of brackish and tidal freshwater wetland plant communities and compares the distribution relative to previously existing ecosystem classification systems for the lower Columbia River and estuary. We have collected vegetation cover, elevation, and hydrology data from 40 reference wetland sites within the floodplain of the 235 km tidally influenced Columbia River. These previously limited data are required to understand the distribution of wetland community types in a regulated river system with complex tidal and flow-dominated hydrologic processes. Analyses include ordination of species richness relative to spatial variation of physical controlling factors, cluster analysis of community types, and the magnitude, timing, and duration of surface water inundation within and between communities/sites. Preliminary results indicate species richness varies with controlling factors longitudinally along the river gradient, community type varies along elevation gradients, and specific inundation patterns are correlated with community types. For example, some invasive species have wide elevation ranges and inundation tolerances lending to their competitive ability. This information fundamentally informs restoration design and monitoring, invasive species management, and climate change research.

Bothwell, **M**. **L**., Environment Canada, Nanaimo, Canada, max.bothwell@dfo-mpo.gc.ca

Kilroy, C., Institute of Water and Atmospheric Research, Christchurch, New Zealand, c.kilroy@niwa.co.nz

FREQUENCY OF DIVIDING CELLS IN THE FRESHWATER BENTHIC DIATOM *DIDYMOSPHENIA GEMINATA*: RESPONSE TO IN SITU NUTRIENT STIMULATION

Didymosphenia geminata typically forms blooms in oligotrophic rivers. The negative association between *D. geminata* abundance and nutrient levels in rivers appears at both catchment and smaller scales. We conducted a series of trials in streamside experimental channels colonized with *D. geminata* using water from the *D. geminata*-affected, oligotrophic Waitaki River, South Island, New Zealand to determine how elevated nitrate and phosphate concentrations affected the growth of *D. geminata*. We developed a procedure to quantify the frequency of dividing cells (FDC) and used this as a metric for the rate of cell division in *D. geminata*. Enrichment of nutrient impoverished *D. geminata* by either switching the water source to N and P-rich spring water or by adding stock solutions of phosphate+nitrate or phosphate alone resulted in a period of explosive growth lasting at least 8 days. *D. geminata* cell division rates increased four-fold over *D. geminata* in control channels. Since *D. geminata* cellular growth rates are greatly stimulated by higher concentrations of inorganic phosphorus, other factors must be responsible for the distribution of *D. geminata* blooms in low nutrient river systems.

Bouchard, **R**. **W**., Minnesota Pollution Control Agency, Saint Paul, USA, Will.Bouchard@state.mn.us

Gerritsen, J., Tetra Tech, Inc., Owings Mills, USA,

Sandberg, J., Minnesota Pollution Control Agency, Saint Paul, USA,

Chirhart, J., Minnesota Pollution Control Agency, Saint Paul, USA,

Yoder, C. O., Midwest Biodiversity Institute, Columbus, USA,

DEVELOPMENT OF THE BIOLOGICAL CONDITION GRADIENT FOR MINNESOTA AND ITS USE IN SETTING STATEWIDE BIOLOGICAL CRITERIA

The Biological Condition Gradient (BCG) was developed for Minnesota to describe how biological communities in warmwater rivers change with increasing levels of stress. Communities were characterized along a stressor gradient for different stream classes using empirical data and the best professional judgment of biologists from the Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Natural Resources. The BCG provides a common framework to interpret changes in biological condition regardless of region or stream type. This consistency allows the BCG to be used to determine how biocriteria thresholds relate to each other across the state and thereby prevents criteria from being under protective in regions where widespread disturbance is present. The BCG will also be integral to the development of exceptional use goals and modified use goals as part of tiered aquatic life uses (TALU).

Bouldin, **J**. **L**., Arkansas State University, Jonesboro, AR, USA, jbouldin@astate.edu

Wright, R. E., Arkansas State University, Jonesboro, AR, USA, rodney.wright@smail.astate.edu

WATER QUALITY AND QUANTITY IMPLICATIONS OF BIOFUEL CROPS

As independence from fossil fuels increases, a shift in land use patterns will occur to include bioenergy crops. First generation bioenergy crops are typically food crops used in the production of either ethanol or biodiesel through fermentation or extraction processes. Second and subsequent generation bioenergy crops do not directly compete with food but the technology is not currently available for mass production from these sources. Directives from the Energy Independence Act of 2007 mandate ethanol production without consideration of water quality and quantity issues. Increased ethanol demand is currently mirrored in increased corn (Zea mays L.) acreage. Crop changes were modeled using AGNPS (Annualized Agricultural Non-Point Source) to predict sediment, nitrogen (N) and phosphorus changes from an AR Delta watershed. A total switch to corn production would result in 7 times greater N loading than present crop distribution. Switchgrass (Panicum virgatum), a second generation bioenergy crop, would contribute substantially less N than present crops and <10% of the N from corn crops. A more sustainable cropping practice will result in a shift to second generation bioenergy crops.

Bouquet, **J**. **M**., Sars International Centre for Marine Molecular Biology, Bergen, Norway, Jean-Marie.bouquet@sars.uib.no

Chourrout, D., Sars International Centre for Marine Molecular Biology, Bergen, Norway, Daniel.Chourrout@sars.uib.no

Thompson, E. M., International Centre for Marine Molecular Biology ; Department of Biology, University of Bergen , Bergen, Norway, Eric.Thompson@sars.uib.no

IN VITRO FERTILIZATION AND SPERM CRYOPRESERVATION OF THE APPENDICULARIAN, *OIKOPLEURA DIOICA*, (FOL, 1872)

We present in vitro fertilization and sperm cryopreservation protocols for the emerging model pelagic tunicate *Oikopleura dioica*. To establish a routine practical fertilization methodology we pooled mature sperm, released naturally by 5 males in 10 mL filtered artificial seawater and then assessed varying aliquots of this stock preparation. We found that aliquot volumes above 50 &microL (sperm: egg ratio ≈ 150:1) negatively impacted development. When stored on ice, sperm retained near optimal viability for 8-10 H. In contrast, temperature variation alone was insufficient to prevent significant decline in oocyte quality (< 1 H at 20°C; 2 H at 5°C). To enhance perspectives for genetic manipulation, of this emergent model organism, a sperm cryopreservation method was successfully developed using: filtered artificial seawater / 0.06M sucrose / 10mg.mL^{-1} BSA / 10% egg yolk tellurite / 10% dimethylsulfoxid, with a freezing rate of -12°C.min^{-1} for 10 min, and thawing rate of 18.75°C.s^{-1} for 10 s. Sperm post-thaw motility score 3.7 (70-80%); and fertilization rates were > 90 %, with normal development assessed at 63% (Day 1) and 48% (Day 3) over the short 6 day life cycle.

Bowe, S., Red Lake Dept. of Natural Resources, Red Lake, USA, sbowe@redlakenation.org

Hanson, M. A., Minnesota Dept. of Natural Resources, Bemidji, USA, mark.hanson@dnr.state.mn.us

Ossman, F. G., North Dakota State University, Fargo, USA,

Fieberg, J., Minnesota Dept. of Natural Resources, Forest Lake, USA,

Butler, M. G., North Dakota State University, Fargo, USA,

Koch, R., Bemidji State University, Bemidji, USA,

INFLUENCES OF FOREST HARVEST AND ENVIRONMENTAL GRADIENTS ON AQUATIC INVERTABRATE COMMUNITIES OF SEASONAL PONDS

Appropriate recommendations for managers regarding forest harvest around seasonal ponds are difficult to infer based on available information. Invertebrate communities have often been useful indicators of stress in other aquatic systems. During 1999-2005, we studied aquatic invertebrate communities in 24 small, seasonally flooded wetlands located in aspen-dominated landscapes with adjacent forest ages varying from 10-59+ years in north central Minnesota, USA. Direct gradient analysis indicated that invertebrate communities were influenced by changes in environmental variables, although relationships were complex, with no single variable explaining >9.3% of invertebrate variance. Invertebrate taxon richness was negatively correlated with stand age and was also lower during the period following tree harvest. However, measurable declines in taxon richness were less apparent in harvested old age stands relative to unharvested controls during the post-harvest time period. Our data indicated weak relationships between invertebrate community composition and measured environmental characteristics of seasonal ponds and adjacent uplands. Innovative research strategies are needed because seasonal variance and adaptations of aquatic invertebrates may limit our ability to accurately elucidate responses to natural and anthropogenic gradients in these habitats.

Bowe, K., Red Lake Dept. of Natural Resources, Red Lake, USA, kbowe@redlakenation.org

BIOASSESSMENT PROGRAM ON THE RED LAKE RESERVATION

The Red Lake Reservation is located in north-central Minnesota. Water resources are of great cultural, economic, and social importance to Tribal members. The Red Lake Department of Natural Resources (RLDNR) strives to keep waters of the Reservation healthy. Water quality parameters have been monitored and nutrients sampled for the last 20 years. A biological monitoring program will help track changes in water quality more effectively than sampling nutrients alone. Methods are being developed following the guidelines of the Minnesota Policy Control Agency (MPCA) to allow for comparison of data across the state, and sites selected from a previous study are being re-visited at a rate of ten streams per year. Approximately 65 sites will be visited. Preliminary sampling has occurred at some of the sites. Monitoring includes physical water quality parameters and water sampling, fish and invertebrate sampling, and habitat evaluation. Upon completion of monitoring all sites, data will be compared with the Index of Biotic Integrity developed by the MPCA for Minnesota streams. Management decisions for waterbodies will be determined based on these results.

Bowman, M. F., n/a, Guelph, Canada, michelle.f.bowman@gmail.com

Orr, P. L., Minnow Environmental Inc., Georgetown, Canada, porr@minnow-environmental.com

Russel, C. K., Minnow Environmental Inc., Georgetown, Canada, crussel@minnow-environmental.com

DEVELOPING THRESHOLDS THAT ARE BOTH ECOLOGICALLY MEANINGFUL AND STATISTICALLY RIGOUROUS

Environmental study designs typically involve comparisons of an ecosystem attribute with a reference threshold (i.e., mean, range). Statistics are an objective means of incorporating information on magnitude of difference, variability, sample size, and probability into a threshold. However, these statistically-derived thresholds are not necessarily meaningful ecologically. We will use applied ecological studies to illustrate the utility of a methodology that reconciles statistical rigor and ecological relevance. This equivalency testing methodology is commonly used for drug efficacy testing in the medical field. The benthic macroinvertebrate community thresholds developed for assessment of metal-mining activities on stream ecosystems using equivalence testing were more ecologically relevant than traditional thresholds. In addition, confidence in our assessments was strengthened by using equivalence testing to ensure an appropriate amount of similarity between the habitat of a potentially impaired stream of interest and the habitat of candidate reference streams. The use of equivalence testing not only improves the accuracy and precision of bioassessments but has many potential applications in ecology.

Boyer, E. W., Penn State, University Park, PA, USA, ewb100@psu.edu

Galloway, J. N., University of Virginia, Charlottesville, VA, USA, jng@virginia.edu

Alexander, R. B., USGS, Reston, VA, USA, ralex@usgs.gov

Smith, R. A., USGS, Reston, USA, rsmith1@usgs.gov

Lashaway, A. R., Penn State, University Park, PA, USA,

A CONTEMPORARY NITROGEN ASSESSMENT FOR WATERSHEDS OF THE USA

Inputs of reactive nitrogen to the environment have increased markedly over the past century, associated with demands for nitrogen in agriculture and industry, and the combustion of fossil fuels. While nitrogen plays a key role in reducing world hunger by improving crop yields, it also is a major contributor to some pressing environmental concerns, including acidification of lakes and streams, disruption of forest processes, and coastal eutrophication. The duality of nitrogen -- important for food and energy yet linked to environmental degradation -- presents a challenge for sustainability. Here, we present a contemporary nitrogen assessment for the USA, quantifying inputs to air, land, and water. We discuss sources and losses of nitrogen in contrasting watersheds; consider potential effectiveness of reducing nitrogen inputs, and highlight implications for water quality in inland and coastal waters. Our accounting framework is useful for considering change over time and progress toward goals as strategies to mitigate nitrogen pollution are implemented.

Bozek, M. A., U.S.G.S., Wisconsin Cooperative Fishery Research Unit, Stevens Point, WI, USA, michael.bozek@uwsp.edu

Scribner, N. T., Wyoming Game and Fish Department, Lander, WY, USA, nick.scribner@wgf.state.wy.us

Newbrey, M. G., Royal Terrell Museum, Drumheller, AB, Canada, mike.newbrey@gov.ab.ca

RELATIONS BETWEEN STRUCTURE OF COARSE WOODY HABITATS AND FISH IN THE LITTORAL ZONE OF A NORTH TEMPERATE LAKE

Submerged trees may be important structural habitats for fish and wildlife in the littoral zones of north temperate lakes, but their role is unclear. The objective of this study was to elucidate patterns of fish abundance and position among and within the complex array of structural habitat created by trees in order to understand how fish use and partition complex habitats. Submerged trees in the littoral zone of Lake Katherine, Wisconsin were surveyed by SCUBA and snorkeling. Habitat created by submerged trees was quantified and fish abundance was estimated from visual observations. Branching complexity was the most important feature of submerged trees in explaining variation in fish abundance for numerous species. At least thirteen species of fish were found inhabiting individual submerged conifer trees and species partitioned those habitats. Bluegill and rock bass were generalists found throughout all areas of the boles and branches. Walleye were specialists found almost exclusively

beneath the trees (boles or branches) in water at least 3 m deep. Largemouth and smallmouth bass were more exclusive to the branches areas of trees with largemouth bass more commonly found above the bole whereas smallmouth bass were more common below the bole. The contribution of riparian trees to the functional dynamics of littoral zones of north temperate lakes is substantial and affects a variety of ecological processes.

Bozeman, **M**. **M**., Yale University, New Haven, USA, maura.bozeman@yale.edu
Raymond, P. A., Yale University, New Haven, USA, peter.raymond@yale.edu

INFLUENCES OF DOM COMPOSITION ON INORGANIC NUTRIENT COMPETITION BETWEEN AUTOTROPHS AND HETEROTROPHS AND THE AFFECTS ON CARBON (C) DISTRIBUTION IN LAKES

The amount and composition of available DOM and inorganic nutrients imported to aquatic ecosystems influences heterotrophic C allocation. Bacteria can deplete inorganic nutrients and exacerbate nutrient limitation of autotrophs and therefore decrease CO_2 fixation and particulate organic matter production (POM). In this way, bacteria not only increase heterotrophy, but curb autotrophy, however characteristics of imported DOM largely temper heterotrophic activity. We added DOM varying in chemical composition (dextrose, wetland derived, and algal derived) over a range of inorganic nutrient concentrations to microcosms of pelagic lake water to understand changes in net metabolism and POM production. Dextrose fueled rapid bacterial growth and nutrient immobilization, however, this extreme heterotrophy induced DOM limitation. This resulted in the slow remineralization of nutrients and allowed autotrophy to recover. Algal derived DOM sustained constant but slower bacterial growth, which maintained low inorganic nutrient availability and lower autotrophy. Bacteria used little wetland derived DOM and unrestricted autotrophy increased algal exudation. Exudates stimulated bacteria and wetland DOM decomposition and highest net POM production. Composition of imported DOM can control links between autotrophs and heterotrophs affecting ecosystem C distribution.

Brabec, **K**., Research Centre for Toxic Compounds in the Environment, Masaryk University, Brno, Czech Republic, brabec@recetox.muni.cz
Kubosova, K., Institute for Biostatistics and Analyses, Masaryk University, Brno, Czech Republic, kubosova@iba.muni.cz
Jarkovsky, J., Institute for Biostatistics and Analyses, Masaryk University, Brno, Czech Republic, jarkovsky@iba.muni.cz
Hajek, O., Department of Botany and Zoology, Masaryk University, Brno, Czech Republic, ohajek@sci.muni.cz
Bartusek, P., Institute for Biostatistics and Analyses, Masaryk University, Brno, Czech Republic,
Kohut, L., Research Centre for Toxic Compounds in the Environment, Masaryk University, Brno, Czech Republic, kohut@iba.muni.cz

NATURAL AND STRESSOR DRIVERS OF INVERTEBRATE COMMUNITIES INTERACTING IN LONGITUDINAL DIMENSION OF STREAM ECOSYSTEMS: FROM PILOT STUDIES TO REGIONAL PATTERNS

Interacting effects of stream zonation, landuse, bank and floodplain characteristics on structure of macroinvertebrate communities complicate tracking of biotic response to environmental changes. Pilot studies were concentrated to specific types of streams, predominant anthopogenic impacts or certain geographical area. Advantage of such studies were detailed and standardized identification of biota, wider spectrum of measured parameters. Statistical analyses of complex data allowed to indentify most relevant biological indicators and arrange them in assessment systems. Individual studies were focused on effects of organic pollution, eutrophication, morphological degradation and river continuum disruption. Structure and trait-based parameters of macroinvertebrate communities were linked to stressor intensity, modified thermal regime and complex longitudinal zonation of streams and rivers. Presented study aimed to upscale of pilot studies results to larger dataset collected within monitoring programmes in the Czech Republic. Cold stenothermy preference, temperature optimum, zonation score, feeding strategies, sensitivity scores, distribution of individual taxa, taxa richness and proportion of taxonomic groups were examples of macroinvertebrate characteristics responding to studied environmental gradients. Upscaling may be associated with new calibration of tresholds and redefinition of stream types.

Gemmell, B. J., University of Texas at Austin, Port Aransas, USA, bgemmell@mail.utexas.edu
Ed Buskey, E. J., Univeristy of Texas at Austin, Port Aransas, USA, ed.buskey@mail.utexas.edu

FLYING PLANKTON? COPEPODS TAKE TO THE SKY IN EFFORT TO AVOID PREDATORS

Planktonic copepods are important prey items for a wide variety of aquatic organisms including fish. As a result these minute crustaceans have developed a strong escape behavior in response to active predators. Until now, all studies on the behavior and escape kinematics of copepods has been performed in a liquid environment, however, we have observed copepods within the genera *Labidocera* and *Anomalocera* exhibiting escapes where individuals frequently broke the surface tension of the water and traveled many times their own body length through air in an effort to avoid fish predators in situ. We used a lab based high speed video system to record and analyze the detailed kinematics of this novel behavior, including speed and the rate of rotation during escapes (which can exceed 1000 mm/sec and 7500 rpm) which allowed us to estimate force and energy requirements for this behavior. We found that these neustonic copepods are able to move a greater distance from a predator by travelling through air, than water, and we illustrate how this may be an adaptive defense mechanism against surface feeding visual predators.

Bradley, **P**. **M**., US Geological Survey, Columbia, USA, pbradley@usgs.gov
Journey, C. A., US Geological Survey, Columbia, USA, cjourney@usgs.gov
Murray, K. R., US Geological Survey, Albany, USA, krmurray@usgs.gove
Burns, D. A., US Geological Survey, Albany, USA, daburns@usgs.gov

ASSESSMENT OF METHYLMERCURY SOURCE AREAS IN SMALL HEADWATER CATCHMENTS IN SOUTH CAROLINA AND NEW YORK

The USGS National Water Quality Assessment Program (NAWQA) is investigating the ecological interactions affecting methylmercury (MeHg) accumulation in the water-columns and indigenous biota of surface water systems across the USA. The current focus is on the sources, transport, and bioavailability of MeHg in two small, headwater catchments (Fishing Brook in the Adirondacks region of New York; McTier Creek in the Atlantic Coastal Plain of South Carolina) in which clear hydrologic and geochemical connections have been demonstrated between the main stream channels (the presumptive primary habitat for higher trophic-level fish species) and the out-of-channel wetland environments (the presumptive primary locations of Hg methylation and MeHg supply). Spatial variability within each study catchment was assessed based on concentrations and area-weighted fluxes of dissolved MeHG from selected catchment sub-compartments. Relatively little spatial variability was observed in the McTier Creek system, suggesting a general balance in the supply of MeHg and water to the stream channel. In contrast, substantial spatial variability was observed in the Fishing Brook system, with distinct areas of MeHg supply and removal being identified. In both study catchments, maximum dissolved MeHg concentrations were observed in out-of-channel wetland areas.

Brandes, **J**. **A**., Skidaway Institute of Oceanography, Savannah, USA, jay.brandes@skio.usg.edu
Paffenhöfer , G., Skidaway Institute of Oceanography, Savannah, USA, Gustav.Paffenhofer@skio.usg.edu
Köster , M. .Germany, koesterm@uni-greifswald.de

CARBON ISOTOPIC SIGNATURES OF DOLIOLID PELLET DEGRADATION

Doliolids and salps are intermittently dominant members of the zooplankton on the southeastern US shelf. These organisms have been shown to produce fecal pellets that differ in important physical and chemical parameters from those produced by copepods. The remineralization of these and other sinking particles creates a measurable signal in the oceanic dissolved inorganic carbon pool (DIC) at depth, and this signal has been used by researchers to constrain the export flux from surface waters. Recent development of small-scale methods for measuring the concentration and isotopic composition of DIC provides an opportunity to measure these signals on individual pellets, thus providing fundamental information. Data from doliolid pellet degradation experiments will be presented, as well as a discussion of this new method.

Brasher, **A**., U.S. Geological Survey, Moab, USA, abrasher@usgs.gov
Delgai, S., University of Arizona, Tucson, USA, sdelgai@hotmail.com
Davis, W., Leech Lake Tribal College, Cass Lake, , widavis@students.lltc.edu

HABITAT UTILIZATION AND LIFE-HISTORY CHARACTERISTICS OF FRESHWATER CRABS (PSEUDOTHELPHUSIDAE) IN THE LAS CRUCES BIOLOGICAL RESERVE, COSTA RICA

A common life-history strategy for tropical stream fauna is amphidromy, where larvae drift to the ocean and spend a period in a planktonic stage prior to returning to streams for the remainder of their life. We conducted a 5-week study to investigate habitat use and life history characteristics of freshwater crabs (Pseudothelphusidae) located above the upper distribution of amphidromous species. Distribution and abundance of crabs were recorded at four sites in three streams ranging in elevation from 1000 to 1350 meters in the Las Cruces Biological Reserve, Coto Bruce, Costa Rica. Juveniles occurred primarily in small shallow tributary streams while adults were only captured in the larger Rio Java. A total of 102 crabs were collected, measured, and tagged during the study, with 12 individuals recaptured one or more times. Habitat characteristics were recorded along a 30-meter reach at each site and included water depth, velocity, substrate type, temperature and riparian canopy cover. Our results suggest that juvenile crabs live in small tributaries and then migrate to large rivers where they spend their adult stage foraging primarily on land.

Bratton, **J**. **F**., U.S. Geological Survey, Woods Hole, USA, jbratton@usgs.gov

CONCEPTUAL MODELS OF CONTROLS ON SPATIAL VARIABILITY OF SUBMARINE GROUNDWATER FLOW AND DISCHARGE

New approaches to studying submarine groundwater systems developed over the last two decades have shown a great amount of spatial variability in flow and discharge. Some of this variability is influenced by well-studied onshore parameters such as hydrostratigraphy, climate, topography, and vegetation. Offshore parameters controlling spatial variability, however, have not generally been conceptualized as clearly. Variability of submarine groundwater flow and discharge on passive continental margins can be examined effectively by considering the following three distinct spatial scales: (1) the nearshore or beach scale, spanning ~0-10 m offshore, and including the unconfined surficial aquifer and the intertidal recirculation cell, where present; (2) the embayment or inner shelf scale, spanning ~10 m to 10 km offshore, and including the uppermost confined submarine aquifer and its terminus; and (3) the shelf scale, spanning the width (generally ~80 km) and thickness of the aquifers of the entire continental shelf, from the base of the uppermost confined aquifer downward, and including influences of geothermal convection and glacio-eustatic sea-level change.

Brauns, **M**., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, brauns@igb-berlin.de
Maehrlein, M., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, marlen.maehrlein@igb-berlin.de

HIGH SPATIAL VARIABILITY OF MACROINVERTEBRATE SECONDARY PRODUCTION IN A SHALLOW LOWLAND LAKE

Benthic secondary production is an important function of lake ecosystems, but little is known about its distribution within and across the different depth zones. We investigated macroinvertebrate secondary production in all occurring habitat types and depth zones of a shallow lowland lake in North-East Germany. Coarse woody debris (CWD), reed stands and sand were sampled for macroinvertebrates in the littoral zone, whereas mud was sampled in the sublittoral and profundal zone. Individual weight and biomass were determined using length-mass relationships and taxon specific secondary production was estimated using the size-frequency method. Secondary production within the littoral zone was highly variably among habitats with 53% of whole-littoral secondary production occurring on reed, 41% on sand and 6% on CWD. Across depth zones, 92% of whole-lake secondary production occurred in the littoral zone, whereas the contribution of the sublittoral and profundal zone to whole-lake secondary production was only 8% and 0.1%, respectively. Our results suggest that studies on secondary production in lakes should be stratified by habitat type and emphasize the significance of the littoral zone for lake ecosystem functioning.

Bremigan, **M**. **T**., Michigan State University, East Lansing, USA, bremigan@msu.edu
Alger, B. M., National Marine Fisheries Service, Gloucester, USA, Brett.Alger@noaa.gov
Cheruvelil, K. S., Michigan State University, East Lansing, USA, ksc@msu.edu
Soranno, P. A., Michigan State University, East Lansing, USA, soranno@msu.edu
Webster, K. E., Michigan State University, East Lansing, USA, k.webster@qub.ac.uk

QUANTIFYING THE INFLUENCE OF TERRESTRIAL, FRESHWATER, AND HUMAN LANDSCAPES ON FISH ASSEMBLAGES IN 360 NORTH-TEMPERATE LAKES

Efforts to classify lakes or streams for fish species composition demonstrate that fish assemblages are strongly influenced by spatially-explicit aspects of terrestrial and freshwater landscapes. However, most classifications have been developed over relatively small spatial scales compared to national and international efforts underway to assess freshwaters. As the spatial breadth of assessments increases, so does the challenge of distinguishing hydrogeomorphic and anthropogenic drivers of variability. We analyzed fish assemblage, hydrogeomorphic, and anthropogenic data from 360 lakes across Maine, New Hampshire, Michigan, Wisconsin, and Iowa, USA. After statistically removing anthropogenic effects, we developed a hydrogeomorphic classification system of 11 classes explaining 60% of among lake variation in fish species richness (mean lake species richness ranging 3.1 – 20.2 species per class), based mainly on lake area, ecological drainage unit (a regional variable) and lake hydrology. Subsequently, we quantified class-specific responses of fish assemblages to anthropogenic factors (land use, dams, human population density, stocking). Despite some consistencies, the significant anthropogenic drivers, and the direction of their effects, varied between small and large lakes, and between recreational and non-recreational species, demonstrating the classification's value.

Brennan, **M**. **P**., Indiana University, Bloomington, USA, mpbrenna@indiana.edu
Johnson, L. T., Indiana University, Bloomington, USA, latjohn@indiana.edu
Royer, T. V., Indiana University, Bloomington, USA, troyer@indiana.edu
Leff, L. G., Kent state University, Kent, USA, leff@kent.edu

TEMPORAL VARIATION IN THE EFFECT OF LABILE CARBON ON DENITRIFICATION IN AN AGRICULTURAL STREAM IN INDIANA

Increased nitrogen concentration is a water quality problem in agricultural streams. Denitrification in sediments can reduce nitrogen in streams although the effect of dissolved organic carbon (DOC) quality on denitrification is not well understood. We examined temporal variation in how carbon of various quality affected denitrification in sediments from a first-order agricultural stream. In addition to simple organic compounds(acetate and formate), we used leachate from corn leaves, maple leaves, soil and algae. Furthermore, a whole-stream six day injection of labile DOC was conducted and denitrification was assessed before and after the addition. Denitrification rates measured March-June averaged 2.8 mg N_2 O-N m^2 h^{-1} (± 0.4). The effect of each carbon treatment was assessed relative to a control. Based on the relative effect, the leachates at times elicited a greater effects than did the organic acids. The whole-stream addition of labile DOC influenced how sediments responded to carbon amendments in laboratory assays. Overall, our results indicate that the effect of DOC quality on denitrification is temporally variable and probably reflects changes in ambient DOC composition or bacterial communities.

Brett, **M**. **T**., Univ. of Washington, Seattle , USA, mtbrett@u.washington.edu
Kainz, M. J., WasserCluster Lunz—Biological Station, Donau-Universitat Krems, Lunz am See, Austria, martin.kainz@donau-uni.ac.at
Taipale, S. J., Univ. of Washington, Seattle , USA, samit@u.washington.edu
Seshan, H., Univ. of Washington, Seattle , USA, hs9@u.washington.edu

THE IMPORTANCE OF ALLOCHTHONOUS CARBON AND PHYTOPLANKTON FOR ZOOPLANKTON PRODUCTION: A FATTY ACID BIOMARKER ASSESSMENT

Terrestrial organic matter inputs have long been thought to play an important role in aquatic food web dynamics and recent whole lake experiments suggest terrestrial particulate organic carbon (t-POC) inputs account for a disproportionate portion of zooplankton production. We conducted direct experiments to test the food quality of t-POC and various phytoplankton for Daphnia. These experiments showed t-POC is much lower food quality than diatoms, cryptophytes and green algae, but similar quality compared

to cyanobacteria. Small additions of high quality phytoplankton to t-POC dominated diets greatly increased Daphnia growth and reproduction. A fatty acid biomarker assessment showed that when Daphnia obtained 80% of their available food from t-POC, they assimilated 84% of their FAs from the phytoplankton component of their diet. Although phytoplankton FAs strongly dominated Daphnia FA profiles when they consumed mixed diets, Daphnia that consumed a high proportion of t-POC were characterized by higher omega-6 and saturated FA content. These results show t-POC is not likely to be an important subsidy of consumer production and FAs can provide strong insights into which food sources support zooplankton production.

Bridges, **L**. **W**., Eastern Washington University, Cheney, USA, shortys8118@msn.com
Hodgson, A., Eastern Washington University, Cheney, USA, noonemaycomehere@gmail.com
Black, A. R., Eastern Washington University, Cheney, USA, rblack@ewu.edu

THE EFFECTS OF A FISH INVASION ON THE INVERTEBRATE CONSTITUENTS OF WETLAND COMMUNITIES.

Our study assessed impacts of invasive brook stickleback (Culaea inconstans) on the invertebrate composition of several wetland communities within the Turnbull National Wildlife Refuge (TNWR: Spokane Co., WA). TNWR possesses in excess of 130 wetlands, originally 96% of which were fish-free. Waterfowl managers have expressed concern due to the potential for competition between Culaea and waterbirds. Our studies focused on testing the significance of Culaea effects on wetland invertebrates. We predicted a reduction in zooplankton and benthic macroinvertebrate abundance in ponds where Culaea have invaded. Comparison of the invertebrate communities of invaded versus fish-free waters shows significantly lower abundance of ostracods, branchiopoda, and copepoda with fish presence. In 350 L mesocosm experiments Culaea significantly reduced the abundance of branchiopoda (Daphnia and Lynceus), copepoda (Diaptomus), and several macroinvertebrates (annelida, diptera, and zygoptera). Electivity trials indicate Culaea exhibit positive electivity for Daphnia and Chaoborus, are neutral towards Diaptomus, and avoid Diacyclops. Our results suggest the effect of Culaea is limited to small (zooplankton) or soft bodied prey (annelida, diptera, zygoptera).

Brigham, **M**. **E**., U.S. Geological Survey, Mounds View, USA, mbrigham@usgs.gov

METHYLMERCURY IN STREAM ECOSYSTEMS ACROSS THE UNITED STATES

Conversion of inorganic mercury to methylmercury is an important biogeochemical process in aquatic ecosystems. Even in waters that receive mercury only through atmospheric deposition, fish can accumulate high methylmercury levels. The U.S. Geological Survey measured methylmercury as part of a national survey that consisted of one-time sampling of 291 streams, and in detailed temporal studies of 10 streams covering a range of seasons and hydrologic conditions. Both studies spanned important gradients relative to the mercury cycle, including wet mercury deposition rate and wetland density. Both within regions of similar mercury atmospheric deposition, and among all streams nationally, wetland density was an important influence on methylmercury in stream water and in fish. Multiple lines of evidence indicate that the source of methylmercury to streams is mercury methylation that occurs predominantly within wetlands and subsequent transport to the stream; in contrast, methylmercury production in streambed sediment is a minor contributor to methylmercury in stream water. Changes in mercury atmospheric deposition would likely produce the greatest changes in methylmercury levels in fish in streams that drain wetland-rich watersheds.

Bright, **E**. **G**., University of Oklahoma, Norman , USA, brighte@ou.edu
Batzer, D. P., University of Georgia, Athens, USA, dbatzer@ou.edu

FLOODPLAIN AQUATIC INVERTEBRATES OF THE SAVANNAH AND ALTAMAHA RIVERS: EFFECTS OF RESTORING NATURAL FLOOD PULSES TO THE SAVANNAH RIVER

In 2004, the US Army Corps of Engineers (USACE) working with The Nature Conservancy began to experimentally release water from reservoirs of the highly regulated Savannah River to mimic natural flood pulses. We examined invertebrate community structure on the Savannah River floodplain in relation to restoring flood pulses. We predicted that floodplain invertebrate community structure of the Savannah River would become more similar to the floodplain invertebrate community structure of the nearby Altamaha River that still has natural flood pulses. USACE released flood pulses in 2005 and 2006, but were not able to in 2007 and 2008. We examined total invertebrate abundance and community structure on floodplains of the two rivers, and between pulsed and non-pulsed years in the Savannah. Overall, invertebrate community structure did not differ significantly between the two rivers, or between pulsed and non-pulsed years in the Savannah. However, abundances of certain taxa (Dytiscidae, Planorbidae, Nematoda, terrestrial spiders) were higher in the Altamaha than Savannah floodplains. These taxa may be useful indicator organisms to evaluate the success of on-going pulse releases scheduled for the Savannah River.

Brim Box, **J**., CTUIR, Pendleton, USA, brimbox@gmail.com
Nez, D., CTUIR, Pendleton, USA, donnanez@ctuir.com
O'Brien, C., CTUIR, Pendleton, USA, christine.amblema@gmail.com
Mock, K., Utah State University, Logan, USA, karen.mock@usu.edu
Wolf, D., CTUIR, Pendleton, USA, davidwolf@ctuir.com

THE CTUIR FRESHWATER MUSSEL PROJECT: USING A FIRST FOODS APPROACH TO ENHANCE CONSERVATION

The Confederated Tribes of the Umatilla Indian Reservation's (CTUIR) Department of Natural Resources has adopted a mission statement based on culturally recognized foods ("First Foods"). All programs in the department strive to protect, restore, and enhance the First Foods for the perpetual cultural, economic and sovereign benefit of the CTUIR. This is accomplished using traditional ecological and cultural knowledge and science. Within this context, freshwater mussels are culturally important and are vital components of intact salmonid ecosystems. In 2003 the CTUIR began its freshwater mussel project in order to better manage, restore and protect this valuable and enigmatic resource. The approach taken by the CTUIR was multi-pronged, and included distributional surveys, genetic and physiological analysis, habitat characterization at multiple scales, and host fish determination. Current efforts include a pilot study to restore freshwater mussels in the Umatilla River, where salmon (a potential host fish) had been missing for over six decades. Project employees work closely with the tribal community, state and federal resource agency personnel, the public and others to further freshwater mussels conservation efforts in the western United States.

Bronk, **D**. **A**., The College of William & Mary/VIMS, Gloucester Point, USA, bronk@vims.edu
Funkey, C. P., The College of William & Mary/VIMS, Gloucester Point, USA, cfunkey@vims.edu
Sanderson, M. P., The College of William & Mary/VIMS, Gloucester Point, USA, mps@vims.edu
Roberts, Q. N., The College of William & Mary/VIMS, Gloucester Point, USA, qroberts@vims.edu
Mulholland, M. R., Old Dominion University, Norfolk, USA, mmulholl@odu.edu
Love, N. G., University of Michigan, Ann Arbor, USA, nglove@umich.edu
Mesfioui, R., Old Dominion University, Norfolk, USA, RMesfiou@odu.edu
Hatcher, P., Old Dominion University, Norfolk, USA, phatcher@odu.edu
Schweitzer, C., Old Dominion University, Norfolk, USA, cschweit@odu.edu
Filippino, K. C., Old Dominion University, Norfolk, USA, kcfilipp@odu.edu

EFFLUENT ORGANIC NITROGEN BIOAVAILABILITY: THE IMPACT OF DIRECT UPTAKE, PHOTOREACTIVITY AND SALINITY-MEDIATED RELEASE

Wastewater treatment plants (WWTP) are significant contributors of nitrogen (N) to coastal eutrophication. The goal of this study was to investigate three ways that the organic N fraction of WWTP effluents (EON) could contribute to coastal eutrophication – direct uptake, photochemical release of labile N, and salinity-mediated release of labile N. Here we update our earlier report on studies where these mechanisms were quantified with effluents from several WWTPs. Bioassays were conducted where EON was added to water from three to four salinities, spanning the salinity spectrum from 0 to 30, collected from the James or York Rivers (VA). Nutrient and biomass concentrations were measured periodically over 2-5 days. Bioassay results for all effluents tested indicate that some fraction of the EON was bioavailable. EON was also found to be highly photolabile with significant production of ammonium and DPA observed in most effluents. Results from salinity release assays indicate that ammonium and DPA can also be released from EON when exposed to higher salinities. Our findings to date indicate that EON can be an important contributor to eutrophication in aquatic systems.

Browman, **H**. **I**., Institute of Marine Research, Storebø, Norway, howard.browman@imr.no

Skiftesvik, A. B., Institute of Marine Research, Storebø, Norway, anne.berit.skiftesvik@imr.no

A MECHANISTIC PERSPECTIVE ON THE FINE-SCALE INTERACTIONS BETWEEN ICHTHYOPLANKTON AND ZOOPLANKTON

As a doctoral student of John's from 1985-1989, I designed and built a silhouette imaging system that we used to obtain observations of the fine-scale interactions of fish larvae and their zooplankton prey. A modernized (all digital) 3-D silhouette imaging system is still a major backbone of our research program. A significant component of my research since leaving John's lab has been devoted to the mechanisms underlying fish predation on zooplankton. The co-author of this presentation has been a close collaborator in this work for the past 12 years. We are thereby continuing John's legacy. We will use a case-study approach to trace this aspect of our W.J. O'Brien-inspired research from 1985 to today, including a range of species both freshwater and marine.

Brown, **A**. **V**., University of Arkansas, Dept. of Biol. Sciences, Fayetteville, USA, artbrown@uark.edu

Matlock, M. D., University of Arkansas, Dept. of Biol. and Agri. Engineering, Fayetteville, USA, mmatlock@uark.edu

Haggard, B. E., University of Arkansas, Dept. of Biol. and Agri. Engineering , Fayetteville, USA, haggard@uark.edu

Cummings, E. C., University of Arkansas, Dept. of Biol. and Agri. Engineering , Fayetteville, USA, ecummin@uark.edu

BIOASSESSMENT OF THE OSAGE CREEK TRIBUTARY TO THE ILLINOIS RIVER OF ARKANSAS AND OKLAHOMA

Water quality was examined from fall 2007-2009 following US Environmental Protection Agency Rapid Bioassessment Protocols and Arkansas Department of Environmental Quality (ADEQ) methods at two reference and eight test sites including up- and downstream of Rogers and Springdale, AR Waste Water Treatment Plants (WWTPs). Study sites were in the Springfield Plateau of the Ozark Plateaus ecoregion. Comparison of test sites with reference streams indicated generally depressed environmental quality below WWTPs, but nutrient concentrations and biotic indicators improved significantly downstream. While upstream and downstream sites differed, ADEQ criteria were not violated by the WWTPs. Total phosphorus was significantly related to periphyton biomass (r^2 0.15, p = 0.006) and grazing fish densities (r^2 0.11, p = 0.02), but not strongly. Fish and invertebrate Indices of Biotic Integrity (IBI) compared favorably with each other (r^2 0.28, p <0.03). Critical and primary season IBIs were not different (p = 0.48-0.58). Habitat was related to IBIs as well as nutrient levels. A stepwise model of factors predicting densities of primary feeding fish selected only total phosphorus and % canopy cover (r^2 0.29, p = 0.0006).

Brown, **B**. **L**., SUNY College of Environmental Science and Forestry, Syracuse, USA, blbrow01@syr.edu

Schulz, K. L., SUNY College of Environmental Science and Forestry, Syracuse, USA, kschulz@syr.edu

Ringler, N. H., SUNY College of Environmental Science and Forestry, Syracuse, USA, neilringler@esf.edu

USING FIELD EXPERIMENTATION TO ASSESS BENTHIC MACROINVERTEBRATE RECOVERY IN A HIGHLY DISTURBED LAKE (ONONDAGA LAKE, NY)

Onondaga Lake is a highly disturbed system undergoing a large scale remediation effort. Recent surveys of the macroinvertebrate community show Onondaga Lake is dominated by pollution-tolerant taxa. To assess potential recovery of the macroinvertebrate community in Onondaga Lake, I compared dispersal of macroinvertebrates to artificial substrates in Onondaga Lake with those in a reference lake (Otisco Lake). Fewer families (19 vs. 24) were collected on substrates in Onondaga Lake than in Otisco Lake. Some taxa dispersed exclusively to one lake, including two mayfly families (Heptageniidae and Caenidae) that only dispersed to Otisco Lake. The exotic quagga mussel was exclusively found in Onondaga Lake; exotic zebra mussels dominated community composition in Onondaga Lake. Crustacea-Mollusca taxa, Percent Exotic Dreissenidae, and Percent Non-insects showed differences between lakes most often. Length of deployment of artificial substrates should be considered in sampling design when monitoring recovery in lentic systems. Stenonema femoratum may not be able to survive in Onondaga Lake; a combination of both sediment and water quality may be inhibiting survival of this species.

Brown, **B**. **L**., Clemson University, Clemson, USA, bbrown3@clemson.edu

Baldwin, R. F., Clemson University, Clemson, USA, ejrbbald@gmail.com

Pike, J., Clemson University, Clemson, USA, PIKE@CLEMSON.EDU

English, W. E., Clemson University, Clemson, USA, renglsh@clemson.edu

LOCAL VERSUS REGIONAL EFFECTS IN STRUCTURING BENTHIC MACROINVERTEBRATE COMMUNITIES

Communities are structured by two types of processes: local and regional. Local processes include species' responses to environmental conditions and interactions between species. Regional processes are primarily driven by dispersal of organisms. For riverine systems, theory and empirical analysis of macroinvertebrate communities has found that the relative balance of local vs. regional effects changes depending on location of within networks. Headwater communities are primarily structured by local forces, while mainstem communities represent a combination of local and regional (i.e., dispersal-driven) forces because mainstems aggregate processes within riverine networks due to the influence of bulk flow of water downstream. We used data from two recent macroinvertebrate surveys in South Carolina to examine how the relative balance of local and regional forces changes with location in riverine networks. Using analysis of distance decay in community and environmental similarity, we determined that invertebrate metacommunities at both Kings Mountain National Military Park and Fort Jackson agreed with previous results that dispersal driven dynamics played a larger role in structuring mainstem communities relative to headwater communities.

Brown, **J**. **H**., University of New Mexico, Albuquerque, USA, jhbrown@unm.edu

Much of ecology is concerned with metabolism: the biological transformation of energy and materials. The metabolic theory of ecology (MTE) provides a unified synthetic framework showing how body size, temperature, and stoichiometry affect the metabolic rates of individual organisms, and how metabolic rates determine many biological processes at levels from molecules to the biosphere. Of course, temperature is particularly important for aquatic ecosystems and their ectothermic invertebrate inhabitants. I will explore the strengths and limitations of how MTE might be applied and the kinds of insights such applications might offer.

Brownstein, **J**. **D**., University of Nevada, Reno, Reno, USA, jbrownstein@cabnr.unr.edu

Chandra, S., University of Nevada, Reno, Reno, USA, sudeep@cabnr.unr.edu

Henery, R., University of Nevada, Reno, Reno, USA, renehenery@gmail.com

Goldman, C. R., University of California, Davis, Davis, USA, crgoldman@ucdavis.edu

SEASONAL AND SPATIAL PATTERNS OF SECONDARY BENTHIC PRODUCTION IN A SUB-ALPINE LAKE (CASTLE LAKE, CALIFORNIA)

To determine seasonal and spatial patterns in aquatic energy contributions to consumers, benthic and emergent invertebrate densities were measured in a mesotrophic sub-alpine lake. The dominant emergent invertebrate, Chironomidae, reached peak densities ($45/m^2$) in the eulittoral and sub-littoral depths. Mean density of emergence decreased by 85% from late spring to early fall. Emergent Ephemeroptera and Odonata were both most abundant at eulittoral depths. Odonate densities peaked ($1.4/m^2$) in late spring and ephemeropterans peaked ($0.8/m^2$) in late summer. Benthic invertebrate densities and diversity were highest in eulittoral and sub-littoral habitats. Chironomidae and Ephemeroptera densities peaked in late summer ($2,683/m^2$ and $678/m^2$, respectively), while Odonata reached peak density ($332/m^2$) in early fall. Pelagic primary production observed early in the season likely contributed to the increased secondary production later in the season. Benthic invertebrate densities outnumbered emergence densities, and during peak emergence, only 4% of dominant benthic invertebrates emerged. This suggests that invertebrates did not enter the terrestrial landscape at their maximum potential possibly due to high fish density from stocking or natural mortality.

Brua, **R. B.**, Environment Canada, National Water Research Institute, Saskatoon, SK, Canada, Bob.Brua@ec.gc.ca

Culp, J. C., Environment Canada, Canadian Rivers Institute & Department of Biology, University of New Brunswick, Fredericton, NB, Canada, Joseph.Culp@ec.gc.ca

Luiker, E. A., Environment Canada, National Water Research Institute, Fredericton, NB, Canada, Eric.Luiker@ec.gc.ca

Curry, R. A., Canadian Rivers Institute & Department of Biology, University of New Brunswick, Fredericton, NB, Canada, racurry@unb.ca

BIODIVERSITY AND FACTORS AFFECTING PERIPHYTON ASSEMBLAGES IN RIVERS ALONG A LATITUDINAL GRADIENT IN CANADA'S EASTERN ARCTIC

Ecological structure and function of Arctic rivers are expected to be modified significantly by climate change and variability, with increased temperature and nutrient availability likely to be key contributors to this change. Through the International Polar Year project, Arctic BioNet, we sampled periphyton assemblages from rock scrapings in 55 rivers along a latitudinal gradient in Canada's Eastern Arctic (i.e., 59° to 82.5°N). We identified 168 algal species; diatoms dominated the assemblages, comprising 81% of all species. The remaining algal species were Cyanobacteria, Chlorophyceae, Chrysophyceae and Euglenophyceae (9, 8, 1 and 1%, respectively). Taxa richness generally declined northward, with greatest richness in Torngats Mountains National Park (Northern Labrador), lowest in Quttinirpaaq National Park (Ellesmere Island), and intermediate at mid-latitude sites in the Resolute (Cornwallis Island) and Iqaluit (Baffin Island) regions. Periphyton assemblages differed among regions except for Quttinirpaaq and Resolute. DOC, pH, and TP were the most influential variables associated with assemblage composition. This research contributes to establishing legacy conditions, and advances our understanding of lotic ecosystem structure and function in Arctic rivers, systems that have received little research attention.

Bruckner, **J. C.**, Desert Research Institute, Las Vegas, NV, USA, bruckner@dri.edu

Fisher, J. C., Desert Research Institute, Las Vegas, NV, USA, jen.fisher@dri.edu

Fritsen, C. H., Desert Research Institute, Reno, NV, USA, chris.fritsen@dri.edu

Memmot, J. C., Desert Research Institute, Reno, NV, USA, jeramie.memmott@dri.edu

Hershey, R. L., Desert Research Institute, Reno, NV, USA, ron.hershey@dri.edu

Heyvaert, A., Desert Research Institute, Reno, NV, USA, Alan.Heyvaert@dri.edu

Szynkewicz, A., Indiana University, Bloomington, IN, USA, aszynkie@indiana.edu

Planer-Friedrich, B., Universitat Bayreuth, Bayreuth, Germany, b.planer-friedrich@uni-bayreuth.de

Moser, D. P., Desert Research Institute, Las Vegas, NV, USA, duane.moser@dri.edu

MICROBIAL BIOGEOCHEMISTRY OF WALKER LAKE, NV: A MODERATELY SALINE, ALKALINE DESERT TERMINAL LAKE.

Walker Lake has been subjected to substantial desiccative stress over the past ~100 years resulting in a >75% decrease in volume and a >5-fold increase in salinity (currently about 1.9%). In recent decades, the hypolimnetic accumulations of sulfide and ammonia of this monomictic terminal lake have been regarded as potentially deleterious to native fish, including the threatened Lahontan cutthroat trout. To characterize the current limnology of Walker Lake, physical measurements, aquatic chemistry analysis and microbiological community surveys were conducted on the water column during stratified and mixing conditions. Molecular and cultivation-based microbial datasets indicated diverse alkaliphilic communities spatially constrained by lake stratification. Several lines of evidence were consistent with metal-driven redox cycling (arsenic, iron) and anaerobic photosynthesis, possibly accounting for an uncharacteristic lack of H_2S observed during stratification. Microscopy, flow cytometry, and pigment analysis revealed a hypolimnetic bloom of putative anaerobic cyanobacteria corresponding to *Synechococcus*-like clones most similar to isolates from Mono Lake, CA. Collectively, these results suggest that Walker Lake may have recently passed a tipping point to a state that increasingly resembles nearby hypersaline Mono Lake.

Bruder, **A.**, Eawag, Dübendorf, Switzerland, andreas.bruder@eawag.ch

Gessner, M. O., Eawag, Dübendorf, Switzerland, mark.gessner@eawag.ch

FUNGAL BIOMASS IN DECOMPOSING LEAF LITTER - COMPARISON AMONG BIOMES ALONG A GREAT LATITUDINAL GRADIENT

Leaf litter is a major source of energy for food webs in forested headwater streams. Factors controlling litter decomposition by microbial decomposers include litter quality, invertebrate decomposer community, and climate. In a multi-site field experiment, we indirectly assessed the influence of these factors on fungal biomass in decomposing leaves. We exposed litter from local species (four functional leaf types: evergreen, nitrogen fixer, fast decomposing, and slow decomposing) in mesh-bags with three different mesh-sizes to vary decomposer communities colonizing the litter. This design was replicated in streams of five biomes ranging from the tropics to the subarctic. Samples were harvested when the most labile species at each site had lost about 60% of the initial leaf mass. Fungal biomass was consistently lowest in the tropics irrespective of functional leaf type and mesh-size. In other biomes, effects of mesh-size and functional litter type on fungal biomass were small. Overall, these findings highlight the similarly important role of fungal litter decomposers in a range of stream ecosystems across a broad latitudinal gradient.

Bruesewitz, **D. A.**, University of Waikato, Department of Biological Sciences, Hamilton, New Zealand, dbruesew@waikato.ac.nz

Hoellein, T. J., Baruch College, City University of New York, Department of Natural Sciences, New York City, USA, Timothy.Hoellein@baruch.cuny.edu

Hamilton, D. P., University of Waikato, Department of Biological Sciences, Hamilton, New Zealand, davidh@waikato.ac.nz

ECOSYSTEM METABOLISM AND NUTRIENT CYCLING IN STREAMS ACROSS A GRADIENT OF GEOTHERMAL ACTIVITY (TAUPO VOLCANIC PLATEAU, NEW ZEALAND)

The iconic Rotorua Lakes of New Zealand are experiencing eutrophication from increasing catchment agricultural land use. Several of these lakes are unique in having geothermal stream inputs that may influence lake trophic status. It is unclear whether rates of nutrient cycling and ecosystem metabolism are different in geothermal vs. non-geothermal streams. In January 2010, we measured gross primary production (GPP), community respiration (CR), uptake rates of nitrate, ammonium, and phosphate, and biofilm nutrient limitation on organic and inorganic substrata in geothermal and non-geothermal streams in this region (N=4 of each). While all study sites were net heterotrophic, GPP was lower in geothermal streams than in non-geothermal streams (0.67 vs. 4.34 $gO_2m^{-2}d^{-1}$, respectively, in the high-discharge sites), as was CR (7.83 vs. 17.25 $gO_2m^{-2}d^{-1}$, respectively, in the high-discharge sites). GPP was not nutrient limited and was lower in geothermal vs. non-geothermal streams. CR was limited by either ammonium or ammonium and phosphate together, regardless of geothermal influence. Geothermal streams actively cycle nutrients, primarily via heterotrophic metabolism, and represent important sites of nutrient retention in an increasingly eutrophic landscape.

Brush, **M. J.**, Virginia Institute of Marine Science, Gloucester Point, USA, brush@vims.edu

MODELING ESTUARINE HYPOXIA WITH AN INTERMEDIATE-COMPLEXITY APPROACH, VALIDATION WITH MULTIPLE LINES OF EVIDENCE, AND HYBRID EMPIRICAL-MECHANISTIC FORMULATIONS

Aquatic simulation models have become critical tools for informing management decisions, particularly with regard to cultural eutrophication. Recent efforts have been focused on application of multiple models to address environmental problems, new methods for increasing confidence in model predictions, and methods for incorporating uncertainty. We have been addressing these issues through use of an intermediate-complexity ecosystem model to simulate hypoxia in Narragansett Bay, RI. Following presentation of the approach, three methods for validating model output will be reviewed, including system-level validation, simulation with parallel process formulations, and stochastic simulation. All are proposed to complement existing statistical techniques and provide "multiple lines of evidence" in evaluating model output. The latter method is also an easily-implemented technique for incorporating uncertainty. Finally, an empirical approach has been implemented to convert model output of daily mean dissolved oxygen (DO) concentrations to instantaneous minimum values which reflect the actual management criteria. This approach provides a critical link for managers between model output and management criteria, and through the use of error bounds incorporates estimates of model uncertainty.

Bryan, **B**. **L**., CSU- Dominguez Hills, Carson, USA, bbryan@csudh.edu
Marshall, M. C., U. Georgia, Athens, USA, trinidad@uga.edu
Lopez-Sepulcre, A., UC Riverside, Riverside, USA, andresls@ucr.edu
El-Sabaawi, R. W., Cornell University, Ithaca, USA, rwe32@cornell.edu
Thomas, S. A., U. Nebraska , Lincoln, USA, sthomas5@unl.edu
Flecker, A. S., Cornell University, Ithaca, USA, asf3@cornell.edu>
Reznick, D. N., UC Riverside, Riverside, USA, gupy@ucr.edu
Pringle, C. M., U. Georgia, Athens, USA, cpringle@uga.edu

EFFECTS OF INTRODUCED GUPPIES ON ALGAL COMMUNITY STRUCTURE IN HEADWATER TRINIDADIAN STREAMS

As part of the NSF Frontiers in Integrative Biological Research (FIBR) Guppy Evolution Project, we examined algal communities in two sets of paired (canopy-thinned and shaded) focal headwater study streams in Trinidad, where predation-adapted guppies had been introduced into predator-free reaches of each stream. We also assessed algal community composition and algal biovolume in upstream guppy-free control reaches (containing only Rivulus and crabs) in each of these four focal streams. We predicted that algal community composition would reflect differences in light (dense versus reduced canopy coverage), habitat (riffles or pools), and macroconsumer assemblage (upstream control reach versus guppy introduction reach). We sampled during the dry season in May 2009, when stream flows are stable and biotic interactions are expected to be strongest. Habitat and light had much stronger effects on algal communities than macroconsumer assemblages. While macroconsumer assemblages had no significant effect on overall algal biovolume, the proportion of diatom biovolume in riffle habitats was lower in introduced guppy-introduction reaches than in control reaches. Findings suggest that top-down effects of newly-introduced guppies on algal communities occurred in sunny riffles.

Bryant, **L**. **D**., Virginia Tech, Blacksburg, USA, lebryan1@vt.edu
Lorrai, C., Eawag / ETH, Zurich, Switzerland, claudia.lorrai@eawag.ch
McGinnis, D. F., IFM-GEOMAR, Kiel, Germany, dmcginnis@ifm-geomar.de
Brand, A., University of California, Berkeley, USA, andreas_brand@berkeley.edu
Wueest, A., Eawag / ETH, Zurich, Switzerland, alfred.wueest@eawag.ch
Little, J. C., Virginia Tech, Blacksburg, USA, jcl@vt.edu

VARIABLE SEDIMENT OXYGEN UPTAKE IN RESPONSE TO DYNAMIC FORCING

The amount of dissolved oxygen (O2) taken up by the sediment largely governs O2 depletion in stratified waters with organic-rich sediment. It is becoming apparent that sediment O2 uptake may vary in response to dynamic forcing much more extensively than previously thought. Hence, we performed a study to determine how seiche-induced turbulence affects sediment O2 uptake rate (JO2) in a freshwater, mesotrophic lake. With simultaneous in situ current velocity and O2 microprofile measurements, we characterized surprisingly rapid changes in JO2 and the vertical distribution of O2 at the sediment-water interface. As turbulence shifted from relatively active to inactive, JO2 decreased from 7.0 to 1.1 mmol m-2 d-1, diffusive boundary layer thickness increased from 1.0 mm to the point of becoming undefined, and sediment oxic zone depth decreased from 2.2 to 0.3 mm over a time span of hours. JO2 and sediment O2 consumption rate (RO2) were found to be almost equivalent, with RO2 adjusting to changes in JO2. Our results reveal the transient nature of sediment O2 uptake and the importance of accurately characterizing turbulence when estimating JO2.

Buccu, V., Northeastern University, Boston, USA, vanni.bucci@gmail.com
Nunez-Milland, D., University of South Carolina, Columbia, Uganda, Nunez-Milland@mail.chem.sc.edu
Twining, B., Bigelow Laboratories, West Boothbay Harbor, USA, btwining@bigelow.org
Hellweger, **F**. **L**., Northeastern University, Boston, USA, ferdi@coe.neu.edu

COMBINING AGENT-BASED MODELING AND OBSERVATIONS OF INTRAPOPULATION-VARIABILITY IN PHYTOPLANKTON

Present phytoplankton models typically use a lumped-system modeling (LSM) approach that assumes average properties of a population within a control volume. For modern biogeochemical models that formulate growth as a nonlinear function of the internal nutrient concentration (e.g. Droop kinetics), this averaging assumption has been demonstrated to introduce a significant error. Agent-based modeling (ABM) does not make the assumption of average properties and can simulate intra-population variability in nutrient content. Several ABMs for phytoplankton have been developed by us and other groups, but their predictions of population heterogeneity have not been validated against measurements. This paper presents results from a study aiming to validate an ABM. We developed an ABM for phytoplankton in the Charles River (Boston). The model utilizes transport from a high-resolution, three-dimensional, time-variable hydrodynamic model and receives input from land-side hydrologic models. It is calibrated using conventional measurements (e.g. Chlorophyll a, PO4). Measurements of intra-population distribution of P quotas were performed using novel synchrotron-based x-ray fluorescence (SXRF) for two samples collected at different times (total 66 samples).

Buchwalter, **D**. **B**., North Carolina State University, Raleigh, USA, david_buchwalter@ncsu.edu
Cable, E., North Carolina State University, Raleigh, USA, cableek@hotmail.com
Conley, J. M., North Carolina State University, Raleigh, USA, justinmconley@hotmail.com

ECOPHYSIOLOGICAL RESPONSES OF AQUATIC INSECTS TO MOUNTAINTOP REMOVAL-VALLEY FILL ASSOCIATED STRESSORS (SE, MN, TDS) – AN OVERVIEW

Major chemical stressors associated with mountaintop removal – valley fill coal mining include elevated concentrations of selenium (Se), manganese (Mn) and total dissolved solids (TDS). Although the effects of valley filling on aquatic insect communities in nature can be profound, the role of each of these chemical constituents in altering aquatic communities is unclear because the physiological responses of aquatic insects to these stressors are poorly understood. This talk will provide a synopsis of our research (some published, some ongoing) to date on this topic. Radioisotopic approaches allowed us to determine that, on average, periphyton concentrated Se from water approximately 1100-fold, and the grazing mayfly *Centroptilum triangulifer* subsequently concentrated Se a further 2 to 3-fold over a full life cycle. A considerable quantity of Se was further transferred to eggs, with morphological malformations observed in subsequent generations. Manganese, however, was shed during molting and did not bioaccumulate, but Mn did inhibit Ca transport in insect larvae. We are currently investigating the consequences of environmentally relevant exposures to Se, Mn and TDS on biochemical, physiological and life history endpoints in aquatic insects.

Buck, **D**. **G**., School of Natural Resources and Environment, University of Florida, Gainesville, USA, dgbuck@ufl.edu
Brenner, M., Department of Geological Sciences, University of Florida, Gainesville, USA, mbrenne@ufl.edu
Cohen, M. J., School of Forest Resources and Conservation, University of Florida, Gainesville, USA, mjc@ufl.edu

TEMPORAL AND SPATIAL VARIABILITY OF IN-STREAM NUTRIENTS IN A SMALL TROPICAL CATCHMENT DOMINATED BY SHIFTING CULTIVATION

Tropical rivers and their riparian zones have long served as centers for rural livelihoods and high deforestation rates coupled with population growth is expected to have a disproportionately large impact on tropical freshwater ecosystems (Sala et al. 2000). However, studies incorporating both terrestrial and aquatic ecosystems are exceedingly rare (McClain 2002) and land use impacts on the biogeochemistry of tropical streams are not well understood nor quantified (Biggs et al. 2004). This research examines the impact of land use and land cover change resulting from slash-and-burn agriculture on nutrient biogeochemistry in the Temash River watershed of southern Belize, Central America. Nutrient dynamics in the Temash are controlled by a combination of seasonal variability in watershed hydrology, land use change, and soils. NO3- concentrations reflect changes in watershed hydrology with a large flux of NO3- being exported at the onset of the rainy season. In-stream NO3- is also related to soil NO3- loss resulting from slash-and-burn. The Temash River is strongly P-limited and SRP concentrations are elevated above seasonal means only downstream of water-use areas proximate to villages.

Buhl, **K**. **J**., U.S. Geological Survey, Yankton , USA, kevin_buhl@usgs.gov

TOLERANCE OF RIO GRANDE SILVERY MINNOW TO ADVERSE WATER QUALITY CONDITIONS

Laboratory studies were conducted to determine the relative tolerance of the endangered Rio Grande silvery minnow (*Hybognathus amarus*) to adverse water quality conditions in the Middle Rio Grande, NM. One set of tests was

conducted to determine the upper lethal levels (LL50s) of water temperature and the lower lethal concentrations (LC50s) of dissolved oxygen (DO, hypoxic conditions) to larvae, juveniles, and subadults. A second set of tests was conducted to determine the effects of pulsed exposures to ammonia on larvae and juveniles. Preliminary results of the temperature tests indicated that subadults were less tolerant of high temperatures and hypoxic water than larvae and juveniles. Fish that had access to the surface generally succumbed at lower DO levels than those denied access to the surface, indicating the importance of aquatic surface respiration. In the pulsed ammonia tests, exposures to high ammonia concentrations for only 1.5 hours were nearly as toxic as exposures to the same concentrations for 96 hours. Based on total ammonia 96-h LC50s, larvae were about twice as sensitive to the ammonia exposures as the juveniles.

Bukaveckas, **P**. **A**., Virginia Commonwealth University, Richmond, USA, pabukaveckas@vcu.edu

Wood, J., Virginia Commonwealth University, Richmond, USA, woodjd@vcu.edu

SEASONAL VARIATION IN NITROGEN EXCHANGE BETWEEN THE JAMES RIVER AND A RESTORED TIDAL FRESHWATER STREAM ASSESSED BY MASS BALANCE AND TRACER APPROACHES.

A partial breach of the dam located on Kimages Creek (VA) re-established its' historical (pre-1920) connection to the James River and provided a well-defined channel to gauge tidal exchange. We quantified N fluxes associated with tidal exchange and non-tidal (watershed) inputs on a monthly basis to assess nutrient retention by a mass balance approach. The tidal stream was a net source of dissolved inorganic N during winter months but a net sink overall. The direction and rate of N transformation was found to be significantly related to temperature and ecosystem metabolism. Tracer experiments were performed in three months by injecting a salt-nutrient solution into the dam breach on a rising tide. Retention was measured based on the mass recovered on the subsequent falling tide. Retention estimates derived from tracer additions generally showed good agreement with mass balance estimates and allowed for comparisons with similar results from non-tidal segments of Kimages Creek. Overall, restoration of tidal exchange to Kimages Creek resulted in a 20-fold increase in water and N fluxes and a two-fold increase in N retention.

Buktenica, M. W., Crater Lake National Park, Crater Lake, USA, mark_buktenica@nps.gov

Girdner, **S**. **F**., Crater Lake National Park, Crater Lake, USA, scott_girdner@nps.gov

Larson, G. L., USGS-FRESC, Corvallis, USA, gary_l._larson@usgs.gov

Collier, R., Oregon State University-Oceanography, Corvallis, USA, rcollier@coas.oregonstate.edu

TWENTY-FIVE YEARS OF MONITORING AND RESEARCH IN AN ULTRA-OLIGOTROPHIC DEEP LAKE

Crater Lake, Oregon, is an ultra-oligotrophic deep lake that symbolizes one end of the oligotrophic spectrum. This talk will explore physical, chemical, and biological characteristics documented by a twenty-five year monitoring and research program. Crater Lake is one of the clearest large lakes in the world, characterized by extremely low nutrients, diverse phytoplankton community, deep primary productivity maximum, even deeper chlorophyll maximum, high dissolved oxygen, deepwater nutrient pool, extreme clarity to ultra-violet light, and a remarkable deepwater moss community. The setting of Crater Lake within a National Park at the crest of the Cascade Mountains isolates this lake from most anthropogenic influences, making it a unique setting in which to assess the impact of regional and global climate change on high elevation oligotrophic lake systems.

FISH MONITORING AND AQUATIC HABITAT RESTORATION ALONG THE PUEBLO OF SANIDA'S STRETCH OF THE RIO GRANDE 2000-2009 WITH EMPHASIS ON THE RIO GRANDE SILVERY MINNOW (HYBOGNATHUS AMARUS)

The Pueblo of Sandia, a federally recognized Indian Tribe has been conducting fish monitoring and aquatic habitat restoration for the past ten (10) years. Located just north of Albuquerque, New Mexico and surrounded to the west and north by urban areas, the Pueblo of Sandia has been active in fish monitoring and aquatic habitat restoration with emphasis on the endangered Rio Grande silvery minnow (Hybognathus amarus). The Pueblo of Sandia has taken an active role in the protection and conservation of this species. This presentation will summarize the fish monitoring and aquatic habitat restoration efforts conducted by the Pueblo of Sandia, discuss other fish studies being conducted in the Rio Grande, touch on other research being conducted on the Rio Grande silvery minnow and give participants an overview of how the Pueblo of Sandia is working on endangered species protection and aquatic habitat restoration.

Bumpers, **P**., University of Arkansas, Fayetteville , USA, bumpersp@gmail.com

Evans-White, M., University of Arkansas, Fayetteville, USA, mevanswh@uark.edu

ECOSYSTEM METABOLISM RESPONSES TO FLOOD EVENTS IN OZARK HIGHLANDS FORESETED, URBAN, AND AGRICULTURAL STREAMS

Climate change may alter precipitation patterns and flood intensity or frequency, making it important to understand how stream ecosystem processes respond to flood events. Stream ecosystem metabolism was measured across three land use types (urban, agriculture, and forested) before and after a flood event in autumn 2009 using the single-station method and night-time regressions for reaeration estimates. Mean daily gross primary production (GPP) prior to a flood event was highest in the urban stream (mean <±> SE = 2.91<±> 0.016 g 0_2/m^2/day) compared to the forested (2.09<±> 0.078 g 0_2/m^2/day) and agricultural stream (1.91<±> 0.07 g 0_2/m^2/day). A flood event reduced forested stream GPP below detection. From 4-14 days after the flood event, no significant increase in GPP was observed (mean+1SE=0.67<±> 0.043 g 0_2/m^2/day, p>0.10). Mean post-flood agricultural stream GPP (2.63<±> 0.075 g 0_2/m^2/day) was higher than pre-flood GPP, which was potentially due to a reduction of a grazing snail population. GPP in the urban stream was not affected by the flood event. Future studies will increase replicate streams within each land use type and measure algal and grazer abundance and biomass responses in addition to metabolism.

Bunting, **L**., University of Regina, Regina, Canada, Lynda.Bunting@uregina.ca

Leavitt, P. R., University of Regina, Regina, Canada, Peter.Leavitt@uregina.ca

Wissel, B., University of Regina, Regina, Canada, Bjoern.Wissel@uregina.ca

Laird, K. R., Queen's University, Kingston, Canada, Lairdk@queensu.ca

Cumming, B. F., Queen's University, Kingston, Canada, cummingb@queensu.ca

St. Amand, A., PhycoTech Inc, St. Joseph, USA, astamand@phycotech.com

Engstrom, D. R., St. Croix Watershed Research Station, St Croix, USA, dre@smm.org

SUDDEN ECOSYSTEM STATE CHANGE CAUSED BY PERSISTENT NUTRIENT BUILD-UP, VALUE ADDED AGRICULTURE AND CLIMATE VARIABILITY: THE CASE OF LAKE WINNIPEG, CANADA.

Recently declared as the most eutrophic Great Lake, Lake Winnipeg has experienced severe N-fixing cyanobacterial blooms since ~1995. To quantify the timing, extent and causes of algal proliferation, sediment cores were analyzed for geochemistry (C, N, P), stable isotope ratios (d13C, d15N), radioisotope activity (210Pb, 137Cs), algal abundance and composition (pigments), diatom and cyanobacterial species composition (morphological fossils). Nutrient P) varied little from ~1700 to 1930, increased steadily,Ninflux (d15 to the present, and was highly correlated with diatom production (diatoxanthin). Total algal (Beta-carotene) and colonial cyanobacterial (canthaxanthin) abundance increased 300% from 1930 to 1990 then declined 50% as akinete concentrations from previously-rare Aphanizomenon and Anabaena spp. increased 10-fold. Although long-term eutrophication correlates strongly with agricultural intensification, sudden reciprocal changes in total algal and N-fixing cyanobacterial abundance coincide with development of the modern hog industry and increased precipitation after 1990 which doubled nutrient flux. These findings suggest remediation efforts must reduce P concentrations and algal abundance ~300% to achieve baseline conditions (15 ug TP/L); however, less substantial changes (TP <25 ug/L) may initiate a return to lower N-fixing cyanobacterial densities.

Burbank, **N**. **K**., Utah State University, Logan, USA, nora.burbank@aggiemail.usu.edu

Hawkins, C. P., Utah State University, Logan, USA, chuck.hawkins@usu.edu

RELATIONSHIPS BETWEEN SCULPIN DISTRIBUTIONS AND BROWN TROUT IN WESTERN USA STREAMS

Introduced Brown trout (BT)(*Salmo trutta*) are known to negatively affect native fish species. However, these effects have typically been observed in systems where other trout species are absent. In many North American streams non-salmonid fish species have evolved with trout, and it is unclear what effects BT have on these species. We used Random Forest models to assess if the distribution of sculpins (*Cottus* spp.) was associated with the presence and abundance of both BT and other trout species in western USA streams. Models were derived from data collected at 407 western USA streams. We found that the

probability of observing sculpins was not related to the presence of BT or other trout species, but was inversely related to BT abundance. The lack of a similar relationship with the abundance of other trout species implies that sculpin have evolved to coexist with native trout. These results imply that despite the functional similarities between BT and native trout, sculpins, and perhaps many other native fish species, are vulnerable to the introduction and spread of BT in North American streams.

Burdett, **A. S.**, University of New Mexico, Albuquerque, USA, aburdett@unm.edu
Turner, T. F., University of New Mexico, Albuquerque, USA, turnert@unm.edu

BIOTIC ASSEMBLAGES AND WETLAND-RIVER INTERACTIONS IN AN ARIDLAND RIVERINE SYSTEM

Globally, wetlands are recognized as important sites of biological diversity and essential for ecosystem functioning. However, linkages between biotic communities of wetland and river systems are rarely considered in arid landscapes where both systems are subject to dramatic seasonal drying. We surveyed two large temporary wetlands at Bosque del Apache National Wildlife Refuge in southern New Mexico, as well as several sites in the main channel of the Rio Grande. Surveys were conducted approximately quarterly at wetland sites and at river sites to investigate spatial and temporal dynamics of the assemblages at each site. Concentrations of NO3 and PO4 were lowest at wetland sites, but chlorophyll *a* concentrations did not differ significantly among sites. Similar families dominated invertebrate communities, although different genera were often found at the wetland sites compared to the river sites. The results of these surveys will be discussed in relation to seasonal fluctuations in discharge in the main channel (which also affect the wetlands) and to relative algal biomass measured at each site as a potential food source for the fish and invertebrate assemblages.

Burdis, **R. M.**, Minnesota Department of Natural Resources, Lake City, USA, robert.burdis@state.mn.us
Hoxmeier, J. H., Minnesota Department of Natural Resources, Lake City, USA, john.hoxmeier@state.mn.us

SPATIAL AND TEMPORAL DISTRIBUTION OF ZOOPLANKTON IN MAIN CHANNEL AND BACKWATER HABITATS OF POOL 4, UPPER MISSISSIPPI RIVER.

The Upper Mississippi River (UMR) is home to over 100 species of native fishes, most of which utilize zooplankton as a food item at sometime during their life history. Currently there is concern over the potential impact planktivorous Asian carps *Hypophthalmichthys spp.* may have on the zooplankton community. In an effort to provide baseline information for understanding ecosystem changes that may occur we used a stratified random sampling design to examine the spatial and temporal distribution of zooplankton in Pool 4 of the UMR. Analysis revealed significant differences in zooplankton density and community structure across habitats and seasons. The turbid backwater habitat of the upper reach of the pool had the highest total zooplankton density, comprised largely of rotifers that exhibited obvious seasonality. The lower reach of the pool is influenced by a natural riverine lake that retains sediment, improves water clarity and creates an environment favorable for large-bodied crustacean zooplankton that are exported to the main channel of the lower reach. The backwater habitat in this reach has abundant aquatic vegetation in which macrophyte-associated cladocerans are common.

Burford, **M. A.**, Griffith University, Brisbane, Australia, m.burford@griffith.edu.au
Smith, J., Geoscience, Canberra, Australia, jodie.smith@ga.gov.au
Revill, A., CSIRO, Hobart, Australia, andy.revill@csiro.au
Haese, R., Geoscience, Canberra, Australia, ralf.haes@ga.gov.au

HOW ARE BIOGEOCHEMICAL PROCESSES DIFFERENTIALLY AFFECTED BY NUTRIENT LOADING?

Many studies examining the effect of nutrient loading rates on biogeochemical processes have typically focussed either on few rate processes in multiple impacted aquatic systems, or multiple processes in one system. Studies of multiple biogeochemical processes across more than one system are less common, but provide a broader perspective of the links between nutrient loads and biogeochemical processes. Our study compared rates of multiple processes across three scales of sewage nutrient loading in tropical tidal creeks to identify which parameters are most sensitive to increased loading. Water column primary productivity, sediment nutrient fluxes and sediment denitrification efficiency were the parameters most affected by increased loading. Nutrient loads directly promoted primary productivity which in turn stimulated increased remineralisation of nutrients. A reduction in denitrification efficiency compounded the effect. Water column and sediment respiration, and sediment primary productivity were less affected by nutrient loads. This study identifies processes most impacted by nutrient loads, and when combined with tidal flushing data, provides key data for developing models of threshold nutrient loads which impact ecosystem functioning.

Burgin, **A. J.**, Wright State University, Dayton, USA, burginam@gmail.com
Groffman, P. M., Cary Institute of Ecosystem Studies, Millbrook, USA, groffmanp@caryinstitute.org

OXYGEN CONTROLS DENITRIFICATION RATES AND END-PRODUCTS IN A RIPARIAN WETLAND

Wetland soil oxygen (O2) is rarely measured, which limits our understanding of a key regulator of nitrogen loss through denitrification. We asked: 1) How does soil O2 vary in riparian wetlands?, and 2) How does this O2 variation affect denitrification rates and end-products? We collected a continuous record O2 in "wet" and "dry" riparian zone areas and measured denitrification by removing the background N2, replacing it with a helium/oxygen mixture, and measuring N2 production. Wetland soil O2 varied considerably, ranging from anoxic conditions when the water table was high to completely oxic conditions when the water table dropped. Denitrification rates were significantly higher in the wetter areas, which correlated to low O2 conditions. Denitrification rates in the drier areas correlated to O2 in the early spring and summer, but significantly decreased in late summer despite decreasing O2 concentrations. Increasing O2 significantly increased N2O production, and therefore may be an important control on N2:N2O ratios. Future research should focus on understanding the biotic and abiotic controls on O2 dynamics, and O2 dynamics should be included in models of N cycling processes.

Burgos, **S.**, University of Puerto Rico, San Juan, Puerto Rico, sofia.burgos@gmail.com
Ramirez, A., University of Puerto Rico, San Juan, Puerto Rico, alonso.ites@gmail.com

BENTHIC STREAM BIOFILM METABOLISM ALONG A LAND USE GRADIENT IN TROPICAL IN PUERTO RICO

Land use activities in the watershed impact stream ecosystems; commonly shifting functioning toward primary production, as nutrient concentration and light availability increase. We measured benthic biofilm metabolism in low-order streams draining different land uses in Puerto Rico. Sixteen streams were selected within a gradient of land use types in the Turabo watershed. Stream subwatershed land use ranged from forested, agricultural, to mostly urban. Land uses were characterized using aerial images and GIS tools. Benthic biofilm metabolism was measured using closed sealed metabolic chambers, as changes in dissolved oxygen concentrations during dark and light incubations. Stream physico-chemistry was measured at each site. Results indicate that agricultural land use plays an important role determining water physico-chemistry. At the same time, physico-chemistry was found directly related to the P/R ratios and productivity, but not to respiration. Although urban land use strongly impacts streams, we found no effects on benthic biofilm metabolism. Overall, our study indicates that in this tropical watershed changes in land use alter stream ecosystem function (i.e., metabolism) via their impact on stream water characteristics.

Burington, **Z. L.**, Dept. of Entomology Soils and Plant Science, Clemson University, Clemson, SC, USA, zburing@clemson.edu

LARVAL TAXONOMY OF THE GENUS *CHEUMATOPSYCHE* (TRICHOPTERA: HYDROPSYCHIDAE) IN THE SOUTHEASTERN UNITED STATES

Species of the genus *Cheumatopsyche* are well known for their importance in North American lotic systems. However, continued inability to identify larval species has inhibited ecological understanding of these organisms and their comprehensive use in freshwater biomonitoring. In this study, several superspecific morphotypes are defined using setal arrangements from museum specimens previously associated with adults. Further larval collections will be associated with adults via COI barcoding and used to delimit species groups on the basis of new characters not yet revealed. The ultimate goal is to produce a functional key for species level diagnosis of *Cheumatopsyche* larvae from the southeastern United States.

Burk, **R**. **A**., University of North Texas, Denton, USA, rosemary@unt.edu
Kennedy, J. H., University of North Texas, Denton, USA, James.Kennedy@unt.edu

PATCH DYNAMICS OF HYDROLOGICALLY DISTINCT REFUGIA: RECOLONIZATION OF BENTHIC MACROINVERTEBRATES AFTER A RECORD DROUGHT IN A SPRING-FED SEMI-ARID LANDSCAPE

This study examines the role of spring-fed refugia during a supraseasonal drought and recolonization of benthic macroinveretebrates in Ash and Silver Creeks (Parker County: TX) over eighteen months. Ash Creek maintained flow for 2.0 km in contrast to other regional streams with minimal surface water and no flow. Recolonization at a downstream intermittent site was slow, compared to rates reported for other prairie streams, with taxonomic richness approaching the headwater site's eight months post flow. Riffles, perennial and shaded disconnected pools were refugia for drought-sensitive aquatic insects and taxonomic richness by macrohabitat type was significantly different (ANOVA, $F_{3,44}$=27.34, p<0.0001). SNK analysis demonstrated preferential invertebrate use of refugia grouping macrohabitats as: Riffles>Perennial pools = Shaded disconnected pools > Full sun disconnected pools. Rare relict taxa with low resilience, such as *Lutrochus* sp., *Mayatrichia* sp., and *Neotrichia* sp., would likely be displaced without lotic refugia. Conservation of groundwater is critical to preserving a spatial and temporal patchwork of refugia for benthic invertebrates that increases these variable ecosystems resilience to disturbances and is thought to maintain regional species diversity.

Burke, **R**. **A**., USEPA/NERL, Athens, GA, USA, burke.roger@epa.gov

EFFECTS OF LAND USE ON STABLE CARBON ISOTOPIC COMPOSITION AND CONCENTRATION OF DOC AND DIC IN SOUTHEASTERN US PIEDMONT HEADWATER STREAMS

Stable carbon isotopic composition (delta 13C) and concentrations of DOC and DIC were measured in stream water samples collected monthly in 15 headwater streams from an area with extensive poultry and cattle production and a rapidly growing human population. Linear regression techniques are used to describe the influence of land cover on DOC and DIC delta 13C and concentrations. Results indicate that: (1) mean delta 13C-DOC and mean delta 13C-DIC in study streams range from -28.8 to -27.2 and -17.3 to -12.7 parts-per-thousand, respectively; (2) mean DOC and DIC concentrations range from 1.2 to 5.4 mg/L and from 3.3 to 7.7 mg/L, respectively; (3) watershed pasture land cover best describes (positive correlation) DOC concentration; (4) watershed pasture (positive correlation) and open water (negative correlation) together best describe delta 13C-DOC; (5) watershed open water best describes DIC concentration; and (6) watershed developed land cover (inverse relationship) best describes delta 13C-DIC. Measureable quantities of 13C-enriched DOC, derived either from organic wastes resulting from poultry and cattle production or from C4 pasture grasses, apparently supplement stream DOC pools.

Burks, **R**. **L**., Southwestern University, Georgetown, USA, burksr@southwestern.edu
Kyle, C. H., University of Chicago, Chicago, USA, ckyle@uchicago.edu
Meerhoff, M., National Environmental Research Institute, Silkeborg, Denmark, mm@dmu.dk

PAINT THE LITTORAL PINK: NATIVE *POMACEA CANALICULATA* CLUTCHES PRESENT POWER OF REPRODUCTION FOR INVASIVE APPLE SNAILS

Macrophytes create a sea of green across littoral zones of shallow subtropical and warm temperate lakes. With this prevalence of green coating our perspective, ecologists recognize structuring roles of macrophytes. Yet, noticeable small pockets of pink often peek out from underneath littoral canopies in habitats containing apple snails. Ubiquitous in native ranges including Uruguay and Argentina, egg clutches laid by *Pomacea canaliculata* stand out on littoral zone structures. As part of our overall work on reproductive trends of invasive apple snails, we investigated oviposition patterns of native snails in a 2-week field experiment (open versus covered enclosures). Adult snails could lay clutches on flat or round wooden substrates or choose between four emergent macrophytes. We recorded reproduction events (N~377 and 177), clutch location and clutch height above water. In addition, we measured dimensions and counted number of eggs for a subset of clutches. Our results indicate a disproportionate number of clutches on short, rounded substrates. As data analysis continues, we hope our observations lend further insight into the power of reproduction for ensuring invasion success in apple snails.

Burlakova, **L**. **E**., Buffalo State College, Buffalo, USA, burlakle@buffalostate.edu
Karatayev, A. Y., Buffalo State College, Buffalo, USA, karataay@buffalostate.edu
Karatayev, V. A., City Honors School, Buffalo, USA, vkaratayev@gmail.com
May, M., Texas Parks and Wildlife Department, Austin, USA, marsha.may@tpwd.state.tx.us

PATTERNS OF DIVERSITY, RARITY AND ENDEMISM: CONSERVATION PRIORITIES FOR FRESHWATER BIVALVES (FAM. UNIONIDAE) IN TEXAS

Due to high human demands, freshwater ecosystems are among the most endangered on Earth, and are experiencing greater declines in biodiversity than many other ecosystems. One of the most endangered group of animals in North America are freshwater molluscs in family Unionidae. Evaluation of unionid diversity and identification of rare species are both critical for their conservation, as higher extinction rates are expected for species with restricted ranges and low density. Using the results of our state-wide surveys of molluscs from 2003-2009, we described and compared diversity and dominance of unionid assemblages at different spatial scales. Cluster analyses on combinations of continuous variables (geographical range, population densities, and habitat specificity) distinguished four groups of rarity, from very common to common, rare and very rare. Over 60% all Texas unionids found in our study (30 species of 46 total) were rare or very rare; 50% of these species were endemic to Texas or local regions. Fifteen species are in need of protection, which will require different conservation approaches at different spatial scales.

Burnett, **W**. **C**., Department of Oceanography, Florida State University, Tallahassee, USA, wburnett@fsu.edu
Taniguchi, M., Research Institute for Humanity & Nature, Kyoto, Japan, makoto@chikyu.ac.jp
Chanyotha, S., Department of Nuclear Technology, Chulalongkorn University, Bangkok, Thailand, supitcha.c@chula.ac.th

COMBINED RADON AND THORON MEASUREMENTS TO PROSPECT FOR GROUNDWATER INPUTS INTO THE CANALS OF BANGKOK, THAILAND

Previous studies by our group using radon (Rn-222, half-life = 3.84 d) and conductivity as groundwater tracers suggested that there is shallow groundwater seeping into the man-made canals ("klongs") around Bangkok. The groundwater seepage was also shown to be an important pathway of nutrient contamination to the surface waters. In the present study, we have re-examined some of the same canals and added thoron (Rn-220, half-life = 56 s) measurements in order to evaluate if this tracer could provide more site-specific information. Because of its rapid decay, the presence of thoron must indicate a nearby source. In the case of measurements in natural waters, sources of thoron (as radon) could indicate groundwater seeps. During our 2009 surveys in the canals of Bangkok, we successfully measured thoron and its distribution was more variable than that of radon, suggesting that seepage into the canals is not uniform. Areas of higher ground elevation, often in areas where Thai temples are located, were particularly high in thoron.

Burns, **D**. **A**., U.S. Geological Survey, Troy, NY, USA, daburns@usgs.gov
Schelker, J., Swedish Agricultural University, Umea, Sweden, jakob.schelker@seksko.slu.se
Murray, K. R., U.S. Geological Survey, Troy, NY, USA, krmurray@usgs.gov

SPATIAL AND TEMPORAL CONTROLS ON THE CYCLING OF TOTAL AND METHYL MERCURY IN AN ADIRONDACK WATERSHED

Mercury bioaccumulation in aquatic ecosystems is influenced by a variety of factors that includes land cover, topography, soils, climate, food web dynamics, and hydrology. In the study described here, we explored how these factors interact to affect the spatial and temporal dynamics of total dissolved mercury (FTHg) and dissolved methyl mercury (FMeHg) in stream water in the 66 km^2 Fishing Brook watershed of the central Adirondack Mountains of New York, a forested region with high levels of Hg in fish. FTHg concentrations were highest during hydrologic events such as spring snowmelt and in the summer during low flow. In contrast, FMeHg concentrations diluted to below detection limit values (0.02 ng L^{-1}) during snowmelt, and were highest during summer low flow. The relation of dissolved organic carbon (DOC) concentrations to Hg species in stream water were weaker than those generally reported, and likely reflect: (1) in-stream losses in a shallow pond just upstream of the principal sampling site, and (2) temporally-variable sources of DOC that reflect the waning hydrologic influence of upland areas relative to riparian wetlands during summer.

Burton, **J**., Australlian Rivers Institute, Griffith University, Brisbane, Australia, J.Burton@griffith.edu.au

Olley, J., Australian River Institute, Griffith , Brisbane, Australia, J.Olley@griffith.edu.au

Pietsch, T., Australian Rivers Institute, Griffith University, Brisbane, Australia, T.Pietsch@griffith.edu.au

Smolders, K., Seq Water, Brisbane, Australia, ksmolders@seqwater.com.au

Udy, J., Seq Water, Brisbane, Australia, judy@seqwater.com.au

CHANGES IN WATER AND SEDIMENT SOURCES DURING RAINSTORM EVENTS IN SUBTROPICAL AUSTRALIA

Successful management of pollutant delivery from catchments to waterways requires an understanding of the processes driving water and pollutant movement through the landscape. In this study, stable isotopes of water (18O, D) and fallout radionuclides (137Cs, 210Pb) are used to determine both the water pathways and erosion processes generating pollutants through rainfall events. During May 2009 water and sediment samples were collected throughout the hydrograph of rainfall events at six event monitoring stations across South East Queensland. The results of this study and their implication for the management of these catchments will be presented and discussed.

Buser, C., Eawag, Dübendorf, Switzerland, claudia.buser@eawag.ch

Wolinska, J., Ludwig-Maximilians-Universität, München, Germany, wolinska@bio.lmu.de

Jansen, M., Katholic University of Leuven, Leuven, Belgium, Mieke.Jansen@bio.kuleuven.be

Spaak, **P.,** Eawag, Dübendorf, Switzerland, spaak@eawag.ch

THE INFLUENCE OF A PESTICIDE (DIAZINON) ON *DAPHNIA*-PARASITE INTERACTIONS

Individuals are exposed to many different environmental stressors. Those can influence dynamics of individuals, populations and communities. Over time species may adapt to both natural (e.g. disease) and anthropogenic (e.g. chemical pollution) stress. We investigated the combined influence of disease and chemical pollution on host fitness on two host systems. For that we exposed several *Daphnia magna* clones to the parasite *Pasteuria ramosa* and the insecticide Diazinon, and investigated how the insecticide influenced the infection pattern. The *D. magna* clones were hatched form different sediment layers from a pond in Belgium where they co-occur with *P. ramosa*. It is known that the parasite densities differ between those sediment layers. Furthermore we investigated in a competition experiment with 2 taxa (*D. galeata* and hybrids) how Diazinon influences the competition in populations which are infected with the parasite *Metschnikowia*. In this experiment we wanted to find out if the most resistant clone takes over the population. Both experiments will show how human induced stress factors can influence host parasite interactions.

Cabaniss, **S**. **E**., University of New Mexico, Albuquerque, USA, cabaniss@unm.edu

AGENT-BASED MODELING OF NATURAL ORGANIC MATTER: DIURNAL AND SEASONAL EFFECTS ON TRANSFORMATIONS AND MINERALIZATION

Natural organic matter (NOM) is a complex, heterogeneous mixture of compounds which is frequently modeled as a single 'average' material. An agent-based approach represents NOM heterogeneity by considering thousands of individual molecules, each with potentially different structure and reactivity. Modeled processes include photochemical, thermal and enzymatic transformations, and are simulated using a stochastic algorithm based on well-defined reactions. Long-term (multi-year) simulations feature seasonal additions of precursor compounds (natural products released by plants), and seasonal and diurnal changes in temperature and light intensity. Forward modeling without calibration to field measurements predicts trends in diurnal and seasonal C mineralization similar to observation. Predicted properties (molecular weight, aromaticity, elemental composition) and reactivity (including acidity and metal complexation behavior) of aquatic NOM also vary seasonally and as a function of precursor type, especially in sunlit waters.

Cable, **J**. **E**., Louisiana State University, Baton Rouge, USA, jcable@lsu.edu

Martin, J. B., University of Florida, Gainesville, USA, jbmartin@ufl.edu

Pounder, C., Caribbean Institute of Meterology and Hydrology, St. James, Barbados, cpounder@cimh.edu.bb

Inniss, L. V., Coastal Zone Management Unit, Bridgetown, Barbados, linniss@coastal.gov.bb

Moseley, A. C., Coastal Zone Management Unit, Bridgetown, Barbados, acmoseley1@gmail.com

Smith, E., University of West Indies, Cave Hill, Barbados, emma.smith@cavehill.uwi.edu

SUBMARINE GROUNDWATER DISCHARGE FROM A CARBONATE SAND AQUIFER, WORTHING BEACH, BARBADOS

Submarine groundwater discharge from small island countries represents a critical unknown in their national estimates of water budgets, but its potential as a vector for nutrient loading to coastal waters is significant. Barbados is the 15th most water scarce country in the world with a population density of about 622 people/square km (just behind China). Resource uncertainties are heightened on islands considering the alarming climate predictions for sea level rise and the hydrologic cycle. Consequently, a groundwater discharge study was conducted along the coast at Worthing Beach to quantify SGD and nutrient fluxes to the adjacent lagoon. Four piezometers were outfitted with conductivity and pressure transducers along a transect perpendicular to shore to monitor migration of the freshwater plume in beach sediments. Adjacent to the piezometers, porewater NO_3 and PO_4 concentrations were discovered to range from 4 to 34 &microM and 1.5 to 6.3 &microM, respectively. DIC, $\delta^{18}O$, $\delta^{13}C$, and major ions were also measured in porewaters. Porewater salinities indicate the seepage face is present at about 3 m seaward of the high tide line and oscillates with the tides.

Cáceres-Charneco, **R**. **I**., Institute for Tropical Ecosystem Studies, University of Puerto Rico, Río Piedras, San Juan, Puerto Rico, ritirene@hotmail.com

Benítez-Joubert, R. J., Institute for Tropical Ecosystem Studies, University of Puerto Rico, Río Piedras, San Juan, Puerto Rico,

Ortiz-Zayas, J., Institute for Tropical Ecosystem Studies, University of Puerto Rico, Río Piedras, San Juan, Puerto Rico,

DYNAMICS OF DISSOLVED ORGANIC CARBON IN AN EPHEMERAL TROPICAL POND

Tamarindo pond is located in the south-west side of Puerto Rico, in the Guánica Dry Forest Biosphere Reserve. It is a temporary pond that is filled during the rainy season and plays a very important role in the reproduction of the endemic and threatened Puerto Rican crested toad (Peltophryne lemur). As part of an extensive pond characterization during the last big rain event in September 2008, water samples were collected from five different sites in the pond to document change in dissolved organic carbon (DOC) by site and through time. After the water samples were filtered in the laboratory, they were analyzed using an Apollo 9000 combustion TOC analyzer. An ANOVA single factor analysis found that there was no statistical difference between sites but there was difference through time. The availability of dissolved organic carbon in this particular temporary ecosystem is important because it may be an indicator of a healthy ecosystem and of food availability for aquatic organisms that inhabit the pond for a short period of time.

Cadmus , **P**. **J**., Colorado State University Department of Fish, Wildlife and Conservation Biology, Fort Collins, USA, cadmus@rams.colostate.edu

Brinkman, S. F., Colorado Department of Wildlife, Aquatic Wildlife Research Group, Fort Collins, USA,

Vieira, N. M., Colorado Department of Wildlife, Aquatic Wildlife Research Group, Fort Collins, USA,

Clements, W. H., Colorado State University Department of Fish, Wildlife and Conservation Biology, Fort Collins, USA,

USE OF MICROCOSM EXPERIMENTS, SUBLETHAL ENDPOINTS AND DIETARY EXPOSURE TO RECONCILE DIFFERENCES BETWEEN LABORATORY AND FIELD STUDIES

Laboratory and stream microcosm experiments were conducted to reconcile discrepancies between the low abundance and diversity of macroinvertebrate communities observed in biomonitoring studies with that predicted by water quality criteria. Single species (Drunella grandis) experiments using Cu and a Cu+Zn mixture were executed simultaneously in the laboratory and in stream microcosms. Survival of D. grandis in the laboratory and in single species

microcosm experiments was similar, suggesting little difference between these test systems. Results from community microcosm experiments showed highly significant reductions in mayfly abundance and richness at lower concentrations then are predicted by laboratory toxicity tests. To assess the relative importance of dietary exposure the mayflies Ameletus sp. and Epeorus sp. were exposed to sublethal levels of aqueous Zn and three levels of dietary exposure including periphyton cultured in Zinc contaminated media. Dietary exposure had a significant influence on Zn accumulation in more subcellular fractions than did aqueous exposure. Photoanalysis reviled less feeding in higher exposure levels. Subcellular concentrations were then compared to organism collected across a gradient of Zn contamination in the Arkansas River, Leadville, CO.

Cain, **D**. **J**., U.S. Geological Survey, Menlo Park, USA, djcain@usgs.gov
Croteau, M., U.S. Geological Survey, Menlo Park, USA, mcroteau@usgs.gov
Luoma, S. N., University of California at Davis, Davis, USA, snluoma@usgs.gov

PERIPHYTON AS A SOURCE OF BIOAVAILABLE METAL TO BENTHIC GRAZERS

High metal body burdens observed in invertebrate benthic grazers suggest that periphyton is an important source of bioavailable metals. We conducted comparative experimental studies among five mayfly species based on the construct of a kinetic bioaccumulation model (DYNBAM). The model incorporates physiological rate constants and metal concentrations in water and food to predict bioaccumulated metal. We quantified uptake of cadmium (Cd) and copper (Cu) from dietary and dissolved exposures, as well as physiological metal loss. We labeled artificial stream water and a benthic diatom (*Nitzschia palea*) with enriched stable metal isotopes and determined physiological rate constants representing metal influx from water, ingestion rate, metal assimilation from food, and elimination of bioaccumulated metal. Model simulations run with environmentally realistic Cu and Cd concentrations and with Cu measured at a field site consistently identified food as the principal exposure route. At least for the taxa considered in this study, we conclude that consumption of metal-contaminated periphyton can result in high metal body burdens and increased risk of metal toxicity.

Caires, **A**. **M**., University of Nevada-Reno, Reno, USA, acaires@cabnr.unr.edu
Chandra, S., University of Nevada-Reno, Reno, USA, sudeep@cabnr.unr.edu
Hayford, B. L., Wayne State College, Wayne, USA, bhayford@gmail.com
Umek, J. W., University of Nevada-Reno, Reno, USA, umekj@unr.nevada.edu

LONG-TERM CHANGES IN CHIRONOMIDAE COMMUNITIES OF LAKE TAHOE WITH A COMPARISON TO OTHER LARGE LAKE ECOSYSTEMS (CRATER LAKE AND LAKE HOVSGOL)

We compared past (1960s) and contemporary chironomid assemblages in Lake Tahoe (USA) to determine how chironomid communities have changed with alterations to the physical and biological character of the lake. We also compared Lake Tahoe chironomid assemblages to those of two other oligotrophic lakes that have been relatively undeveloped (Crater Lake, USA and Lake Hovsgol, Mongolia). Although lakewide-weighted chironomid density in Lake Tahoe has declined 65% since the 1960s, genera richness has tripled. Among lakes, present-day genera richness was greatest in Lake Tahoe, followed by Lake Hovsgol and Crater Lake (61, 33, and 19 genera, respectively). Present-day dominant genera in Lake Tahoe were *Paratendipes* and *Chironomus*. In Crater Lake, dominants were *Heterotrissocladius* and *Orthocladius*, and in Lake Hovsgol, dominant genera were *Micropsectra* and *Polypedilum*. Overall, chironomid assemblage structure in Lake Tahoe indicates a shift from ultra-oligotrophic taxa to oligotrophic and mesotrophic taxa over the past 50 years, which is substantiated by the increase in cultural eutrophication that has been well documented in the lake during this time. Potential effects of introduced species in the lakes are also discussed.

Caldwell, C., USGS, Las Cruces, USA, ccaldwell@mnsu.edu

INFLUENCE OF CAPTURE, HANDLING, AND TRANSPORT ACTIVITIES ON RECOVERY AND SURVIVAL OF RIO GRANDE SILVERY MINNOW SUBJECTED TO RIVER INTERMITTENCY

The U.S. Fish and Wildlife Service determined rescue of Rio Grande silvery minnow from intermittent pools throughout the middle Rio Grande a reasonable measure to minimize the incidental take of the federally endangered fish. A systematic evaluation of the wild minnow's physiological responses (plasma cortisol, glucose, osmolality) and survival was conducted during river intermittency and resue and revealed plasma cortisol and glucose concentrations as high as 423ng/mL and 174 mg/dL, respectively. Plasma osmolality decreased to 230mOsmol/kg indicating severe osmoregulatory disfunction. Within three days of rescue from isolated pools, survival was less than 1%. Fish health diagnostics revealed fish in isolated pools incurred a greater risk of exposure to parasites and bacteria. Rescue protocol was subsequently improved and a second systematic evaluation of the minnow's physiological responses revealed cumulative effects of isolation and rescue were severe, however, survival was high (77%). Although stressors were cumulative, fish health diagnostics revealed that pathogens were incidental. This work demonstrated that simple changes to routine management practices can alter the "tipping point" with regards to disease susceptibility and thus survival in the wild minnow.

Caldwell, **T**. **J**., University of Idaho, Moscow, USA, cald3105@vandals.uidaho.edu
Wilhelm, F. M., University of Idaho, Moscow, USA, fwilhlem@uidaho.edu

THE ROLE OF *MYSIS RELICTA* IN THE NUTRIENT AND ZOOPLANKTON COMMUNITY DYNAMICS OF A LARGE AND DEEP OLIGOTROPHIC LAKE IN NORTHERN IDAHO, USA.

Mysids introduced into Pacific Northwest lakes in the 1960's often disrupted lake food webs because of competition with fish fry for zooplankton prey. Additionally, mysids may remove nutrients from surface waters via diel vertical migration (DVM), limiting lake productivity. Lake Pend Oreille (LPO) is a large (38,000ha) and deep (351m) oligotrophic lake. We tested that; i) mysids represent a net sink of nutrients from the surface to the deep water via DVM in LPO due to its depth; and ii) that mysids compete with fish for zooplankton prey. We measured phosphorous (P) release by mysids during stages of DVM and compared gut contents to the zooplankton assemblage at two widely separated sites. Release rates between ascending and descending phases of DVM were similar. Gut analysis revealed consumption of cladocerans, copepods, diatoms, and algae. Our results suggest that mysids do not represent a net loss of nutrients from surface waters. However, predation of zooplankton by mysids likely negatively affects fish production.

Campbell, **C**. **A**., US Geological Survey, Northern Appalachian Research Lab, Wellsboro, USA, ccampbell@usgs.gov
Lellis, W. A., US Geological Survey, Northern Appalachian Research Lab, Wellsboro, USA, wlellis@usgs.gov
Luckenbill, S., US Geological Survey, Northern Appalachian Research Lab, Wellsboro, USA, luckenbillsi10@mounties.mansfield.edu

A LONGITUDINAL ANALYSIS OF THE EASTERN ELLIPTIO IN THE DELAWARE RIVER

Freshwater mussels are among the most imperiled freshwater fauna, yet predicting species occurrence remains problematic. Most insights arise from surveys conducted at individual reaches scattered throughout a river system, but continuous surveys, encompassing hundreds of miles and habitat gradients, can provide a unique perspective into species-habitat relationships. We conducted qualitative snorkel surveys for 125 miles of the mainstem Delaware River. Abundance, catch-per-unit effort, and density estimates of the eastern elliptio, *Elliptio complanata*, were generated for consecutive 200 meter reaches. Stream measurements, road and tributary locations, and land use information were synthesized for each reach. Longitudinal analyses were performed to examine the distribution of *E. complanata* in relation to the physical attributes. Results illustrated how the character of the river changes longitudinally from upstream to downstream. These changes corresponded to peaks and valleys in *E. complanata* distribution, suggesting possible mechanisms underlying the species distribution that can be further investigated under more controlled environments. This novel approach provides a unique view of a species along an environmental gradient that can benefit both the research and management communities.

Campbell, **E**. **Y**., Michigan State University, East Lansing, USA, campb613@msu.edu
Merritt, R. W., Michigan State University, East Lansing, USA, merrittr@msu.edu
Hudson, J. P., , Juneau, USA, jhudson@gci.net
Benbow, M. E., University of Dayton, Dayton, USA, benbowme@notes.udayton.edu
Tiegs, S. D., Oakland University, Rochester, USA, tiegs@oakland.edu
Lamberti, G. A., Notre Dame, Notre Dame, USA, glambert@nd.edu

TIMBER HARVEST INTENSIFIES SALMON DISTURBANCE OF MACROINVERTEBRATE COMMUNITIES IN SOUTHEAST ALASKA STREAMS

Natural and anthropogenic disturbances can interact to affect freshwater ecosystems but are typically studied separately. In southeastern Alaska, timber harvest is a widespread disturbance that alters stream channel morphology, habitat complexity, and substrate composition. We examined the interactive effects of timber harvest and spawning salmon on macroinvertebrate communities in seven streams across a harvest gradient on Prince of Wales Island, Alaska. We predicted that spawning salmon would reduce macroinvertebrate density and biomass, and that this disturbance effect would increase with increasing harvest intensity due to reduced refugia provided by large sediments and wood debris. Multivariate ordination demonstrated significant separation of communities before and during the salmon run. Indicator species analysis found several diverse significant indicator taxa before-salmon and two significant indicator taxa during-salmon. Plecoptera biomass increased while Diptera biomass decreased across all streams during the run. Macroinvertebrate density, total biomass, and biomass of scrapers, predators, gathering-collectors, and Ephemeroptera increased during the run in less-harvested watersheds and decreased in heavily-harvested watersheds. These results suggest that timber harvest intensifies the effects of spawning salmon disturbance on macroinvertebrate communities in Southeast Alaska streams.

Campbell, **V**., Dalhousie University, Halifax, Canada, veronik.campbell@hotmail.com
Romanuk, T. N., Dalhousie University, Halifax, Canada, romanuk@dal.ca

POPULATION DYNAMICS OF EXTINCTION AND RECOVERY: IMPACT OF DIFFERENT MORTALITY REGIMES

Widespread changes in the global environment have led to an important increase in the rate of species extinction. The reduction in population size preceding species extinction can be sudden, caused by large-scale environmental disturbances, or it can be gradual, leading to extinction due to demographic or environmental stochasticity. To determine whether the rate of mortality in a population affects its extinction pattern, we varied the mortality regime of three invertebrate species commonly found in aquatic communities. For each species, mortality frequency was manipulated by removing 20% of the number of individuals every ¼, ½ and total generation time. Population abundance of the declining species was monitored every half generation time until extinction while abundances of all other species in the community were monitored on a weekly basis. Preliminary results indicate that mortality frequency influences population persistence time, temporal variability of abundance and rate of the final decline across all species studied. Given the current widespread species loss, our study provides important insights into how population dynamics of extinction respond to temporal differences in mortality regimes.

Candelaria-Ley, **R**. **I**., University of New Mexico, Albuquerque, USA, roxcley@unm.edu
Van Horn, D. J., University of New Mexico, Albuquerque, USA, vanhorn@unm.edu
Dahm, C. N., University of New Mexico, Albuquerque, USA, cdahm@sevilleta.unm.edu

FACTORS SHAPING METABOLISM IN THE RIO GRANDE

Healthy aquatic ecosystems in arid land rivers have become increasingly important as climate change and swelling populations place greater strain upon already limited water resources. Cities in arid regions, like Albuquerque, NM, are turning to surface water to supplement groundwater supplies. The goal of this multi-year investigation is to assess water quality trends and stream metabolism within a gradient of anthropogenic use along a 60 km reach of the Middle Rio Grande in central NM. Urban runoff from episodic flooding, light availability and substrate type significantly affect ratios between primary productivity and respiration. Continuous measurement of temperature, pH, dissolved oxygen, turbidity and conductivity at four sites allow estimation of rates of primary production and ecosystem metabolism along different reaches of the river. The upstream site above the influence of urban and agricultural landscapes had highest rates of primary production with peak rates in winter months. Turbidity pulses and a mobile sandy bed at downstream sites appear to limit rates of primary production. Clear longitudinal trends in primary production and respiration are seen along this section of river.

Canhoto, **C**., University of Coimbra, Coimbra, Portugal, ccanhoto@ci.uc.pt
Calapez, A. R., University of Coimbra, Coimbra, Portugal, anacalapez@student.biologia.uc.pt
Moreira-Santos, M., University of Coimbra, Coimbra, Portugal, matilde.santos@zoo.uc.pt

EUCALYPTUS GLOBULUS EXOTIC LEAF LEACHATES: EFFECTS ON SURVIVAL, AVOIDANCE AND FEEDING BEHAVIOR OF STREAM INVERTEBRATES

A large number of riparian areas of Central Portugal are now forested with monocultures of the exotic *Eucalyptus globulus*. In summer, these streams are frequently subjected to drought resulting in isolated pools, saturated with leaf litter, in which the leachates may generate toxic and hypoxic conditions. We gauged the effects of an ecological relevant gradient of leachate dilutions, with and without aeration, on survivorship, avoidance behavior and feeding activity of *Sericostoma vittatum*, *Echinogammarus meridionalis* and *Chironomus riparius*. Toxicity tests showed lethal effects of the leachates for all invertebrates, mostly in oxygen depleted conditions. *E. meridionalis* was the species most affected. Only *S. vittatum* avoided high solute concentrations and discriminated leaves conditioned in aerated water over leaves conditioned in non-aerated leachates. This feeding behavior may be related with reduced microbial quality and biomass promoted by the leachates, in the absence of oxygen. The ecological consequences of the replacement of the authochthonous deciduous forest by eucalypt plantations maybe exacerbated in summer: important changes in the patterns and protagonists of stream processes are expected.

Cao, **Y**., Uiniversity of Illinois, Champaign, USA, yongcao@illinois.edu
Holtrop, A. M., Illinois Department of Natural Resources, Springfield, USA, Ann.Holtrop@illinois.gov

EFFECTS OF HABITAT AND WATERSHED CHARACTERISTICS ON MEAN SPECIES-OCCURRENCE PROBABILITY IN STREAM FISH SURVEY

Obtaining reliable fish assemblage data remains to be a challenge for bioassessment and biodiversity conservation. A great amount of efforts has been devoted to estimate the sampling distance required for capturing all or a high proportion of all species at a site. Those estimates, however, often vary substantially among sites. A standard effort often leads to over-sampling at some sites and under-sampling at some others. Understanding what environmental factors affect mean species-occurrence probability (i.e., the proportion of all species captured) is critical to set site-specific efforts that meet a given data-quality goal. We used Random-Forests to model the variation of the mean detectability across 11 wadeable streams in Illinois based on a range of watershed and habitat variables. The models explained 27-52% of the total variance, depending on the sampling effort used. The mean detectability decreased with watershed size, % of clay substrates, and average water depth, but increased with % of riffle habitats, % of rock substrates, and the presence of submerged objects. These findings provide the possibility of setting site-specific sampling efforts in stream fish surveys.

Capps, **K**. **A**., Cornell University, Ithaca, USA, kac98@cornell.edu
Flecker, A. S., Cornell University, Ithaca, USA, asf3@cornell.edu
Rodiles-Hernandez, R., El Colegio de la Frontera Sur, San Cristobal de las Casas, Mexico, rrodiles@ecosur.mx

THE IMPACTS OF AN EXOTIC GRAZING FISH ON ORGANIC MATTER BIOMASS AND EPILITHON STOICHIOMETRY IN A TROPICAL STREAM

The rates at which biotic invasions are occurring are unprecedented and this is especially true with fish species. Though animals may be important drivers of nutrient cycling and the processing of organic matter, few studies have investigated how the effects of fish invasions alter these processes in tropical streams. The objective of our study was to elucidate the impact of an exotic grazer, the armored catfish *Pterygoplichthys* sp. (Siluriformes: Loricariidae), on epilithon biomass and nutrient composition. We measured epilithon dry mass, percent organic matter, and elemental stoichiometry in a series of in situ enclosures and exclosures in an invaded river in Chiapas, Mexico. Grazing by high densities of exotic armored catfish significantly reduced the abundance of epilithon compared to ungrazed treatments. Moreover, ungrazed treatments displayed greater carbon and nitrogen content than grazed treatments. These results suggest that exotic grazing fishes may be important in modifying organic matter dynamics in invaded ecosystems.

Cardenas, **M. B.**, University of Texas at Austin, Austin, USA, cardenas@jsg.utexas.edu
Cook, P. L., Monash University, Victoria, Australia, perran.cook@sci.monash.edu.au
Gerecht, K. E., Smith College, Northampton, USA, kgerecht@smith.edu
Jiang, H. S., Woods Hole Oceanographic Institution, Woods Hole, USA, hsjiang@whoi.edu
Markowski, M. S., University of Texas at Austin, Austin, USA, michael_markowski55@yahoo.com
Nowinski, J. D., University of Texas at Austin, Austin, USA, jnowinski@mail.utexas.edu
Sawyer, A. H., University of Texas at Austin, Austin, USA, asawyer@mail.utexas.edu
Swanson, T. E., University of Texas at Austin, Austin, USA, tswanson@mail.utexas.edu
Wilson, J. L., New Mexico Inst. of Mining and Technology, Socorro, USA, jwilson@nmt.edu

FLUID DYNAMIC INTERACTIONS NEAR SEDIMENT-WATER INTERFACES IN AQUATIC AND COASTAL ENVIRONMENTS

We present an overview of our recent and on-going research on flow and transport phenomena near the sediment-water interface (SWI), and associated 'far-field' processes, in aquatic and coastal systems. Case studies illustrating how a more complete understanding of hyporheic flow and solute and heat transport was achieved through high-fidelity simulations are first presented; the models progress from simple to those integrating information at mm-scale spatial and sub-second temporal resolution and multiple non-conservative solutes. Simulation studies are followed by experiments that show the impacts of wood found near SWIs. Finally, the presentation will highlight field observations where we are studying the effects of river regulation on surface water-groundwater interactions. Regular river stage fluctuations lead to bi-directional pumping of water across the SWI which drives pronounced cyclic warming/heating of the sediment. Moreover, time lapse electrical resistivity tomograms suggest that the dynamic river-groundwater mixing zone extends down to several meters under the SWI. Our studies are but a few that illustrate that 'fluid dynamic interactions near SWIs' is a fertile and relevant research field which will hopefully be represented in L&O: F&E.

Cardinale, **B. J.**, University of California - Santa Barbara, Santa Barbara, USA, cardinale@lifesci.ucsb.edu
Kulacki, K., University of California - Santa Barbara, Santa Barbara, USA,
Klanjscek, T., University of California - Santa Barbara, Santa Barbara, USA,
Matulich, K., University of California - Santa Barbara, Santa Barbara, USA,
Nisbet, R., University of California - Santa Barbara, Santa Barbara, USA,

TIO2 NANOPARTICLES STIMULATE BIOMASS PRODUCTION IN FRESHWATER ALGAE

Nanotechnology has opened up a new industrial revolution in which novel materials are being manufactured and utilized to enhance everything from medicine, to electronics, to energy production. Proliferation and release of these materials into the environment has also prompted concern about the potential unintended impacts of nanomaterials on everything from cells to ecosystems. Here we report results from a laboratory experiment in which we examined how nano-TiO2, one of the most widely used nanoparticles, impacts the production of biomass by 20 of the most common species of algae in North America. After exposing algae to five increasing concentrations of nano-TiO2 (from 0 to 300-ppm), we found that population growth rates were only minimally affected; however, maximum biomass at equilibrium of most species (75%) was stimulated by TiO2, often increasing by an order of magnitude. These results could be due to altered nutrient availabilities that set carrying capacities, and/or the provision of new growth surfaces on TiO2 aggregates. Regardless of the mechanism, our results suggest that nano-sized metal oxides could enhance the production of biomass by algae in streams and lakes.

Carey, **C. C.**, Cornell University, Ithaca, USA, ccc99@cornell.edu
Weathers, K. C., Cary Institute of Ecosystem Studies, Millbrook, USA, weathersk@caryinstitute.org
Cottingham, K. L., Dartmouth College, Hanover, USA, cottingham@dartmouth.edu

CYANOBACTERIAL BLOOMS MAY INCREASE NUTRIENT AVAILABILITY AND SUBSIDIZE PLANKTON FOOD WEBS IN AN OLIGOTROPHIC LAKE

The effects of cyanobacterial blooms on oligotrophic lakes are not well-understood, even though blooms may be increasing in these systems. *Gloeotrichia echinulata*, a large scum-forming cyanobacterium present in oligotrophic lakes across the northeastern United States, has the potential to substantially affect phosphorus-limited lakes because it translocates phosphorus from the sediments to the water column during recruitment. We examined the effects of *G. echinulata* on nutrients and plankton by adding rinsed colonies in bloom densities to *in situ* mesocosms suspended in an oligotrophic lake in the summer of 2008 (low zooplankton) and 2009 (high zooplankton). In both years, experimental *G. echinulata* blooms significantly increased nitrogen and phosphorus concentrations. In 2008, *G. echinulata* blooms significantly increased phytoplankton species biomass *and* taxa richness, but not zooplankton. In 2009, mesocosms with blooms had significantly higher zooplankton biomass than no-bloom controls at the end of the experiment, which we hypothesize may be due to *G. echinulata*'s stimulation of phytoplankton. Our findings indicate that in a nutrient-limited system, *G. echinulata* may increase nutrient availability and subsidize plankton food webs, thereby accelerating eutrophication in oligotrophic lakes.

Carlisle, **D. M.**, US Geological Survey, Reston, VA, USA, dcarlisle@usgs.gov
Wolock, D. M., US Geological Survey, Lawrence, KS, USA, dwolock@usgs.gov

MACROINVERTEBRATE TRAITS RELATED TO STREAMFLOW ALTERATION: LINKING PREDICTIVE MODELS AND FUNCTIONAL TRAITS

We assessed the alteration of natural streamflow magnitudes in 2,888 rivers and streams throughout the contiguous US using daily streamflow data collected from 1980-2007. At 275 of these sites, we also assessed the condition of macroinvertebrate communities using empirical models that predict taxa that are expected to occur at each site in the absence of anthropogenic disturbance. After accounting for several chemical and physical covariates, hydrological alteration was the most important predictor of biological impairment, which was defined as sites having 20% fewer taxa than expected. Models used to assess biological condition were also used to estimate the expected richness of taxa having specific traits such as habit and current preference. The average ratio of observed to expected richness of each trait was compared between sites with and without altered streamflow magnitudes. Sites with altered minimum and maximum flow magnitudes appear to have disproportionately lost macroinvertebrate taxa with specific traits. Results from analysis of species traits strengthened the evidence that streamflow alteration was likely the chief factor causing reductions in macroinvertebrate taxa richness.

Carlson, **P. E.**, Swedish University of Agricultural Sciences, Uppsala, Sweden, peter.carlson@vatten.slu.se
Johnson, R. K., Swedish University of Agricultural Sciences, Uppsala, Sweden, Richard.Johnson@vatten.slu.se
Mckie, B. G., Swedish University of Agricultural Sciences, Uppsala, Sweden, Brendan.Mckie@vatten.slu.se

CONSEQUENCES OF AQUATIC SUBSIDIES ON THE DISTRIBUTION AND STRUCTURE OF RIPARIAN CONSUMERS

Transfers of nutrients, matter, and organisms across habitat boundaries (spatial subsidies) can change the structure and dynamics of populations, communities, and food webs in recipient habitats. Streams and their adjacent terrestrial environments share a long edge boundary, and therefore offer exceptional models for the study of how transfers of spatial subsidies affect recipient habitats. However, while terrestrial to aquatic subsidies have been reasonably well studied, research on aquatic-terrestrial subsidies is more limited. We studied aquatic-terrestrial subsidies along a gradient of eight boreal streams varying in nutrient content in south central Sweden. Between May-November 2009, we took monthly samples of the lateral distribution of emerging aquatic insects and their terrestrial consumers at distances of 1, 10, 50, and 100 meters from the stream edge using pit-fall and sticky traps. In addition, we sampled benthic invertebrates and emerging insects from the streams. In this presentation we will describe the consequences of the timing, magnitude, and quality of these subsidies on the distribution and structure of recipients.

Carr, **H. E.**, University of Vermont, Burlington, USA, hecarr@uvm.edu
Levine, S. N., University of Vermont, Burlington, USA, slevine@uvm.edu
Boumans, R., University of Vermont, Burlington, USA, rboumans@uvm.edu
Lini, A., University of Vermont, Burlington, USA, alini@uvm.edu

MODELING 200 YEARS OF CHANGING TROPHIC STATUS IN LAKE CHAMPLAIN BASED ON LAND USE AND COMMERCIAL PRACTICES

Paleolimnological records from Lake Champlain, USA-Canada, indicate that since Europeans began settling in the region about 250 years ago, the lake has become more eutrophic. While the underlying causes of productivity increase in Lake Champlain have been inferred from anecdotal evidence, quantitative inferences based on modeled nutrient fluxes are lacking. To meet this need, a dynamic simulation model was developed in the Simile declarative modeling package to link phosphorus loading to land use change and other factors in the Lake Champlain Basin. A coarse spatial and temporal resolution allows the model to incorporate the large size of the Lake Champlain Basin and simulate two centuries of data. The model divides the basin into four land uses and uses empirically derived coefficients to estimate the amount of phosphorous input from each. Other factors known to contribute to eutrophication, such as population, livestock numbers, fertilizer use, waste water effluent, and natural factors, are additional driving forces to the model. The prediction of phosphorus input and algal response by the model was calibrated against trends in sediment cores and monitoring data.

Carrick, **H**. **J**., Pennsylvania State University, University, USA, hjc11@psu.edu
Twiss, M., Clarkston University, Potsdam, USA,
Bourbonniere , R. A., Environmental Canada, Burlington, Canada,
Bullerjahn, G. S., Bowling Green State University, Bowling Green, USA,
McKay, R. M., Bowling Green State University, Bowling Green, USA,
Smith, R. E., University of Waterloo, Waterloo, Canada,
Wilhelm, S. W., University of Tennessee, Knoxville, USA,

WINTER PHYTOPLANKTON IN LAKE ERIE: CONTRASTING ICE AND OPEN WATER ASSEMBLAGES

Despite the long duration of winter, relative few observations are made at this time for lakes residing in the temperate zone. As such, we examined microbial assemblages imbedded in ice and occurring in the open water. We hypothesized that the abundance and production of winter microbial assemblages would be low compared with quantities measured for summer assemblages. To test this hypothesis, water samples were collected at 5 offshore stations along a west-east transect in Lake Erie. Surprisingly, the range in phytoplankton abundance observed here was comparable to that measured during the summer (range 20-150 ugC/L), and biomass decreased from west to east. Diatoms dominated the assemblage, while cryptophytes and picocyanobacteria were present but rare. Levels of primary production were appreciable at the five stations, and ranged from 0.4 to 11 ug C/L/h. These values corresponded well with those measured on summer assemblages incubated at low irradiance (<80 uEinst/m2/s). Plankton imbedded in the ice were several times greater in abundance compared with open water assemblages, and again were dominated by diatoms. Collectively, these data indicate that winter phytoplankton was large, and exhibited production rates comparable to those measured for summer assemblages in Lake Erie. Ice may act as a refuge for phytoplankton, where large numbers are concentrated.

Carroll, **T**. **M**., Drury University, Springfield, USA, tcarroll@drury.edu
Thorp, J. H., University of Kansas, Lawrence, USA, thorp@ku.edu

SPATIOTEMPORAL CHANGES IN FOODWEB PATHWAYS IN KARST CAVE SPRING ECOSYSTEMS

The breadth of research on trophic dynamics of surface systems is limited in general but especially for spring ecosystems where few data are available on spatial and seasonal effects. Karst springs are characterized by hydrologically and seasonally driven, organic pulses which are spatially subsidized from the spring source to downstream by changes in both epigean-hypogean flow and riparian-springbrook interactions. Current foodweb models would suggest that springs are supported primarily by allochthonous organic inputs because springs are classified as first-order, headwater streams. However, original models, founded primarily on forested systems, may not apply to spring systems. We examined spatial and seasonal foodweb dynamics and complexity in three karst springs located in the Ozarks Region of Missouri, USA. Food source-consumer interactions and foodweb structure were determined using carbon and nitrogen stable isotope and stoichiometric analyses. Foodweb analyses indicated that the trophic base of the foodweb, along both temporal and spatial scales, was autochthonous, shifting temporally towards a greater reliance on allochthonous resources. Spatial and temporal shifts in food availability and use were associated with corresponding increases in foodweb complexity.

Caruso, **B**. **S**., University of Canterbury, Christchurch, New Zealand, brian.caruso@canterbury.ac.nz
Haynes, J., Summit Technical Resources, Denver, USA, josh.haynes@mac.com

AQUATIC RESOURCES CONNECTIVITY AND JURISDICTIONAL DETERMINATIONS DURING JUNE 2007-2008 IN EPA REGION 8

Following Supreme Court decisions and inter-agency guidance, coordination between the Environmental Protection Agency (EPA) and the Army Corps of Engineers (COE) is required for jurisdictional determinations (JDs) of waters considered to be 'geographically isolated' or requiring an evaluation of 'significant nexus' to navigable waters under the U.S Clean Water Act Section 404. EPA Region 8 evaluated all coordinated JDs from three COE districts during the first year of guidance implementation from June 2007-June 2008. The region includes portions of 20 Level III Ecoregions in the semi-arid western U.S., including the Rocky Mountains, Great Plains, and parts of the Colorado Plateau. Of the total stream length, 54% is 1st-order and 77% is intermittent. JDs for 1,265 waters were evaluated, with 824 considered isolated and 441 requiring significant nexus evaluation. All of the isolated waters and 29% of the significant nexus waters were considered non-jurisdictional. Of these, 793 wetlands, 12 streams, and 18 water bodies were considered non-jurisdictional due to isolation, and 49 wetlands, 66 streams and 14 other water bodies had no significant nexus to downstream navigable waters.

Cashman, **M**. **J**., Louis Calder Center - Biological Field Station, Fordham University, Armonk, USA, MatthewJCashman@gmail.com
Wehr, J. D., Louis Calder Center - Biological Field Station, Fordham University, Armonk, USA, wehr@fordham.edu
Truhn, K., Louis Calder Center - Biological Field Station, Fordham University, Armonk, USA, find_kam@yahoo.com

LAND-USE AND NUTRIENT EFFECTS ON BENTHIC ALGAL BIOMASS, NUTRIENT STOICHIOMETRY, AND SPECIES COMPOSITION IN AN URBANIZED WATERSHED

We examined the effects of urbanization, based on % impervious surface (IS%) in the watershed and riparian zone, on water quality, and periphyton biomass and nutrient content. A comparison of 10 streams in southern NY state with varying IS% determined that stream-water conductance strongly varied with watershed (r^2 = 0.91; P<0.0001) and buffer (r^2 = 0.70; P=0.0026) IS%. [Mg] and [NO3-] also varied with watershed buffer IS%. Periphyton biomass varied only with riparian buffer IS% (Chl-a: r^2 = 0.47, P=0.028; AFDM: r^2 = 0.65; P = 0.005). Periphyton-C (r^2 = 0.71, P = 0.002) and N (r^2 = 0.76, P = 0.001) increased with urbanization, but only vs. buffer IS%; we observed no significant pattern for periphyton-P at either scale. A 41d experiment using nutrient-diffusing (+P+N) substrata at varying pulse rates in rural, suburban, and urban streams did not find a significant effect of nutrient treatments on periphyton biomass accrual, but responses varied significantly among watershed type (F = 6.127, P=0.005). Data suggest that effects of local and watershed-scale land-use changes may exceed that of short-term nutrient pulses within streams.

Casper, **A**. **F**., Aquatic Ecology Branch, Environmental Lab, USACE ERDC, Vicksburg , USA, andrew.f.casper@usace.army.mil
Rautio, M., Université du Québec à Chicoutimi , Chicoutimi, Canada, milla.rautio@uqac.ca
Martineau, C., Université Laval, Québec, Canada,
Vincent, W. F., Université Laval, Québec, Canada, warwick.vincent@bio.ulaval.ca

FROM THE RIVER TO THE SEA: VARIATION AND ASSIMILATION OF RIVERINE SESTON IN THE PELAGIC FOOD WEB OF THE MACKENZIE RIVER-DELTA AND BEAUFORT SEA TRANSITION ZONE

If increased terrestrial/freshwater material exported to the Mackenzie River and Delta is available to the plankton food web, then it could result in a shift in the nature of carbon supporting plankton productivity. Analysis of the $\delta^{13}C$ of POM from the riverine, estuarine and marine (shelf) zones of the Mackenzie delta and shelf show that the terrestrial/freshwater carbon does extend onto the shelf, although it diminishes with distance from the Mackenzie River. $\delta^{13}C$ values of calanoid copepods, Mysid shrimp, and two species of Amphipods varied depending on their environment (river, estuary, or marine) and local POM $\delta^{13}C$ signature. From this, we conclude that exported terrestrial POM can be a subsidy for portions of the both the riverine, estuarine, and marine pelagic food web. However because the response of consumer $\delta^{13}C$ depended on both species and location, we also conclude that the response to increased riverine POM will be different for estuarine versus marine biota. The implication is that

increases in exported terrestrial carbon represent a significant potential shift in coastal pelagic structure and ecosystem function.

CENTIS, **B.**, IASMA RESEARCH AND INNOVATION CENTER, FONDAZIONE E. MACH, SAN MICHELE ALL'ADIGE, Italy, centis.barbara@gmail.com
SALMASO, N., IASMA RESEARCH AND INNOVATION CENTER, FONDAZIONE E. MACH, SAN MICHELE ALL'ADIGE, Italy, nico.salmaso@iasma.it

SPATIAL PATTERNS AND ECOLOGICAL DETERMINANTS OF DIATOM COM-MUNITIES IN AN ALPINE FLOW RIVER (ADIGE RIVER, NORTH-EASTERN ITALY). IMPLICATIONS FOR THE

Epilithic, epipsammic and epipelic diatoms were sampled in River Adige (North Eastern Italy) and its three major highwater tributaries (Isarco, Noce and Avisio streams) in eight stations to examine the spatial community patterns and the ecological determinants influencing diatom communities. The temporal variation of successive samples in the ordination space was substantial and without an evident pattern: there were similar results between the three habitats even if several species display specificity for, and fidelity to, certain substrates. Many of the species confined to each habitat were, as expected, influenced by their autoecologies (e.g. genera Nitzschia and Navicula were abundant in the epipelon while adnate species such as Acnhantes and Cocconeis spp. were more abundant in the epilithon). This leads to assume that representative results of the state of the waterbody could be obtained irrespective of the substrate and more localised microenvironments but also that there's an impact on the selection of sampling substrate in water monitoring programs.

Cerco, **C**. **F**., US Army ERDC, Vicksburg, USA, carl.f.cerco@usace.army.mil
Dalyander, P. A., US Army ERDC, Vicksburg, USA, patricia.a.dalyander@usace.army.mil

MULTIPLE APPROACHES TO COUPLING THE CHESAPEAKE BAY EUTROPHICATION MODEL WITH HIGHER TROPHIC LEVELS

The ultimate purpose of eutrophication modeling is often the protection of precious living resources. However, the effects of management actions on living resources are commonly modeled by indirect means. For example, dissolved oxygen is computed and the impact on benthos is inferred. We present here results of three different approaches to direct incorporation of living resources into eutrophication models. In the first, filter feeders are represented as biomass with kinetics described by continuous partial differential equations. In the second approach, herbivorous fish are represented as discrete schools governed by bioenergetics relationships. In the third approach, the eutrophication model is linked to a multi-species network model. The first approach is most readily implemented and has provided the most valuable management information, although the representation of species dynamics is limited. The second approach is more realistic and, perhaps, more reliable although the implementation is more difficult that the first. The linkage to the network model provides the least predictive capability, apparently due to limitations of the steady-state approach.

Chadwick, **M**. **A**., King's College London, Strand, United Kingdom, michael.chadwick@kcl.ac.uk

MULTIPLE STRESSORS INFLUENCE INVERTEBRATE BIODIVERSITY OF TIDALLY-INFLUENCED RIVERS

In river/estuary transition zones, physicochemical conditions naturally vary at multiple spatial and temporal scales. Accordingly, these reaches have unique habitats for invertebrates and community shifts can occur along small distances. This project investigated if catchment-specific characteristics can also affect community structure. As expected, invertebrate richness decreased along the river to estuarine gradient in all rivers. This pattern was driven by the loss of salinity intolerant insects. However, in several rivers there were anomalies to this general pattern. Community structure, as reflected by ordination, was influenced by location along the gradient and catchment-specific characteristics. From this, it appears that natural stressors working at multiple scales are important for invertebrate biodiversity. We also observed that biodiversity was affected by anthropogenic structures which reduced habitat heterogeneity and restricted saltwater intrusion. Given the threats to lowland rivers and their associated estuaries, this project provides important information needed to protect and conserve river/estuary transition zones.

Chakraborty, **S**., The University of Southern Mississippi, Stennis Space Center, USA, sumit.chakraborty@eagles.usm.edu
Lohrenz, S. E., The University of Southern Mississippi, Stennis Space Center, USA, steven.lohrenz@usm.edu

PHYTOPLANKTON DYNAMICS IN RELATION TO WATER MASS PROPERTIES IN THE NORTHERN GULF OF MEXICO AND THE WESTERN NORTH ATLANTIC OCEAN.

Diagnostic pigment indices were used to characterize continental margin phytoplankton communities during a summer 2007 cruise extending along the U.S. Gulf of Mexico (GMx) coast from Galveston, Texas and up the eastern continental U.S. to Boston, Massachusetts. Cluster analysis of temperature and salinity data was used to differentiate stations corresponding to river-influenced near shore waters from the offshore open ocean waters in the GMx and the colder less saline waters of the Gulf of Maine and Georges Bank from warmer waters of South Atlantic bight and Cape Hatteras. Average total chlorophyll a (TChla) values were highest (~2.5 mg/m^3) in the coastal GMx and lowest (~0.14 mg/m^3) in open ocean waters off Cape Hatteras. Microplankton and nanoplankton (~50-60%) dominated the higher chlorophyll *a* waters while picoplankton (>50%) was predominant in low chlorophyll *a* waters. At high temperatures and low nutrient conditions, photoprotective carotenoids were prominent, while at lower temperature and higher nutrient conditions photosynthetic carotenoids increased in proportion. Overall, this unique dataset provides insight as to relationships of phytoplankton composition with environmental conditions over a wide geographic area.

Chambers, **P**. **A**., Environment Canada, Burlington, Canada, Patricia.Chambers@ec.gc.ca
Culp, J. M., Environment Canada & Canadian Rivers Institute, Fredericton, Canada, Joseph.Culp@ec.gc.ca

ROLE OF RESEARCH IN INFORMING SCIENCE POLICY: EXPERIENCES GAINED FROM CANADA'S ECOSYSTEM AND ISSUE INITIATIVES

Canada's Environment Department conducts ecosystem and issue-driven initiatives to advance science-based policy to ensure environmental sustainability. Here we discuss science results from two initiatives and how conclusions informed policy decisions. The Northern River Basins Study was an ecosystem initiative focused on effects of pulp mill expansion. Findings on: (a) dissolved oxygen depletions under ice and sensitivities of vulnerable life stages of fish resulted in new objectives for oxygen; (b) nutrient enrichment led to a cap on wastewater discharge; (c) drying-out of a riverine delta led to changes in hydroelectric dam regulation. The National Agri-Environmental Standards Initiative was an issue-driven initiative to identify ecosystem thresholds protective of aquatic life in agriculturally-dominated watersheds. Thresholds identified for nitrogen, phosphorus and suspended sediments served to define environmental outcomes for watershed management programs, prioritize options for beneficial management practices, and set risk levels for a national report card. Our experience has shown that delivering science to policy makers demands science programs be designed at the onset to address policy questions and requires a personal commitment to give fearless science advice in the face of opposition.

Chandra, **S**., University of Nevada- Reno, Reno, USA, sudeep@cabnr.unr.edu
Caires, A., University of Nevada- Reno, Reno, USA, acaires@cabnr.unr.edu
Wittmann, M., University of California- Davis, Davis, USA, mwittmann@ucdavis.edu
Schladow, G., University of California- Davis, Davis, USA, gschladow@ucdavis.edu

ALTERATIONS TO ZOOBENTHOS IN LAKE TAHOE DUE TO EUTROPHICATION AND INCREASED GRAZING PRESSURE FROM NONNATIVE SPECIES

Both the biological and physical characteristics of Lake Tahoe have changed substantially since the 1960s, when the last comprehensive benthic invertebrate survey was conducted. We collected benthic invertebrate samples along 4 transects from 0-500 meters and compared our collections to those made in similar locations in 1962 and 1963. Lakewide-weighted total benthic invertebrate density has declined 87% since the 1960s. Oligochaeta was the most common taxon observed in our samples and Chironomidae was the second most abundant taxon. Lakewide-weighted oligochaete density has declined 79% and lakewide-weighted chironomid density has declined 65% since the 1960s. Two unique endemic taxa, the stonefly Capnia lacustra and the blind amphipod

Stygobromus, are still present in the lake, but their densities have declined dramatically since the 1960s (98%, and 99%, respectively). Two mechanisms have been proposed to explain the loss of benthic secondary production in Lake Tahoe. Previous research suggests cultural eutrophication may disrupt benthic production; however, increasing numbers of introduced aquatic species (e.g. signal crayfish and Mysid shrimp) may be competing with or preying upon native invertebrates. The interplay of these mechanisms is discussed.

Chapman, **E**. **L**., University of Alabama, Tuscaloosa, USA, elchapman@crimson.ua.edu

Sponseller, R. A., University of Alabama, Tuscaloosa, USA, rsponseller@as.ua.edu

Edmonds, J. W., University of Alabama, Tuscaloosa, USA, jwedmonds@as.ua.edu

RELATIONSHIPS BETWEEN GEOMORPHOLOGY AND ECOSYSTEM METABOLISM IN THE CAHABA RIVER, AL

Notable changes in geomorphology can occur along large rivers, with important consequences for ecosystem structure and function. We explored relationships among channel form, water turbidity, and ecosystem metabolism along the Cahaba River in central Alabama. The Cahaba is one of the longest free flowing rivers remaining in the Gulf Coast region, and is characterized by abrupt changes in geomorphic structure as it flows from the Ridge and Valley physiographic province across the fall line onto the Gulf Coastal Plain. Transitions in channel form are accompanied by longitudinal increases in turbidity as well as changes in the dominant primary producers, from benthic algae in the Ridge and Valley province, dense macrophyte beds associated with the fall line, and phytoplankton in the Coastal Plain. We used single-station, diel oxygen curves to estimate gross primary production (GPP) and community respiration (CR) at sites above and below the fall line. Preliminary results from summer 2009 suggest that both GPP and P/R increase at downstream locations. This work highlights important linkages among channel form, light availability, and ecosystem metabolism in a large river setting.

Chapperon, **c**., Flinders University, Adelaide, Australia, coraline.chapperon@flinders.edu.au

Seuront, Flinders University, Adelaide, Australia, coraline.chapperon@flinders.edu.au

DETECTING SMALL-SCALE SPATIAL HETEROGENEITY IN SNAIL BODY TEMPERATURE USING THERMAL IMAGING: TOWARDS AN ORGANISM PERSPECTIVE

In the context of global warming, recent mechanistic models have focused on the individual physiological responses of marine ectotherms to thermal stress. Although coupling those models with climate envelop models may provide insights into species thermal windows of adaptation, hence future distribution ranges, a few gaps still exist. Particularly, it is critically needed to integrate (i) the space-time heterogeneity in thermal stress and associated physiological responses and (ii) the organism behavioural response to thermal stress. Thermal imaging was used as a novel and non-invasive approach to assess the variability in body temperatures of intertidal gastropods inhabiting different habitats in two seasons. Additionally, thermal pictures of individuals and surrounding substrates were examined in regards to microhabitat position and status (solitary, aggregated). Our results show that substrate temperatures could be used as a good proxy for body temperatures, but only under some conditions. Moreover, microhabitat occupation and aggregation do not always reduce thermal stress. Finally, understanding the ecosystem response to global change requests a thoroughly examination of the organism response as stressed here by the small-scale spatial heterogeneity in body temperatures.

Chasar, **L**. **C**., US Geological Survey , Tallahassee, FL, USA, lchasar@usgs.gov

Scudder, B. C., US Geological Survey, Middleton, WI, USA, bscudder@usgs.gov

Brigham, M. E., US Geological Survey, Mounds View, MN, , mbrigham@usgs.gov

Riva-Murray, K., US Geological Survey, Albany, NY, USA, krmurray@usgs.gov

Stewart, A. R., US Geological Survey, Menlo Park, USA, arstewar@usgs.gov

CHARACTERIZING METHYLMERCURY BIOACCUMULATION AND BIOMAGNIFICATION IN STREAMS ACROSS LARGE ENVIRONMENTAL GRADIENTS

The US Environmental Protection Agency recently issued guidelines for implementing the 2001 fish-tissue-based methylmercury (MeHg) water quality criterion, suggesting it be based on MeHg bioaccumulation factors for target fish species (BAF; MeHg in fish muscle tissue/MeHg in water). BAFs in streams are influenced by many factors: scale (stream, watershed, region); sample timing and number of samples; environmental setting (Hg source strength, land use/land cover, stream biogeochemistry, hydrodynamics); ecology, physiology and life history of fish and their prey. We evaluated BAFs for fish from streams in Oregon, Wisconsin, New York, South Carolina, and Florida from 2002-2009 spanning a large range in Hg source strength and environmental settings. We found consistent patterns of MeHg biomagnification (increasing MeHg with increasing trophic level from macroinvertebrates to predator fish) across ecosystems, and strong correlations of MeHg in aquatic organisms with dissolved organic carbon in stream water and forested wetlands in the watershed. The extensive spatial and temporal coverage of these studies promotes understanding of the physical, chemical, and biological mechanisms that influence the uptake, accumulation, and trophic transfer of MeHg (hence, BAFs) in aquatic biota.

Chaves-Ulloa, **R**., Dartmouth College, Hanover, USA, ramsa.chaves.ulloa@dartmouth.edu

Springer, M., Universidad de Costa Rica, San Jose, Costa Rica, springer@biologia.ucr.ac.cr

Umaña, G., Universidad de Costa Rica, San Jose, Costa Rica, gumana@biologia.ucr.ac.cr

EFFECTS OF HYDROELECTRIC PRODUCTION ON BENTHIC MACROINVERTEBRATES IN TWO COSTA RICAN RIVERS

Little information exists about the consequences of hydropower production in tropical areas, especially during the operational phase. In Latin America, hydroelectric energy is the primary method of fulfilling growing electrical demands. Most large dams (>15m in height) currently under construction or consideration are in the tropics. We investigated the effects of large hydroelectric dams on benthic-macroinvertebrate communities in two Costa Rican rivers. We measured physical-chemical characteristics and sampled benthic-macroinvertebrates from March 2003 to March 2004 in the Peñas Blancas and San Lorenzo Rivers. We also sampled the undammed Chachagua River. The physical-chemical characteristics were similar among the study sites. Species richness did not change significantly in areas affected by hydroelectric production. Community composition was different above and below the dam in the Peñas Blancas River. In the San Lorenzo River, the site below the turbine house showed less abundance than the site above, likely due to hydropower production discharge. We also document the effects of the October 2003 sediment purge on benthic-macroinvertebrates in the Peñas Blancas River. This study shows that mitigation techniques can reduce environmental damage from hydropower production.

Cheever, **B**. **M**., Virginia Polytechnic Institute and State University, Blacksburg, USA, bcheever@vt.edu

Webster, J. R., Virginia Polytechnic Institute and State University, Blacksburg, USA, jwebster@vt.edu

Kratzer, E. B., Virginia Polytechnic Institute and State University, Blacksburg, USA, ekratzer@vt.edu

N AND P MINERALIZATION BY HETEROTROPHIC BIOFILMS OVER THE COURSE OF LEAF DECOMPOSITION ACROSS A NUTRIENT GRADIENT.

According to theory, the rate and stoichiometry of microbial mineralization will depend in part on nutrient availability. For microbes associated with leaves in streams, nutrients are available from both the water column and the leaf. Therefore, microbial nutrient cycling may also change with nutrient availability and over the course of leaf decomposition. We explored spatial and temporal patterns of mineralization by heterotrophic biofilms by placing packs of red maple leaves in five Appalachian streams spanning a range of nitrogen and phosphorus availability. Packs were collected four times from each stream. Leaf disks from these packs were incubated in microcosms. Uptake rates and steady state concentrations of ammonium and phosphate were used to calculate mineralization rates. Uptake and mineralization of ammonium across all streams peaked after 55 days while phosphate mineralization peaked after 60-65 days. Neither uptake nor mineralization of ammonium or phosphate was related to stream water chemistry. However, ammonium uptake increased with stream water N:P. Our results suggest the relative availability of nitrogen and phosphorus is important to microbial nutrient processing.

Chen, **C. Y.**, Dartmouth College, Hanover, USA, celia.chen@dartmouth.edu
Kamman, N. C., Vermont Department of Environmental Conservation, Waterbury, USA, Neil.Kamman@state.vt.us
Williams, J. J., TerraGraphics, Moscow, USA, jason.williams@terragraphics.com
Bugge, D. M., Dartmouth College, Hanover, USA, Deenie.M.Bugge@Dartmouth.edu
Taylor, V. F., Dartmouth College, Hanover, USA, Vivien.F.Taylor@dartmouth.edu
Jackson, B. P., Dartmouth College, Hanover, USA, Brian.P.Jackson@dartmouth.edu
Miller, E. K., Ecosystems Research Group, Ltd., Norwich, USA, ekmiller@ecosystems-research.com

SPATIAL AND TEMPORAL VARIATION IN MERCURY BIOACCUMULATION BY ZOOPLANKTON IN LAKE CHAMPLAIN

We investigated the Hg bioaccumulation in zooplankton from contrasting basins in L. Champlain to test the hypothesis that more eutrophic conditions result in lower total Hg and MeHg bioaccumulation in lower trophic levels of the food web. In 2004-2006, zooplankton samples were taken in Malletts Bay (oligotrophic) and Missisquoi Bay (eutrophic) in mid-summer to compare Hg bioaccumulation between basins. In 2007-8, we measured seasonal variation in Hg and MeHg bioaccumulation in zooplankton. Although concentrations of Hg and MeHg in zooplankton varied year to year, bioaccumulation in the eutrophic basin had consistently lower total Hg and MeHg concentrations than in the oligotrophic basin in 2005, 2006, and 2008 suggesting that plankton biodilution of Hg was occurring in Missisquoi Bay. Seasonally, there were differing patterns of variation in zooplankton Hg and MeHg between Malletts and Missisquoi Bay. The results of this study show that despite major year-to-year variability in Hg bioaccumulation in zooplankton, there are consistent patterns across years related to the trophic status of individual basins.

Chen, **H.**, Institute of Environment Sciences, University of Quebec at Montreal, Montreal, Canada, chenhuai81@gmail.com
Peng, C., Institute of Environment Sciences, University of Quebec at Montrea, Montreal, Canada, peng.changhui@uqam.ca
Wu, N., Chengdu Institute of Biology, Chinese Academy of Sciences, Chengdu, China, wuning@cib.ac.cn

PRELIMINARY ESTIMATE OF METHANE EMISSIONS FROM SURFACE OF LAKES AND RESERVIORS IN CHINA

China is a country with numerous lakes and reservoirs. There are about 2759 lakes (larger than 1 km2) and 83387 reservoirs in China, covering areas of 75610 and 23020 km2, respectively. Though, inland waters are regarded as a source of CH4, there is so limited observation data of CH4 emissions available from lakes and reservoirs in China. Based on existing studies and literatures, the present study preliminarily estimated the methane emission from surface of lakes and reservoirs in China as 0.203 Tg CH4 a-1, which is only 9% of the total methane emission from natural wetlands (2.2 Tg CH4 a-1). Three major lake regions are the main centres of methane emissions (0.106 Tg CH4 a-1 from Eastern Plain; 0.065 Tg CH4 a-1 from Qinghai-Tibetan Plateau; 0.022 Tg CH4 a-1 from Mongolia-Xinjiang Plateau). A very small amount of methane is emitted from Northeast Plain (0.006 Tg CH4 a-1) and Yunnan-Guizhou Plateau (0.004 Tg CH4 a-1). However, the results are very preliminary with uncertainty. Therefore, further measurements and modellings are needed to make the estimate more accurate and reasonable.

Chengala , **A.**, University of Minnesota , Minneapolis, USA, cheng107@umn.edu
Hondzo, M., University of Minnesota , Minneapolis, USA, mhondzo@umn.edu
Sheng, J., University of Minnesota , Minneapolis, USA, jsheng@aem.umn.edu

THREE-DIMENSIONAL SWIMMING CHARACTERISTICS OF DUNALIELLA PRIMOLECTA IN A MOVING FLUID

Microscopic algae are often mediated by various environmental factors in the field, yet its response is not well studied. Experiments are conducted in an in-house developed microfluidic channel to study the effects of fluid motion on the swimming responses of halophilic microalga Dunaliella primolecta. Digital holographic microscopy allows us instantaneous three-dimensional (3D) measurements of swimming characteristics of microscopic organisms in a dense suspension, and microfluidics provides exquisite control over fluid flow. The swimming behavior of Dunaliella primolecta is characterized by 3D velocities, velocity auto-correlation functions, kinetic power spectral densities and swimming induced cellular dispersion. To investigate the shear induced response, the algal culture is injected into a 20mm channel with cross section of 3.5×0.4mm (latter being height) at several fluid flow rates, generating flow shear rates that are consistent with the energy dissipation levels in estuaries, coastal waters, and lakes. Preliminary measurements indicate that swimming velocities and dispersion were strongly mediated by local fluid shear rates. On-going analysis is to reveal scaling parameters and functional relationships among small-scale fluid motion and microorganism motility characteristics.

Cheruvelil, **K. S.**, Michigan State University, E Lansing, USA, ksc@msu.edu
Soranno, P. A., Michigan State University, E Lansing, USA, soranno@msu.edu
Bremigan, M. T., Michigan State University, E Lansing, USA, bremigan@msu.edu
Webster, K. E., Michigan State University, E Lansing, USA,
Wagner, T., Pennsylvania State University, State College, USA,
Stow, C. A., NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, USA,

LANDSCAPE LIMNOLOGY: INTEGRATING FRESHWATER, TERRESTRIAL, AND HUMAN LANDSCAPES FOR ECOLOGICAL UNDERSTANDING AND NATURAL RESOURCE MANAGEMENT AND CONSERVATION

Effective freshwater ecosystem management of thousands of waterbodies is a significant challenge, largely because sparse resources prevent ecosystem-specific management plans. Consequently, management often treats all waterbodies as if they respond similarly to management actions, even though a one-size-fits-all approach typically is ineffective. Alternatively, the principles of landscape limnology can be used to classify waterbodies into a more tractable number of management-relevant classes. We present a predictive classification modeling approach for management and conservation that is built on landscape limnology principles and explicitly integrates freshwater, terrestrial, and human landscapes. Our approach allows flexibility to address multiple management and conservation goals by including options for developing state- or response-based classifications. We provide two example applications by classifying 1,998 North American lakes for two important classification endpoints relevant to lake eutrophication and nutrient policy: lake classes with similar total phosphorus values (a state-based classification) and lake classes with similar relationships between chlorophyll and total phosphorus (a response-based classification). Although our examples focus on lakes, this approach can be applied to other systems managed at broad spatial scales, such as stream segments and wetlands.

Childress, **E. S.**, University of Michigan, School of Natural Resources and Environment, Ann Arbor, USA, echild@umich.edu
McIntyre, P. B., University of Michigan, School of Natural Resources and Environment, Ann Arbor, USA, pbmcinty@umich.edu
Allan, J. D., University of Michigan, School of Natural Resources and Environment, Ann Arbor, USA, dallan@umich.edu

FISH MIGRATIONS PROVIDE NUTRIENT SUBSIDIES TO FOOD WEBS IN GREAT LAKES TRIBUTARIES

Catostomid fishes migrate in huge numbers out of the Great Lakes into tributaries to spawn, potentially supplementing the supply of carbon and nitrogen to riverine food webs. Sucker migrations differ in size among tributaries and in extent of upstream penetration due to barriers. These fish have enriched nitrogen isotope ratios compared to tributary food webs, enabling isotopic tracking of nutrient subsidies delivered by the migrations. We tested the effects of carcass access on nitrogen isotope ratios of *Limnephilus* caddisflies using an enclosure experiment. Additionally, growth and isotope ratios of *Limnephilus* were tracked over the course of the spawning migration upstream and downstream of an experimental barrier to migration in a nutrient-poor stream. Caddisflies rapidly incorporated fish-derived N in both enclosures and field conditions. Spawning catostomids represent an important seasonal nutrient source for stream food webs. Obstruction of breeding migrations of suckers and other native fishes by anthropogenic barriers has probably altered fundamental ecosystem processes in Great Lakes tributaries.

Christensen, C., Oregon State University, Corvallis, USA, christce@onid.orst.edu
González-Pinzón, **R**., Oregon State University, Corvallis, USA, gonzaric@geo.oregonstate.edu
Argerich, A., Oregon State University, Corvallis, USA, argerica@geo.oregonstate.edu
Haggerty, R., Oregon State University, Corvallis, USA, haggertr@geo.oregonstate.edu
Myrold, D., Oregon State University, Corvallis, USA, david.myrold@oregonstate.edu
Martí , E., Centre d'Estudis Avançats de Blanes (CSIC) , Blanes, Spain, eugenia@ceab.csic.es

RESAZURIN TRANSFORMATION CORRELATED TO AEROBIC RESPIRATION IN STREAM SEDIMENTS

Resazurin, "Raz", is a weakly fluorescent, redox-sensitive dye that undergoes an irreversible reduction to strongly fluorescent resorufin, "Rru", when exposed to aerobic respiration. Previous research has shown that the transformation of Raz to Rru can be used as a "smart" tracer to detect changes in metabolic activity in stream sediment and to measure the fraction of metabolically active transient storage (MATS; see Argerich et al. and Haggerty et al., this session). We hypothesize that the reaction rate of Raz to Rru is proportional to aerobic respiration. We tested this hypothesis by measuring the Raz reaction and respiration rates in sediments under different temperatures and different dissolved organic carbon concentrations. The reaction rate of Raz is linearly correlated to the respiration rate ($r2 = 0.93$, $N = 38$, $p < 0.01$). We developed an expression relating the rate of Raz transformation to aerobic respiration and intend to use Raz transformation to measure aerobic respiration in the field. This will be useful in environments where direct measurement of respiration is challenging and in characterizing spatial heterogeneity in respiration rates.

Chumchal, **M**. **M**., Texas Christian University, Fort Worth, USA, m.m.chumchal@tcu.edu
Rainwater, T. R., Texas Tech University, Lubbock, USA,
Osborn, S. C., Texas Christian University, Fort Worth, USA,
Roberts, A. P., University of North Texas, Denton, USA,
Cobb, G. P., Texas Tech University, Lubbock, USA,
Smith, P. N., Texas Tech University, Lubbock, USA,
Bailey, F. C., Middle Tennessee State University, Murfreesboro, USA,

ASSESSMENT OF MERCURY BIOMAGNIFICATION IN A SUBTROPICAL FRESHWATER ECOSYSTEM (CADDO LAKE, TEXAS/LOUISIANA, USA)

We studied the biomagnification of total and methylmercury in a subtropical freshwater lake, Caddo Lake, TX/LA. Our study is unique in that we not only included invertebrates (seven species) and fish (six species) but also an amphibian (bullfrog), reptiles (cottonmouth and American alligator) and mammals (nutria and raccoon). Non-fish vertebrates like the ones included in this study are often overlooked in assessments of trophic transfer of mercury. Mercury concentrations were positively correlated with trophic position, indicating that biomagnification occurs in the food web of Caddo Lake. The food web magnification factor (FWMF, slope of the relationship between mean mercury concentration and trophic position) for both total and methylmercury was similar to those observed in other studies. The FWMF for methylmercury was 1.2 times greater than total mercury, indicating that methylmercury was transferred through the food web faster than total mercury. Some of the non-fish vertebrates examined in this study, like American alligators and nutria, had low concentrations of mercury, similar to those observed in invertebrates, while cottonmouths and raccoons had concentrations high enough that their health could be negatively impacted.

Church, **J**. **O**., Iowa State University, Ames, USA, jochurch@iastate.edu
Heathcote, A. J., Iowa State University, Ames, USA, aheathco@iastate.edu

DETRENDING WITHOUT DETRENDING: RE-EXAMINING THE 'ARCH EFFECT' IN ECOLOGICAL ORDINATION

Multivariate ordinations of ecological data frequently reveal an arch pattern formed across localities. Such patterns are often viewed as methodological artifacts or distortions of the underlying ecological patterns, and methods have been proposed that mitigate these effects to identify the underlying trends across localities. In some circumstances, the arch may reflect the actual biological signal in the data, and in these instances it should be preserved and biologically interpreted. Here we present a comparison of various ordination methods to a method that directly fits a model to the arch. We analyzed simulated and empirical phytoplankton-community data to demonstrate that modeling the arch, rather than suppressing it, enables detection of such patterns, and that an underlying gradient in ecological data across localities is frequently responsible for such patterns. When used in conjunction with other approaches, quantifying the arch provides a richer description of ecological patterns across the landscape.

Church, **M**. **R**., US EPA, Corvallis, USA, church.robbins@epa.gov
Ebersole, J. L., US EPA, Corvallis, USA, ebersole.joe@epa.gov
Rensmeyer, K. M., NAPCA, Corvallis, USA, rensmeyer.kirk@epa.gov
Couture, R. B., Oregon Dept. Fish and Wildlife, Alsea, USA, ryan.b.couture@state.or.us
Barrows, F. T., USDA, ARS, Hagerman, USA, rick.barrows@ARS.USDA.gov
Noakes, D. L., Oregon State University, Corvallis, USA, noakes@oregonstate.edu

STABLE ISOTOPE ANALYSIS OF FISH MUCUS DURING A CONTROLLED DIET SWITCH

We have used a controlled diet switch in steelhead trout (Oncorhynchus mykiss) at the Oregon Hatchery Research Center to study the time rates of changes in stable isotopes of carbon and nitrogen (delta13C and delta15N) in epidermal mucus, a rapidly responding "tissue." Because of the rapidity with which mucus responds, due to high rates of synthesis and turnover, it holds promise for stable isotope analyses of diet or habitat switching of fish in certain natural situations. In our experiment we switched the diets of eighteen individually PIT-tagged fish from one with relatively higher delta values (delta 13C = -21, delta 15N = 13) to one with relatively lower delta values (delta 13C = -26, delta 15N = 3). Delta values for actively feeding fish responded rapidly in mucus with half lives typically less than 20 days. Assuming that mucus is synthesized primarily from either recently ingested feed or recycled muscle tissue allows computation, via the reaction progress variable approach of Cerling et al., of the relative contribution of each source to mucus synthesis.

Ciborowski, **J**. **J**., Biological Sciences, University of Windsor, Windsor, Canada, cibor@uwindsor.ca
Johnson, L. B., Natural Resources Research Inst., Univ. Minnesota - Duluth, Duluth, USA, ljohnson@d.umn.edu
Tomal, J. H., Dept. of Statistics, University of British Columbia, Vancouver, Canada, jtomal@stat.ubc.ca
Fung, K., Department of Mathematics & Statistics, University of Windsor, Windsor, Canada, kfung@uwindsor.ca
Bhagat, Y., Annis Water Resources Institute, Grand Valley State University, Muskegon, Canada, bhagaty@gvsu.edu
Zhang, J., Freshwater Institute, Fisheries & Oceans Canada, Winnipeg, Canada, 204-984-1775

CALIBRATING BIOLOGICAL INDICATORS AGAINST THE REFERENCE-DEGRADED CONTINUUM - EXAMPLES FROM GREAT LAKES BIOTA

Environmental assessment typical entails comparing a test site to the reference condition (the RCA), whose limits are determined empirically by sampling many reference sites. The reference condition is defined by physicochemical characteristics of 'best available' sites and associated biota. Applying the RCA becomes difficult when most of the study region is subject to varying degrees of disturbance. We operationally define the complementary "degraded condition", wherein physicochemical characteristics ("disturbances") are deemed unacceptable by consensus. A test site's relative quality can thus be estimated from its position along a reference-degraded continuum (RDC). We analysed changes in assemblages of Great Lakes biota (zoobenthos, fishes, and birds) against disturbance to derive taxon-specific bioindicators. Changepoints, identified using piecewise quantile regression, were common manifestations of responses to anthropogenic disturbance, permitting us to estimate boundaries of the reference and degraded conditions, respectively, as points on the RDC.

Claeson, **S**. **M**., USDA Forest Service, PNW Research Station, Olympia, USA, sclaeson@fs.fed.us
Foster, A. D., USDA Forest Service, PNW Research Station, Olympia, USA, alexfoster@fs.fed.us
Wondzell, S. M., USDA Forest Service, PNW Research Station, Olympia, USA, swondzell@fs.fed.us
Bisson, P. A., USDA Forest Service, PNW Research Station, Olympia, USA, pbisson@fs.fed.us

DEBRIS FLOW EFFECTS ON STREAM BIOTA IN WASHINGTON STATE

Because debris flows are unpredictable, studies comparing pre- vs. post-disturbance effects on aquatic biota are scarce. A large rain-on-snow storm struck southwestern Washington State in December 2007. Within Capitol State Forest, two adjacent, headwater streams experienced large-scale debris flows (2-2.6km long, 30-50m wide), removing all vegetation. We studied water temperatures and fish populations for 4 years pre- and 2 years post-disturbance. Summer maximum temperatures and diurnal fluctuations were elevated after the debris flows. Cutthroat trout repopulated the study reaches within 7 months at greater abundance than before, but were smaller than pre-disturbance. Overall fish diversity was reduced to 99% cutthroat trout. Sculpins had not yet repopulated the study reaches, but began moving upstream. Emerging stream insects were collected in spring 2009 from the 2 debris flow streams and 1 forested, reference stream for comparison. Macroinvertebrate communities differed between the debris flow and reference streams, along with community changes over time. Climate change models for the Pacific Northwest predict more extreme events; thus studies monitoring biotic recovery will become more important to land and fisheries management.

Clark, **C**. **D**., Chapman University, Orange, USA, cclark@chapman.edu
De Bruyn, W. J., Chapman University, Orange, USA, debruyn@chapman.edu
Aiona, P., Chapman University, Orange, USA,
Brahm, B., Chapman University, Orange, USA,

DIEL VARIABILITY OF HYDROGEN PEROXIDE AND CHROMOPHORIC DISSOLVED ORGANIC MATTER (CDOM) OPTICAL PROPERTIES IN THE SURF ZONE

Chromophoric dissolved organic matter (CDOM) absorbs sunlight to undergo a series of reactions that produce reactive transient species like hydrogen peroxide (H2O2). Peroxide is a strong oxidant that has been implicated in the cycling of fecal indicator bacteria, a measure of microbial water quality in marine recreational waters. We report the results of 4 diel studies conducted at Crystal Cove State Beach in Southern California in summer 2009. H2O2 levels ranged over an order of magnitude from around 20 to 200 nM, with clear photochemical production cycles and maxima after solar noon. Significant short-term variability in CDOM optical properties was observed (min to hr), with pulses of lower spectral slope waters corresponding to fresh proteinaceous peaks on 3D excitation-emission matrices. Higher spectral slope pulses correlated with mixed terrestrial and marine humic peaks and significantly reduced or absent protein peaks. Potential CDOM sources in the near-shore dynamic surf zone environment are discussed. Evidence is presented for the production of H2O2 from sources other than photoexcited CDOM.

Clements, **W**. **H**., Colorado State University, Fort Collins, USA, willc@cnr.colostate.edu
Arnold, J. L., Fisheries and Aquatic Sciences Program, Yellowstone National Park, USA,
Koel, T. M., Fisheries and Aquatic Sciences Program, Yellowstone National Park, USA,
Daley, R., Greater Yellowstone Network, Bozeman, USA,
Jean, C., Greater Yellowstone Network, Bozeman, USA,

RESPONSES OF STREAM BENTHIC COMMUNITIES TO GEOTHERMAL DISCHARGES IN YELLOWSTONE NATIONAL PARK

We examined responses of benthic macroinvertebrate communities to natural geothermal discharges in 32 streams in Yellowstone National Park (YNP). Discharges from geothermal areas played a major role in structuring benthic communities. Downstream sites were characterized by low species richness, reduced abundance of EPT taxa and increased abundance of tolerant Trichoptera, chironomids and non-insects. While some taxa were a subset of tolerant organisms that were also common at references sites, others were found exclusively in geothermal streams. Because geothermal waters are a common feature of YNP, monitoring programs designed to assess long-term status and trends of Yellowstone's aquatic ecosystems must account for the influence of these discharges. A multimetric index based on benthic communities clearly identified geothermal streams and showed a well-defined threshold response at very low levels of geothermal discharge. Our findings may provide important insights into how benthic macroinvertebrate communities respond to global change. Reduced discharge and warmer temperatures predicted for Rocky Mountain streams may favor the establishment and expansion of exotic species such as New Zealand mudsnails (P. antipodarum), which were highly tolerant of geothermal influences.

Clinton, **S**. **M**., University of North Carolina Charlotte/Department of Biology, Charlotte, USA, sclinto1@uncc.edu
McMillan, S. K., University of North Carolina Charlotte/Department of Engineering Technology, Charlotte, USA, SMcMillan

MICROBIAL DIVERSITY IN URBAN STREAMS WITH VARYING LANDSCAPE HISTORIES

Stream microbial communities play significant roles in nutrient cycling and organic matter decomposition. In order to understand linkages between community structure and ecosystem function, we need to better understand changes in microbial diversity over time and space in stream ecosystems. We are currently measuring benthic microbial diversity in three urban streams with varying landscape histories in Charlotte, North Carolina, U.S.A. using automated ribosomal spacer analysis (ARISA) and direct sequencing of the 16S rRNA gene. The three streams (urban restored, high urban, low urban) have similar nutrient concentrations but vary in the amount of algal biomass and sediment organic matter. Microbial diversity varied both within and among sites suggesting that not only seasonal changes but also geomorphic heterogeneity and the effects of scouring floods are important controlling factors in urban streams. By applying molecular techniques to stream ecosystems we can better understand changes in urban stream microbial diversity and link these patterns to ecosystem processes.

Clivot, **H**., LIEBE, Metz, France, hugues.clivot@umail.univ-metz.fr
Pagnout, C., LIEBE
Rousselle, P., LIEBE
Wagner, P., LIEBE
Poupin, P., LIEBE
Guerold, F., LIEBE

ACIDIFICATION OF HEADWATER STREAMS: STRUCTURAL AND FUNCTIONAL ASSESSMENT OF MICROBIAL COMMUNITIES ASSOCIATED WITH DECAYING LEAVES.

Acid depositions due to anthropogenic activities have severely affected forested headwater streams draining granite and sandstone watersheds in the Vosges Mountains (North-eastern France). Detrimental effects have been reported on biodiversity and key ecosystem processes such as leaf-litter breakdown. In such heterotrophic ecosystems micro-organisms play a pivotal role in allochthonous organic matter processing. The aim of this study was to highlight shifts in microbial communities and consequently in microbial activities that could explain reduced leaf breakdown rates. We compared microbial colonization, enzymatic activities and litter processing in three acidic streams (mean pH 4.48, 4.62 and 4.66) and three circumneutral streams (mean pH 6.80, 7.43, 7.58) during a 70 day period. The breakdown rates were significantly reduced in the three acidic streams compared with the circumneutral ones. Through time, activity peaks of lignin and cellulose-degrading enzymes appeared earlier in circumneutral streams and patterns of enzymatic activities were strongly similar within each group of streams suggesting similar processes of decomposition. Comparisons of bacterial and fungal taxonomical structures were investigated using respectively 16S rDNA and 18S rDNA fingerprinting of communities by PCR-DGGE.

Coats, **R. N.**, Univ. Calif., Dept. Environ.Sci. & Policy, Davis, Ca, USA, rncoats@ucdavis.edu
Sahoo, G., Univ. Calif., Dept. Civil & Environ. Eng., Davis, Ca, USA, gbsahoo@ucdavis.edu
Riverson, J., Tetra Tech Inc., Fairfax, VA, USA, john.riverson@tetratech-ffx.com
Reuter, J., Univ. Calif., Dept. Environ.Sci. & Policy, Davis, CA, USA, jereuter@ucdavis.edu
Wolfe, B., Northwest Hydraulic Consultants, West Sacramento, CA, USA, bwolfe@nhcweb.com
Schladow, G., Univ. Calif. Dept. Civil & Environ. Eng., Davis, CA, USA, gschladow@ucdavis.edu

HISTORIC AND LIKELY FUTURE IMPACTS OF CLIMATE CHANGE ON LAKE TAHOE

Using historic lake temperature, air temperature and hydrologic data, we previously showed that 1) the average temperature and thermal stability of Lake Tahoe have increased since 1970; 2) basin air temperatures have increased since 1910; 3) date of snowmelt peak runoff is shifting, and 4) the snowfall:rainfall ratio is decreasing. Here we report on the results of efforts to model impacts of 21st century climate change on Lake Tahoe, and effects of climate change on water quality BMP design. Meteorological data from the GFDL model for two emission scenarios were downscaled to a 7.5' grid, and used to drive a distributed hydrologic model. The hydrologic outputs, along with the meteorological data, were then used as input to a 1-d hydrodynamic/clarity model of the lake. The results indicate that 1) recent trends in basin climate and hydrology will continue, with a possible 5 deg. C increase in average annual air temperature by 2100; 2) the lake will continue warming, and its increasing thermal stability will likely reduce deep mixing, with concomitant episodes of deep-water anoxia and release of phosphorus and ammonia from the sediment.

Cohen, **M. J.**, University of Florida, Gainesville, USA, mjc@ufl.edu
Heffernan, J. B., Florida International University, Miami, USA, jheffer@fiu.edu
Douglass, R. L., University of Florida, Gainesville, USA, rldouglass@ufl.edu
Liebowitz, D., University of Florida, Gainesville, USA, dinalieb@ufl.edu
Albertin, A., University of Florida, Gainesville, USA, albertin@ufl.edu
Foster, C. R., University of Florida, Gainesville, USA, chadrfos@ufl.edu

COUPLED CARBON AND NITROGEN METABOLISM IN SPRING FED RIVERS

Florida's springs present an ideal setting to study aquatic ecosystem metabolism because they exhibit low variability in discharge, chemistry and temperature, and high levels of benthic primary production. H.T. Odum's work in springs established the diel oxygen technique for assessing riverine metabolism; recent work using diel variance techniques has allowed similar inference of riverine nitrogen dynamics. Here we use both oxygen and nitrogen metabolism to examine three facets of ecosystem C and N coupling in Florida's spring-fed rivers. First, we use 6 months of continuous measurements of C and N metabolism (and resulting stoichiometric relations) in the Ichetucknee River with changing season and discharge to refine our understanding of direct and indirect coupling of N dynamics with primary production. Second, we test the hypothesis that these systems are N saturated by comparing C and N metabolism in rivers spanning a gradient of N enrichment (0.05 to 1.5 mg N/L). Finally, we compare C and N metabolism in the Ichetucknee and Alexander systems to test the hypothesis that whole-ecosystem stoichiometric relations can be used to deconvolve the contribution of algae and vascular plants to primary production.

Colburn, **E. A.**, Harvard Forest, Petersham, MA, USA, colburn@fas.harvard.edu
Sobczak, W. V., Holy Cross College, Worcester, MA, USA, wsobczak@holycross.edu
Orwig, D. A., Harvard Forest, Petersham, MA, USA, orwig@fas.harvard.edu
Hadley, J., Harvard Forest, Petersham, MA, USA, julianhdl1@gmail.com
Willacker, J. J., University of Alaska, Fairbanks, AK, USA, jjwillac@gmail.com
Jensen-Herrin, H., Harvard Forest, Petersham, MA, USA, whydah1009@aol.com
Boose, E., Harvard Forest, Petersham, MA, USA, boose@fas.harvard.edu
Ellison, A. M., Harvard Forest, Petersham, MA, USA, aellison@fas.harvard.edu
Foster, D. R., Harvard Forest, Petersham, MA, USA, drfoster@fas.harvard.edu

WIDESPREAD LOSS OF A FOUNDATION FOREST TREE SPECIES TO AN INVASIVE HERBIVORE: IMPLICATIONS FOR HEADWATER STREAMS IN CENTRAL NEW ENGLAND

Eastern hemlock (*Tsuga canadensis*) is a long-lived foundation tree species found in dense upland and riparian stands. Widespread hemlock decline due to an invasive herbivore, the hemlock woolly adelgid (*Adelges tsugae*), is moving north into central New England. Further south, this regional landscape disturbance is replacing hemlock with a succession of black birch (*Betula lenta*), red maple (*Acer rubrum*), and mixed oaks (*Quercus*). Research by forest ecologists shows that hemlock stands use half the water of deciduous stands during the growing season and create a cool, dark, microenvironment with acidic soils, slow decomposition, and few understory plants. Preliminary evidence indicates that hemlock-dominated streams have higher baseflows, lower PAR, less variable temperatures, slower decomposition, and different biota than streams in deciduous stands. We predict that streams affected by hemlock decline will experience more intermittent summer flow, greater seasonal temperature extremes, greater in-channel photosynthesis from fall to late spring, and higher nutrient availability, leaf substrate quality, and rates of leaf decomposition. These functional changes are likely to lead to altered aquatic communities, including potential losses of some coldwater species.

COLE, **J. J.**, Cary Institute of Ecosystem Studies, Millbrook, USA, colej@ecostudies.org
PACE, M. L., University of Virginia, Charlottesville, USA, mlp5fy@virginia.edu
CARPENTER, S. R., University of Wisconsin, Madison, USA, srcarpen@wisc.edu
SOLOMON, C. T., University of Wisconsin, Madison, USA, ctsolomon@wisc.edu
KITCHELL, J. F., University of Wisconsin, Madison, USA, kitchell@wisc.edu
WEIDEL, B. C., University of Wisconsin, Madison, USA, bweidel@gmail.com

STRONG EVIDENCE FOR SUPPORT OF ZOOPLANKTON IN SMALL LAKES

In traditional models of pelagic food webs, zooplankton consume mainly phytoplankton, bacteria, and protozoa. Using whole-lake additions of inorganic 13C, we estimated that 20 to 60% of the organic C in zooplankton is ultimately from terrestrial sources. Models of these experiments demonstrated that the pathway from terrestrial DOC to bacteria to zooplankton was only of minor importance and that zooplankton were likely consuming particles of terrestrial origin. The 13C manipulations have potential drawbacks: 1) the possibility of significant zooplankton feeding below the mixed (13C-labeled layer); and 2) utilization of detritus of phytoplankton origin but produced prior to the labeling experiment. Either could lead to an overestimate of the importance of terrestrial C. Here, we use ambient levels of three stable isotopes (13C, 15N and 2H) to re-evaluate terrestrial support of zooplankton at multiple depths. The new results support the hypothesis that zooplankton in small lakes consume a mixture of particles of terrestrial and phytoplanktonic origin. Contrary to some recent claims, these results cannot be explained by deep feeding by zooplankton or by the consumption of detritus of algal origin

Coleman Wasik, **J. K.**, University of Minnesota, Minneapolis, MN, USA, jcoleman@smm.org
Almendinger, J. E., St. Croix Watershed Research Station, Marine on St. Croix, MN, USA, dinger@smm.org
Balogh, S. J., Metropolitan Council Environmental Services, St. Paul, MN, USA, steve.balogh@metc.state.mn.us
Branfireun, B. A., University of Toronto at Mississauga, Mississauga, ON, Canada, brian.branfireun@utoronto.ca
Eggert, S., USDA Forest Service, Northern Research Station, Grand Rapids, MN, USA, seggert@fs.fed.us
Engstrom, D. R., St. Croix Watershed Research Station, Marine on St. Croix, MN, USA, dre@smm.org
Hong, A. C., University of Toronto at Scarborough, Toronto, ON, Canada, angelac.hong@utoronto.ca
Jeremiason, J. D., Gustavus Adolphus College, St. Peter, MN, USA, jjeremia@gustavus.edu
Kolka, R. K., USDA Forest Service, Northern Research Station, Grand Rapids, MN, USA, rkolka@fs.fed.us
Mitchell, C. P., University of Toronto at Scarborough, Toronto, ON , Canada, carl.mitchell@utoronto.ca

WETLAND METHYLMERCURY DECLINES RAPIDLY FOLLOWING DECREASES IN SULFATE DEPOSITION

Although many studies have demonstrated the stimulatory effect of sulfate addition on mercury methylation in wetlands, none have directly measured the recovery of such systems once sulfate addition ceases. Sulfate loads were experimentally elevated through simulated rainfall to half of a 2.5-ha peatland in northern Minnesota between 2001 and 2008. In 2006 sulfate addition was halted

to a portion of the experimental treatment, and methylmercury concentrations were monitored. Porewater methylmercury concentrations in this recovery treatment declined to control levels by summer-2008 and in the solid phase by spring-2009, but remained significantly elevated in the experimental treatment. Total mercury concentrations in predaceous diving-beetle larvae collected during spring- 2009 followed the same trends observed for methylmercury concentrations in wetland soils. Preliminary data suggest that sequestration of added sulfate in an increasingly recalcitrant organic pool contributed to declining methylmercury concentrations in the recovery treatment. Overall these results indicate that controls on atmospheric sulfate emissions and deposition could lead to rapid reductions in wetland methylmercury pools with possible consequences for mercury accumulation in wetland foodchains.

Collins, **S. F.**, Idaho State University, Pocatello, USA, collscot@isu.edu
Baxter, C. V., Idaho State University, Pocatello, USA, baxtcold@isu.edu
Marcarelli, A., Michigan Technological University, Houghton, USA, ammarcar@mtu.edu
Wipfli, M. S., University of Alaska Fairbanks, Fairbanks, USA, mwipfli@alaska.edu

RESPONSES OF RIPARIAN INSECTS AND SPIDERS TO EXPERIMENTAL ADDITIONS OF SALMON CARCASSES

Riparian insects incorporate marine-derived nutrients from salmon carcasses directly by consuming carcass material, or indirectly when salmon nutrients stimulate primary producers and invertebrate consumers. We hypothesized that addition of salmon carcass and salmon analog would increase abundance, alter species composition, and affect distribution of insects in riparian areas, which would result in higher abundance of predators, in this case riparian spiders (Tetragnathidae). Sticky traps were systematically deployed in and adjacent to 9 streams treated with salmon carcasses, salmon analog and control (n=3 of each). Treatments increased abundance and altered composition of both terrestrial and adult aquatic insects 2 and 4 weeks post-treatment. Carcass additions increased terrestrial dipterans more than analog whereas analog primarily increased aquatic dipteran (midge) abundance. Spider abundance was highest at analog sites three weeks post-treatment, which may have been driven by increases in their prey - adult aquatic insects. The consequences of differential responses of insect taxa to treatments may further affect other predators such as fish or bats, and may improve understanding of bottom-up influences of mitigation tools and subsequent energy flow through food webs.

Collins, **S. M.**, Cornell University, Ithaca, USA, smc322@cornell.edu
Thomas, S. A., University of Nebraska, Lincoln, USA, sthomas5@unl.edu
El-Sabaawi, R. W., Cornell University, Ithaca, USA, rwe32@cornell.edu
Dodds, W. K., Kansas State University, Manhattan, USA, wkdodds@k-state.edu
Flecker, A. S., Cornell University, Ithaca, USA, asf3@cornell.edu

A DUAL-ISOTOPE TRACER APPROACH TO ASSESSING STREAM FOOD WEB DYNAMICS

Nitrogen stable isotope tracers have been used in many studies of biogeochemical cycles and food web dynamics in streams, but carbon stable isotope tracers have been used in comparatively few studies. Since bacteria, but not algae, are able to assimilate dissolved carbon compounds, ^{13}C-labeled tracers can be used to track energy fluxes from bacteria to higher trophic levels. We conducted a dual-isotope tracer study in which we simultaneously injected ^{15}N and ^{13}C tracer compounds to two headwater streams in the Adirondack Mountain region of upstate New York. By modeling fluxes of both ^{13}C, which is assimilated selectively by heterotrophic microorganisms, and ^{15}N, which is assimilated by both heterotrophs and autotrophs, we were able to compare the relative importance of detrital versus autotrophic pathways in the food web. We collected tracer data in two forested, headwater streams with low levels of light, but after data collection we thinned the canopy of one stream to increase light availability and simulate the effects of land-use change. Our pre-manipulation data provide a baseline for post-manipulation studies of how land-use change in riparian areas influences food web dynamics in streams

Colon-Gaud, **C.**, University of Puerto Rico - Rio Piedras/ Institute for Tropical Ecosystem Studies, San Juan, Puerto Rico, checo@ites.upr.edu
Ramirez, A., University of Puerto Rico - Rio Piedras/ Institute for Tropical Ecosystem Studies, San Juan, Puerto Rico, aramirez@ites.upr.edu

FEEDING PREFERENCES AND GROWTH OF TALLAPERLA SP. (PLECOPTERA: PELTOPERLIDAE): A CROSS-SITE COMPARISON USING TROPICAL AND TEMPERATE LEAVES

Shredders can be important consumers of leaf detritus in headwater streams, where they influence decomposition and facilitate other consumers. Leaf quality can also be a major controlling factor of the leaf decay process, as consumers tend to show preference for higher quality resources. Although many studies have examined the importance of shredders to leaf decay, only a handful of studies have addressed consumer feeding preferences and differences in resource quality using tropical vs. temperate leaf types. We examined growth rates of nymphs of the stonefly Tallaperla, a common temperate-zone shredder, in laboratory feeding trials using individual and mixed treatments of temperate (Liriodendron tulipifera) and tropical (Cecropia schreberiana) leaves. We also estimated percent leaf mass loss semi-weekly over a 56 d period. We found no significant differences in Tallaperla growth rates between treatments, however, growth rates differed over time. There were significant differences in leaf mass loss between leaf types, with tulip leaves exhibiting faster breakdown rates. Our results suggest that during the initial stages of decomposition, leaf quality (i.e. chemistry) may have a greater influence on decomposition than consumer activities.

Coloso, **J. J.**, University of Virginia, Charlottesville, USA, jjc9r@virginia.edu
Pace, M. L., University of Virginia, Charlottesville, USA, mlp5fy@virginia.edu
Cole, J. J., Cary Institute of Ecosystem Studies, Millbook, USA, cole@caryinstitute.org

THE IMPORTANCE OF HIGH-FREQUENCY MEASUREMENTS OF THERMAL STRATIFICATION TO ESTIMATES OF LAKE METABOLISM

Many previous studies using dissolved oxygen (DO) sondes to measure lake metabolism have only used discrete weekly measurements of thermal stratification to estimate the depth of the mixed layer (Zmix). However, Zmix is dynamic and changes on scales of minutes rather than days or weeks. This study uses DO sondes to estimate metabolism in two small north temperate lakes using values of Zmix measured at seasonal, weekly, daily, and five-minute time scales. Estimates of metabolism are dependent on the frequency at which Zmix is sampled. Areal rates of gross primary production (GPP) and ecosystem respiration (R) were up to 24% and 29% less, respectively, using the five-minute measurements of Zmix rather than weekly Zmix. Microstratification occurred frequently within the stably stratified mixed layer and resulted in significantly lower rates of areal GPP and R in both lakes and significantly lower volumetric rates of R in one lake. Short-term dynamics in stratification have important impacts on rates of metabolism. High-frequency measurements of stratification and models that couple biological and physical processes are needed to ensure more accurate estimates of whole-lake metabolism.

Colvin, **M. E.**, Iowa State University, Ames, USA, mcolvin@iastate.edu
Grummer, S., Iowa Department of Natural Resources, Clear Lake, USA,
Wahl, J., Iowa Department of Natural Resources, Clear Lake, USA,
Stewart, T. W., Iowa State University, Ames, USA, twstewar@iastate.edu
Pierce, C. L., Iowa Cooperative Fish and Wildlife Research Unit, Ames, USA, cpierce@iastate.edu

IMPACTS OF INVASIVE SPECIES AND RESTORATION ON RECREATIONAL FISHERIES: ZEBRA MUSSELS AND COMMON CARP IN A SHALLOW HYPEREUTROPHIC LAKE

Aquatic ecosystems of the Midwestern United States suffer from eutrophication due to external nutrient loading from land use, and internal loading caused by invasive common carp (Cyprinus carpio). Clear Lake, Iowa is an economically important system undergoing management actions to reverse eutrophication and improve water quality, including dredging and intensive carp harvest. Potential impacts of recent zebra mussel (Dreissena polymorpha) invasion and actions to reverse eutrophication on the recreational fishery of Clear Lake are uncertain. An ECOPATH model was used to quantify trophic dynamics early in the zebra mussel invasion based on field data and empirical relationships. Predicted impacts of zebra mussels on sport fishes and the fishery under nutrient reduction scenarios designed to emulate effects of restoration were evaluated using ECOSIM. Predicted declines in sport fish forage were larger in nutrient reduction scenarios than losses attributed to zebra mussels. Predicted effects of

nutrient reductions and carp on trophic interactions, and ultimately, on sport fishes were stronger than zebra mussel effects. Suitable habitat for zebra mussel attachment is limited in Clear Lake, thus limiting reductions in phytoplankton biomass due to zebra mussel grazing.

Connelly, **R**. **A**., EA Engineering, Science, and Technology, Inc., Sparks, USA, rconnelly@eaest.com

Matkowski, J. G., EA Engineering, Science, and Technology, Inc., Sparks, USA, jmatkowski@eaest.com

SEDIMENT EFFECTS FROM A LANDFILL ON A SMALL STREAM BENTHIC MACROINVERTEBRATE COMMUNITY

As a result of the construction of a closure cap on a landfill during November 2006 through April 2007, significant sediment was released into a small stream. Following slope stabilization measures at the landfill to mitigate sediment releases, a benthic bioassessment was conducted to monitor recovery of the community. Sampling followed the methods established by the Maryland Biological Stream Survey which includes a habitat assessment and collecting benthos from multiple habitats in a 75 meter reach of stream using a 20 sweep D-frame dip net approach. A suite of biological metrics suitable for the Piedmont ecoregion of Maryland were calculated and the resulting Index of Biotic Integrity (IBI) was used to evaluate the condition of the community. In 2008 the IBI indicated impairment at the stations closest to the landfill with a narrative rating of very poor to poor, fair downstream, and good at the reference station. The 2009 study indicated improvement in the health of the benthic community with an increase in IBI scores at all downstream locations which were all rated as fair.

Contant, **J**. **C**., University of Ottawa, Ottawa , Canada, jcont052@uottawa.ca

Pick, F. R., University of Ottawa, Ottawa, Canada, Frances.Pick@uottawa.ca

PICOPHYTOPLANKTON ABUNDANCE IN TEMPERATE RIVERS

Picophytoplankton (0.2-2 µm) are among the most ubiquitous and abundant photosynthetic organisms and may contribute as much as half of the global primary production. Although they are found in both freshwater and marine ecosystems, their abundance in rivers is considered insignificant both in terms of biomass and food chain dynamics. This study revisited this finding and assessed picophytoplankton abundance in five temperate rivers. We sampled five rivers ranging in trophic state (10-100 µg/L total phosphorus) in Ontario and Quebec from May to November 2009 for phytoplankton and various chemical and physical variables. Epifluorescence microscopy was used to enumerate cell abundance by exciting phycoerythrin and phycocyanin-rich cells as well as eukaryotic chlorophyll a bearing cells. For the most part, picophytoplankton abundance was dominated by non-phycoerythrin containing cyanobacteria. In the mesotrophic Rideau River, abundance ranged from a low of $1.55x10^3$ cells/mL in spring to a maximum density of $4.63x10^4$ cells/mL in late August. These concentrations are as high as those observed in lakes suggesting these organisms are important in river ecosystems as well.

Cook, **P**. **M**., Monash University, Melbourne, Australia, perran.cook@sci.monash.edu.au

Holland, D. P., Monash University, Melbourne, , daryl.holland@sci.monash.edu.au

Longmore, A. R., Fisheries Research Branch, Queenscliff, Australia,

FLOODS, FIRES, PHYTOPLANKTON AND A LARGE TEMPERATE AUSTRALIAN LAGOON

We document the physical and biogeochemical factors preceding two cyanobacterial blooms in the Gippsland Lakes, a temperate lagoon system in S.E. Australia. A winter flood in 1998 resulted in high surface water concentrations of inorganic nitrogen (IN = NO2- +NO3- + NH4+) relative to reactive phosphorus (RP) with a IN:RP ratio >100. This resulted in a rapid diatom and dinoflagellate bloom, which collapsed as water column nutrients were exhausted. Increased carbon delivery to the sediment stimulated benthic respiration and depleted bottom water oxygen, which led to a large release of RP from the sediments, decreasing the IN:RP ratio in the bottom water to ~6. Strong stratification of the water column allowed the accumulation of RP in the bottom water over spring and into summer. Mixing of RP from the bottom water over summer triggered the development of a Nodularia spumigena Mertens bloom. In 2007, a flood with very similar timing and magnitude to 1998, but following extensive wildfires in the catchment resulted in an extreme and unprecedented catchment exports of nitrate and nitrite (NOx) leading to high concentrations of NOx within the surface waters of the Gippsland Lakes through the second half of 2007 and the start of 2008. We hypothesize that the persistently high NOx concentrations extending into summer were a key factor leading to an unprecedented Synechococcus sp. bloom that developed in the austral summer of 2007-2008.

Cookingham, **M**. **N**., Grand Valley State University, Allendale, USA, mcookingham@gmail.com

Davis, J. C., Aquatic Restoration and Research Institute, Talkeetna, USA, arri@mtaonline.net

Snyder, E. B., Grand Valley State University, Allendale, USA, snydeeri@gvsu.edu

Davis, G. A., Aquatic Restoration and Research Institute, Talkeetna, USA, arri@mtaonline.net

ECOLOGY OF JUVENILE SALMON IN UPLAND VS. LOWLAND ALASKAN STREAMS: AN ASSESSMENT OF FOOD WEBS USING STABLE ISOTOPE ANALYSIS

Stable isotope analyses were used to track the food webs of 6 upland and 7 lowland coho salmon rearing streams in the Matanuska-Susitna Valley, Alaska. Wetland streams are characterized by slow moving tanic water, silty substrate and are dominated by grass and shrub riparian vegetation, whereas upland streams are characteristically clear, fast flowing, with gravel or cobble substrate, and dominated by grass and tree riparian vegetation. CPOM, algae, and juvenile salmon samples were analyzed for carbon and nitrogen stable isotopes. Preliminary data from 2008 show significantly different δ13C signatures between upland and wetland sites, suggesting food webs have different energy sources. The data also show similar δ15N signatures, suggesting juvenile salmon maintain a similar trophic position, regardless of site. We hypothesize upland streams' food webs will be autochthounously driven due to clear water conditions and characterized by δ13C signatures similar to algae, whereas wetland streams will be fueled by allochthonous input due to tanic water and be characterized by δ13C signatures similar to CPOM. Hypotheses are currently being tested with 2009 data.

Cooper, **M**. **J**., University of Notre Dame, Notre Dame, IN, USA, mcooper3@nd.edu

Uzarski, D. G., Central Michigan University, Mount Pleasant, MI, USA, uzars1dg@cmich.edu

Steinman, A. D., Annis Water Resources Institute, Muskegon, MI, USA, steinmaa@gvsu.edu

THE IMPORTANCE OF HYDROGEOMORPHIC SETTING ON COMMUNITY METABOLISM IN GREAT LAKES COASTAL WETLANDS

Coastal wetlands are critical to the Laurentian Great Lakes ecosystem in part due to high rates of primary and secondary production. We predicted that gross primary production (GPP) and respiration (R) would be strongly influenced by hydrogeomorphology, especially the degree of wave exposure. We measured GPP and R seasonally in 2007 at 12 wetlands of Lakes Michigan and Huron using benthic, water column, and epiphyte chambers. In the summer, R (range: 28-227 mmol O2 $m^{-2}day^{-1}$) was strongly correlated with sediment organic content, which was negatively correlated with wave exposure. Summer GPP (range: 37-214 mmol $O_2 m^{-2}day^{-1}$) was not related to hydrogeomorphology directly but the proportion of water column GPP relative to the other compartments increased with increasing sediment organic content. Extending our seasonal measurements to annual estimates of net productivity suggested that most wetlands were net autotrophic, producing an average of 105 g C $m^{-2}yr^{-1}$ more than was respired (range: -121-270). Our results demonstrate the importance of hydrogeomorphology on carbon cycling in the nearshore and the potential for coastal wetlands to provide organic subsidies to other lake habitats.

Corkum, **L**. **D**., University of Windsor, Windsor, Canada, corkum@uwindsor.ca

SPATIAL-TEMPORAL PATTERNS OF RECOLONIZING ADULT MAYFLIES IN LAKE ERIE AFTER A MAJOR DISTURBANCE

This 12-year study documents the recovery of two species of burrowing mayflies, *Hexagenia limbata* and *H. rigida* in western Lake Erie after a 30-year absence due to hypoxia. Annual adult mayfly collections were made at night during peak emergence at four shoreline sites from1997 to 2008. *Hexagenia rigida* was the early colonizer, representing about 90% of all male imagos sampled in 1997. Twice weekly collections throughout the extended emergence period at one site revealed that *H. rigida* was the dominant species in 1997, species were co-dominant in 2000, and *H. limbata* was dominant in 2002 and beyond. In 2000, when the species were co-dominant, both inland aerial dispersal (5.5 km) and

lakeward (0.25 to 4 km) oviposition patterns confirmed species co-existence. Adult density of both species decreased with increasing distance from shore; most adults were present within 1 km from shore. No significant differences in mean egg density occurred between species among the sites extending lakeward. Results from lab experiments showed that differential egg hatching and survivorship after prolonged cold storage explained the shift in species dominance exhibited by adults.

Cormier, **N**., US Geological Survey, National Wetlands Research Center, Lafayette, USA, cormiern@usgs.gov

Noe, G. B., US Geological Survey, National Research Program, Reston, USA, gnoe@usgs.gov

Krauss, K. W., US Geological Survey, National Wetlands Research Center, Lafayette, USA, kraussk@usgs.gov

Lockaby, B. G., Auburn University, School of Forestry, Auburn, USA, lockabg@auburn.edu

Conner, W. H., Clemson University, Baruch Institute of Coastal Ecology and Forest Science, Georgetown, USA, wconner@exchange.clemson.edu

FOREST PRODUCTIVITY AND NUTRIENT MINERALIZATION ALONG A TIDAL FORESTED WETLAND TO MARSH TRANSITION

Tidal freshwater forested wetlands are productive ecosystems due in part to the quantity of nutrients received from upstream and marine sources during overbank and tidal flooding. We documented changes in forest structure and growth potential of trees in salt– and drought–impacted tidal swamps of South Carolina and Georgia. We found that salinity, soil total nitrogen, flood duration, and flood frequency affected forest diameter increment, litterfall, and basal area the greatest. Salinity concentrations of 1.3 g/L drastically decreased basal area increment growth rates and litterfall production. Preliminary measurements found that the redwater Savannah River has 350% greater soil phosphorus mineralization and 30% lower soil nitrogen mineralization fluxes than the blackwater Waccamaw River. Nitrogen mineralization increased from moderate to higher salinity forested sites, while phosphorus mineralization peaked after conversion from salt–impacted forest to oligohaline marsh. These observations support our hypotheses that soils store less nitrogen at higher (~2–3 g/L) salinities because of both greater sulfate–induced soil mineralization and reduced forest productivity. As estuarine influence shifts inland with sea–level rise, forest growth becomes linked to salinity and perhaps salinity–induced changes in nutrient availability.

Cornejo, **D**. **M**., Universidad de Antioquia, Medellín, Colombia, dcornejo88@gmail.com

Blanco, J. F., Universidad de Antioquia, Medellín, Colombia,

Ortíz, L. F., Universidad de Antioquia, Medellín, Colombia, lfortiz24@gmail.com

Gómez-Aguirre, A. M., Universidad de Antioquia, Medellín, Colombia,

PREDATION MARKS AND SHELL FEATURES IN NERITINA VIRGINEA (GASTROPODA) ALONG SALINITY GRADIENTS AT INSULAR AND CONTINENTAL SITES IN THE CARIBBEAN

Predation pressure has been hypothesized as a major driver of upstream migration in Neritidae gastropods, however field tests are scant. Predation pressure was evaluated by counting marks inflicted by decapods on shells of Neritina virginea in estuarine, mangrove and river habitats in Puerto Rico-Greater Antilles (insular sites, N=32) and in Urabá Gulf-Colombia-Southern Caribbean (continental sites, N=92). Erosion marks were noted as proxies of calcium availability. Shell width, length (total, axial and aperture), height and weight were measured for all individuals. A greater percentage of predated individuals and more scars per capita were found in estuaries and mangroves than in rivers. Erosion marks showed the opposite trend suggesting calcium limitation in freshwaters. Shells were heavier in estuaries and mangroves than in rivers, regardless of shell size. No other morphological change was observed among habitats. Maximum percent of scared individuals was greater at insular (80%) than at continental mangroves (21%) receiving a greater freshwater discharge. Neritids dwelling in marine habitats experienced a stronger predation pressure regardless of shell thickness. Upstream migration behavior is seemly an adaptation to escape from marine predatory decapods.

Cornell, **J**. **J**., Idaho State University, Pocatello, USA, jpcornell4@yahoo.com

Davis, J. M., Idaho State University, Pocatello, USA, jmdavis@isu.edu

Minshall, G. W., Idaho State University, Pocatello, USA, minswayn@isu.edu

Baxter, C. V., Idaho State University, Pocatello, USA, baxtcold@isu.edu

Rugenski, A. T., Southern Illinois University, Carbondale, USA, arugenski@yahoo.com

Olson, N. F., Idaho State University, Pocatello, USA, olsoneil@isu.edu

Crosby, B. T., Idaho State University, Pocatello, USA, crosby@isu.edu

EFFECTS OF EARLIER SPRING SNOW MELT ON PERIPHYTON BIOMASS: POTENTIAL CLIMATE CHANGE IMPLICATIONS FROM A 20-YEAR STUDY OF A WILDERNESS STREAM ECOSYSTEM

In the western U.S., earlier spring snow melt predicted with global climate change (GCC) will likely lead to earlier, but lower magnitude, peak stream flows. These shifts in the hydrologic regime may affect the timing and amount of basal resource availability and organic matter export. Using a 20-yr data set from the Big Creek watershed, a tributary of the Salmon River in central Idaho, we tested the prediction that periphyton chlorophyll-a and ash free dry mass (AFDM) were correlated with average annual flow, timing and magnitude of peak flows, and the annual variability of stream flows. Periphyton AFDM was negatively related to the timing, but not to the magnitude, of peak stream flows. Thus, earlier peak stream flows were associated with higher levels of summer periphyton AFDM. Chlorophyll¬¬-a was not correlated with any flow metrics. This suggests that the earlier peak flows predicted under GCC scenarios may affect the temporal availability of periphyton biomass, potentially altering its availability to stream consumers and leading to seasonal shifts in the amount and forms of organic matter exported.

Cornut, J., EcoLab; CNRS, Université de Toulouse, Toulouse, France, cornut@cict.fr

Gierlinski, P., LIEBE; Université Paul Verlaine, Metz, France, gierlinski@univ-metz.fr

Elger, A., EcoLab; CNRS, Université de Toulouse, Toulouse, France, elger@cict.fr

Guérold, F., LIEBE; Université Paul Verlaine, Metz, France, guerold@univ-metz.fr

Chauvet, **E**., EcoLab; CNRS, Université de Toulouse, Toulouse, France, echauvet@cict.fr

EFFECTS OF ANTHROPOGENIC ACIDIFICATION ON LEAF LITTER BREAKDOWN IN THE HYPORHEIC ZONE OF HEADWATER STREAMS

Anthropogenic acidification has been shown to induce deleterious effects on both structure and functioning of surface water ecosystems. This study examined how it may affect the leaf breakdown rate and the community structure and activity of decomposers in the hyporheic zone of five headwater streams along an acidification gradient. Leaf breakdown was faster both in the hyporheic and benthic zones of the circumneutral stream (k = 0.0068 and 0.0534 /d, respectively) than in the most acidic stream (pH 4.6; k = 0.0016 and 0.0055 /d, respectively). Shredder taxa were much less abundant and performing in acidic streams. In contrast, fungal biomass showed no particular trend except that maximum was higher in the most acidic stream likely resulting from the depressed competition and predation by shredders. Overall, responses to acidification in the hyporheic zones although generally less pronounced were similar to those in their benthic counterparts. The reduced leaf litter breakdown in the hyporheic zone of acidified streams was mostly due to depressed fungal activity, maybe linked to the adverse chemical conditions and the lower fungal species diversity.

Cornwall, **J**. **W**., Yakama Nation Environmental Management , Toppenish, USA, littlejoe@yakama.com

SELECTION OF THE BEST MONITORING TOOLS TO ACCURATELY ASSESS LOW ORDER STREAMS ON THE YAKAMA RESERVATION

In 2009, 16 stream sites in the "closed area" of the Yakama Reservation were monitored to assess and document baseline water quality conditions. Activities in these 1.1 million acres are limited to hunting, fishing, logging, and seasonal grazing. Water chemistry, physical habitat and biological data were collected in two adjacent ecoregions in Washington State. Four streams in the Yakima basin, occupying the shrub steppe of the Columbia Basin ecoregion, and five streams in the forested Klickitat basin within the East Slope Cascades ecoregion were assessed. Our results suggest that, owing to the uniqueness of these small streams, current water quality standards and available tools to assess physical habitat conditions may be inappropriate. A study of the macroinvertebrate

communities in these streams, in progress, seeks to characterize the benthic assemblages in these small streams and assess their potential as indicators of ecological condition in these areas. Further study of these and other small streams within the region will be necessary to understand the range of conditions occurring in these systems and the effects of human activities on these conditions.

CORTI, **R.**, CEMAGREF, LYON, France, roland.corti@cemagref.fr
DATRY, T., CEMAGREF, LYON, France, thibault.datry@cemagref.fr
CLARET, C., Marseille University - IMEP, MARSEILLE, France, cecile.claret@univ-cezanne.fr
PHILIPPE, M., CEMAGREF, LYON, France, michel.philippe@cemagref.fr

FLOW INTERMITTENCE CONTROLS LEAF LITTER DECOMPOSITION IN A FRENCH TEMPORARY RIVER : THE IMPORTANCE OF PAST DRYING EVENTS

Temporary rivers are common ecosystems, but basic ecological knowledge about their functioning lags behind that of perennial streams. The role of flow intermittence (FI) in organic matter processing is particularly poorly understood. We measured effects of FI on leaf litter decomposition (LLD) in the Albarine River, France. We first estimated locations, frequencies and durations of drying events for the past 25 years using an empirical model. We then measured LLD and leaf litter microbial activity rates and leaf litter invertebrates assemblages at 10 sites along the FI gradient during the flowing period. The effect of past drying events was still detectable four month after flow resumed. An exponential model fit to the LLD and drying frequency data indicated that an increase from 0 to 4 dry events/year caused a 75% decline in the mean LLD rate, as a consequence of an 80 % decrease in shredder abundance. Effects of microbial activity on LLD were undetectable. Our observations indicate that drying events influence organic matter processing long after the resumption of flow. This study has produced the first quantitative LLD-FI relationships.

Costa, **O. S.**, The Ohio State University, Mansfield, USA, costa.47@osu.edu

PHYSICAL AND ANTHROPOGENIC CONTROLS ON NUTRIENT CONCENTRATIONS ACROSS A MIXED-USE HEADWATER CATCHMENT IN NORTH-CENTRAL OHIO

The conversion of naturally vegetated watersheds to urban or agricultural uses often results in degradation of stream water quality and such negative influences have been well documented. Nevertheless, the mechanisms through which land use and other physical factors (e.g., climate, topography, geology, hydrology) affect nutrient concentrations in streams ecosystems are still poorly understood. Such limited understanding is due in part to the fact that the relationship between land use change and alteration of stream physical characteristics can be complex and influenced by many factors acting at different spatial and temporal scales. In order to confront this challenge, new tools are needed that integrate physical and anthropogenic factors affecting stream water quality in a spatially-explicit model, allowing the quantification of stream processes at multiple scales. Here we present the results of an ongoing investigation of the effects of multiple stressors on the nutrient dynamics of 65 streams draining a small, mixed-use watershed. We use a combination of hydrological, geomorphic and geochemical metrics to characterize the behavior of stream water quality over a complete seasonal cycle.

Costello, D. M., University of Michigan, Ann Arbor, USA, dcostel@umich.edu
Burton, G. A., University of Michigan, Ann Arbor, USA,
Hammerschmidt, C. R., Wright State University, Dayton, USA,
Honick, **A. S.**, University of Michigan, Ann Arbor, USA,
Custer, K. W., Wright State University, Dayton, USA,
Rogevich, E. C., The Nickel Producers Environmental Research Association, Durham, USA,
Schlekat, C. E., The Nickel Producers Environmental Research Association, Durham, USA,

FIELD TESTING OF NICKEL CONTAMINATED SEDIMENTS: CONTAMINANT FLUX, CHEMICAL SPECIATION, AND TOXICITY TO AQUATIC INVERTEBRATES

Metals in freshwater sediments are important stressors to benthic organisms. Indices of toxicity are often poorly related to bulk measurements of metals due to differences in bioavailability from ligand complexation (e.g., sulfide, DOC) and competition at the site of toxic action (e.g., Mg^{2+}, Ca^{2+}). Six sediments representing a range of binding capacity were spiked with nickel (control, predicted no-effect concentration (PNEC), 2x PNEC, and 4x PNEC) and deployed in streams across a gradient of hardness and DOC. Multiple endpoints were monitored as indices of toxicity, including: *Hyalella azteca* survival and feeding, invertebrate colonization, and cotton degradation (i.e., microbial decomposition). Nickel was rapidly lost from surface sediment but remained in deeper sediments. Caged *H. azteca* exhibited acute toxicity in sediments with the lowest binding capacity. Benthic community changes and cotton degradation were best predicted by simultaneously-extracted nickel to acid-volatile sulfide ratio (SEM/AVS). Reduced invertebrate abundance and taxa richness was observed at SEM/AVS>8. The ability of sediments to bind nickel varies widely and the biogeochemical context of a contaminated stream must be examined to better predict toxicity.

Cotner, **J. B.**, University of Minnesota, Saint Paul, USA, cotne002@umn.edu
Theissen, K., University of St. Thomas, Saint Paul, USA, KMTHEISSEN@stthomas.edu
Zimmer, K., University of St. Thomas, Saint Paul, USA, KDZIMMER@stthomas.edu
Domine, L., University of Minnesota, Saint Paul, USA, lauri050@umn.edu

ORGANIC CARBON BURIAL AND DYNAMICS IN PRAIRIE POTHOLE LAKES

Small lakes bury organic carbon sink intensively and we will address the primary sources for the buried material, the mechanisms that facilitate burial and the quantities of organic carbon that are buried in shallow Prairie Pothole lakes north-central North America. In half of the lakes, primary production is dominated by pelagic phytoplankton whereas in the remaining lakes primary production is dominated by macrophytes (primarily Potomogeton). Primary production in these two types of systems is very similar despite large differences in the dominant primary producers. We found that the primary sources of buried material were likely to be terrestrial in origin with an indication of increased burial of phytoplankton organic carbon since human settlement (ca. 1880 A.D.). The latter trend was most obvious in phytoplankton lakes where sediment organic matter had a C:N signature of ca. 11-14 (mean 12.1) whereas in macrophyte lakes the C:N was 13-18 (mean 13.7). Both lake types had δ13C isotope ratios most similar to terrestrial organic matter and a trend towards both higher δ13C and C:N values downcore. Furthermore, both of these lake types have increased the rate of organic matter burial since human settlement by about a factor of 10. Current organic carbon burial rates are approximately 50-100 g C m-2 yr-1. Assuming similar burial rates in small wetland lakes across the Prairie Pothole Region, current burial rates are approximately 2-5 Tg OC per year.

Cottingham, **K. L.**, Dartmouth College, Hanover, NH, USA, cottingham@dartmouth.edu
Weathers, K. C., Cary Institute of Ecosystem Studies, Millbrook, NY, USA, weathersk@ecostudies.org
Ewing, H. A., Bates College, Lewiston, ME, USA, hewing@bates.edu
Carey, C. C., Cornell University, Ithaca, NY, USA, ccc99@cornell.edu
Fey, S. B., Dartmouth College, Hanover, NH, USA, samuel.b.fey@dartmouth.edu
Greer, M. L., Bates College, Lewiston, ME, USA, mgreer@bates.edu
Leavitt, P. R., University of Regina, Regina, SK, Canada, Peter.Leavitt@uregina.ca

OPENING PANDORA'S BOX WITH A BIOTIC KEY: CAN CYANOBACTERIAL BLOOMS IN NUTRIENT-POOR LAKES ACCELERATE EUTROPHICATION?

Gloeotrichia echinulata is a large nitrogen-fixing cyanobacterium that is causing nuisance blooms in oligotrophic and mesotrophic lakes across northern New England. We hypothesize that *G. echinulata* accelerates eutrophication by alleviating nitrogen and phosphorus limitation. Previous work in eutrophic lakes has established that meroplanktonic *G. echinulata* translocate significant amounts of phosphorus from sediments into the water column during recruitment. We estimate that phosphorus loading by G. echinulata in Lake Sunapee, NH, is currently comparable to that from a small tributary, and predict that it could become comparable to a major tributary if recruitment continues to increase. Moreover, models suggest that this loading can substantially impact P cycling, particularly in lakes with oxic hypolimnia and low external inputs. Finally, paleoecological evidence from Long Pond, ME, documents an association between *G. echinulata* and eutrophication: *G. echinulata* were present prior to major changes in the algal community, and a recent large shift in the algal assemblage co-occurred with increases in *G. echinulata*. These findings

suggest that if *G. echinulata* bloom duration and extent continue to increase, lake water quality could be significantly impacted.

Courtwright, **J**. **L**., Cary Institute of Ecosystem Studies and Northland College, Slidell, USA, courtwrightj01@charter.net
Findlay, S., Cary Institute of Ecosystem Studies, Millbrook, USA, findlays@caryinstitute.org

THE EFFECTS OF MICROTOPOGRAPHY ON HYDROLOGY, PHYSICOCHEMISTRY, AND VEGETATIVE COMMUNITIES IN FRESHWATER TIDAL SWAMPS OF THE HUDSON RIVER

Hudson River freshwater tidal swamps have dynamic flooding and oxygenation regimes due to daily tidal flooding. Microtopography, small scale differences in elevation, adds even more complexity to this hydrology and has important implications for nutrient flow and wetland plant communities. We measured several hydrological, chemical, and biological processes on higher elevation hummocks for comparison to lower elevation hollows. Microtopography significantly affected flooding duration and redox conditions. Hummocks had lower concentrations of soluble phosphate in their porewater probably due to differing depths of iron oxidation. Therefore, hummocks had less soluble phosphate in their porewater available to export during the next tidal cycle. Decomposition rates were found to be slower in hollows. This was attributed to lack of oxygen due flooding or differing decomposer communities. Fewer herbaceous plant species were found in hollows compared to hummocks perhaps because of hollow's anoxic soils. Microtopography affects freshwater tidal swamp ecosystem function by affecting oxygen penetration, nutrient availability, rates of decomposition, and herbaceous plant species distributions.

Cover, **M**. **R**., California State University, Stanislaus, Turlock, CA, USA, mcover@biology.csustan.edu
de la Fuente, J., Klamath National Forest, Yreka, CA, USA,
Resh, V. H., University of California, Berkeley, Berkeley, CA, USA,

DEBRIS FLOWS AND DEBRIS FLOODS: LINKAGES AMONG LAND USE, SEDIMENT DELIVERY, AND CATASTROPHIC DISTURBANCES IN STREAM NETWORKS

Debris flows and debris floods are catastrophic disturbances in steep, mountainous landscapes throughout the world, but little is known about the long-term ecological effects of these rare events on headwater streams and downstream habitats. In 10 basins (10 - 20 km2) in the Klamath Mountains, northern California, we used a space-for-time substitution to infer the long-term (10 – 100 y) effects of debris flows on stream ecosystems. Debris flows mobilized sediment and wood and removed riparian vegetation from large portions of channel networks. Large woody debris, benthic organic matter, detritivorous stoneflies, and amphibians were very sparse in recent debris flow streams. Canopy removal resulted in elevated stream temperatures, affecting the availability of cold-water refugia for salmonids in large mainstem rivers. Increased frequencies of debris flows associated with forest management practices can have significant negative impacts on aquatic biodiversity. Channel slope, determined by regional patterns of uplift and erosion, controls the distance that debris floods can travel; in the steepest landscapes, up to 90% of the stream network is susceptible to these catastrophic disturbances.

Covich, **A**. **P**., University of Georgia, Athens, GA, USA, alanc@uga.edu
Crowl, T. A., Utah State University, Logan, UT, USA, facrowl@gmail.com

NETWORK ANALYSIS OF FOODWEB STRUCURE AT DIFFERENT DRAINAGE BASIN LOCATIONS: A GEOMORPHIC APPROACH TO STREAM ECOLOGY

Stream ecologists rely on the geomorphic structure of drainage networks to compare how species distributions are affected by stream sizes, connectivity and the centrality of optimal habitats. The structure of these drainage networks influences how species assemble to form food webs with complex linkages among terrestrial and aquatic species. The importance of channel width and stream order was initially highlighted in the River Continuum Concept that influenced stream research for three decades. Including new measures of network structure in analyses of drainage basins increases the capacity to consider the spatial heterogeneity that characterizes watersheds and influences the composition and dynamics of stream food webs. Examples of recent applications of this network approach include studies of food webs in rainforest drainages in the Luquillo Experimental Forest, Puerto Rico where geomorphic barriers (steep waterfalls and shallow headwaters) to dispersal create distinct assemblages across different drainage basins. This geomorphic exclusion of predatory fishes by natural barriers provides insights to how energy flows through food webs of different structure and connectivity.

Covich, **A**. **P**., University of Georgia, Athens, GA, USA, alanc@uga.edu
Crowl, T. A., Utah State University, Logan, USA,
Lodge, D. J., U.S. Forest Service, Luquillo, USA,

LEAF-LITTER PULSES IN CARIBBEAN RAINFOREST STREAMS: DETRITAL STORAGE, PROCESSING AND TRANSPORT DYNAMICS IN EXTREMELY VARIABLE FLOW REGIMES

Non-seasonal rainforests, such in Puerto Rico's Luquillo Experimental Forest, generally have relatively high rainfall every month. This pattern of frequent high stream flows is changing to a more variable pattern of seasonal rainfall. The shift is altering the way leaf litter accumulates and is being biologically processed in headwater streams. Species-specific differences in rates of leaf-litterfall and litter breakdown indicate the importance of terrestrial (Basidiomycetes white-rot fungi) microbes in processing accumulated leaves during dry periods with intermittent rainfall. If leaves remain wet, there is microbial breakdown on the forest floor until the first storm flow occurs. Then stored litter is transported downslope in both intermittent channels and surrounding riparian zones into active channels where aquatic fungi and detritivores continue to microbially breakdown the pulsed input of litter. This pulse of terrestrially accumulated and partially processed leaf litter forms debris dams, especially at confluences of zero-order and first-order streams. The pulse of terrestrial litter provides high-quality food and cover for a wide range of detritivores for extended periods in different pool and debris dam locations within the drainage network.

Covino, **T**. **P**., Montana State University, Bozeman, USA, tpcovino@gmail.com
McGlynn, B. L., Montana State University, Bozeman, USA, bmcglynn@montana.edu
McNamara, B. A., Montana State University, Bozeman, USA, rebecca.mcnamara@msu.montana.edu

QUANTIFYING STREAM NUTRIENT UPTAKE KINETICS FROM AMBIENT TO SATURATION: TRACER ADDITIONS FOR SPIRALING CURVE CHARACTERIZATION

Nutrient spiraling couples the hydrological and biological processes that influence downstream transport. Biological uptake of nutrients within a stream reach is strongly impacted by concentration; however, quantifying this relationship has remained a challenge. Here we present a rapid technique for quantifying nutrient uptake kinetics from ambient to saturation using Tracer Additions for Spiraling Curve Characterization (TASCC). This approach allows one to: 1) quantify continuous uptake kinetic curves, 2) assign and parameterize appropriate kinetic models, 3) estimate ambient spiraling parameters with extrapolation techniques, and 4) assess stream reach proximity to saturation. Through increased data density this approach improves kinetic model parameterization such as Michaelis-Menten model parameters maximum uptake and half saturation constant, assessment of proximity to saturation, and estimates of ambient spiraling. By quantifying this suite of metrics this method should help improve our basic understanding of stream spiraling, how stream reaches respond to increased nutrient loads, and improve export models and estimates of downstream transport.

Cozic-Houly, **A**., University of Brest - IUEM, Plouzané, France, amandine.cozichouly@univ-brest.fr
Boye, M., University of Brest - IUEM, Plouzané, France, Marie.boye@univ-brest.fr
De la Broise, D., University of Brest - IUEM, Plouzané, France, Denis.de-LaBroise@univ-brest.fr

A NEW CHEMOSTAT TO DETERMINE THE EFFECTS OF TRACE METALS CO-LIMITATION ON A COCCOLITHOPHORID, GEPHYROCAPSA OCEANICA, UNDER A PCO2MIMICKING THE HIGH-CO2 WORLD

Many scientist teams used batch production to study microalgae. However, using this kind of techniques, environmental factors can be altered and induce modifications in cells and so, continuous culture are preferred to have a better control over the growth environment. The elaborated chemostat called oxystat provided new insights into the co-impact of pCO_2 and Co/Zn limitation on the metabolism and physiology of *Gephyrocapsa oceanica*. The particularity of our chemostat is the control of pO_2 into the culture medium. The pO_2 is held constant by manipulating the rate at which the medium is fed; if pO_2 tends to increase, the

supply of new culture medium increases to dilute the phytoplankton culture and back the pO_2 to its fixed value. The CO_2 is supplied by continuously air diffusion and the metal speciation is controlled using artificial EDTA-containing seawater. Thanks to the oxystat use, no metal cellular quotas bias was introduced and phytoplankton culture was maintained into a steady-state for several weeks.

Craig, **L. S.**, University of Maryland Center for Environmental Science-Chesapeake Biological Laboratory, Solomons, USA, lscraig@umd.edu
Palmer, M. A., University of Maryland Center for Environmental Science-Chesapeake Biological Laboratory, Solomons, USA, palmer@umces.edu

LACK OF EVIDENCE FOR NITRATE UPTAKE MAY INFORM OUR UNDERSTANDING OF NITROGEN SATURATION IN STREAM ECOSYSTEMS

We attempted to quantify nitrate removal in forested and urban high-N streams (905 to 3828 µg NO3-N L-1) using nutrient additions but were unable to detect uptake. Several measurements, including whole-stream metabolism, nitrification rates, and additions of potentially limiting nutrients, were made to identify factors influencing nitrate removal. TN:TP ratios were high and relative demand for P increased as TN:TP increased, suggesting P limitation. GPP and GPP/ER were consistently low and GPP was positively correlated to SRP, suggesting possible P-limitation of autotrophic metabolism. We determined that non-significant uptake was caused primarily by P limitation and low autotrophic demand; longitudinal variation and masking of removal of by groundwater inputs secondarily contributed to our inability to measure uptake. To provide context for our results, we surveyed the literature to find other studies where nitrate uptake rate coefficients were not statistically different from zero, identify patterns underlying the inability to detect removal, and determine the frequency with which non-significant results could be equated with negligible uptake. Increased knowledge of streams where nitrate uptake cannot be detected may improve our understanding of N saturation.

Creed, **R. P.**, Appalachian State University, Boone, USA, creedrp@appstate.edu
Cherry, R. P., National Park Service, Blowing Rock, USA, Bob_Cherry@nps.gov
Rollins, M. A., Appalachian State University, Boone, USA, rollinsma@appstate.edu
Tornwall, B., Appalachian State University, Boone, USA, bretttornwall@gmail.com

THE IMPORTANCE OF DOMINANT SPECIES FOR THE CONSERVATION OF ECOSYSTEM FUNCTION

The accelerated loss of species in recent decades has led to an examination of the importance of biodiversity for ecosystem function. The results of numerous studies, including some with aquatic detritivores, suggest that many ecosystem functions do increase with increases in diversity. However, our research with stream detritivores suggests that this is not always the case. In various experiments we have determined that the caddisfly Pycnopsyche gentilis is a dominant detritivore in some southern Appalachian streams. Other detritivores appear to have a limited effect on leaf breakdown. Moreover, some of these functionally subordinate detritivores may inhibit each other which further accentuates the impact of P. gentilis. The distribution of P. gentilis is affected by land use; this species is uncommon in sections of stream flowing through pastures and below dams. The absence of P. gentilis from these stream sections results in reduced rates of leaf breakdown despite the presence of other detritivore taxa. Our results have implications for stream conservation. Conservation strategies focused on preserving P. gentilis should result in conserving ecosystem function in these streams. As many other macroinvertebrate taxa co-occur with P. gentilis such conservation plans should also result in the preservation of stream macroinvertebrate diversity.

Cross, **W. F.**, Montana State University, Bozeman, USA, wyatt.cross@montana.edu
Baxter, C. V., Idaho State University, Pocatello, USA,
Donner, K. C., Idaho State University, Pocatello, USA,
Rosi-Marshall, E. J., Cary Institute of Ecosystem Studies, Milbrook, USA,
Kennedy, T. A., Grand Canyon Monitoring and Research Center, Flagstaff, USA,
Hall, Jr., R. O., University of Wyoming, Laramie, USA,
Wellard, H., Loyola University Chicago, Chicago, USA,
Kincaid, D., Cary Institute of Ecosystem Studies, Milibrook, USA,

ENERGETIC FOOD WEBS HELP EXPLAIN UNANTICIPATED INCREASE IN TROUT PRODUCTION FOLLOWING THE 2008 CONTROLLED FLOOD IN THE COLORADO RIVER, GLEN CANYON

Controlled floods have been implemented by the Glen Canyon Dam Adaptive Management Program on three occasions to benefit physical (e.g., sand bars) and biological (e.g., native fish) resources in Grand Canyon. We documented effects of a recent controlled flood on the tailwater ecosystem that supports a rainbow trout fishery by constructing detailed organic matter flow food webs for two years before and one year after the March 2008 controlled flood. Prior to the flood, invertebrate production far exceeded annual demands of rainbow trout, but high proportions of filamentous algae in guts suggest trout production may be constrained by their ability to access high quality prey. In the year following the flood, invertebrate production was strongly reduced (from 29 to 13 g AFDM m^{-2} y^{-1}), but trout production nearly doubled (from 0.9 to 1.5 g AFDM m^{-2} y^{-1}) and was coincident with increased dietary proportions of, and stronger interaction strengths with, high quality prey. We suggest that trout production may be limited by the accessibility of high quality prey, and that controlled floods may benefit production of these prey.

Crossman, **J. H.**, University of Birmingham, Birmingham, United Kingdom, jhc649@bham.ac.uk
Boomer, I., University of Birmingham, Birmingham, United Kingdom, i.boomer@bham.ac.uk
Bradley, C., University of Birmingham, Birmingham, United Kingdom, c.bradley@bham.ac.uk
Milner, A. M., University of Birmingham, Birmingham, United Kingdom, a.m.milner@bham.ac.uk

MACROINVERTEBRATE COMMUNITY AND SOURCE WATER DYNAMICS OF SPRING-FED SYSTEMS, OF A GLACIERISED CATCMENT IN INTERIOR ALASKA

Groundwater input into surface river systems is widely recognised as a significant driver of macroinvertebrate communities, increasing stream stability, water temperature and clarity. However, groundwater-fed systems display marked local variations in hydrology and hydrochemistry, reflecting differences in water sources and flow pathways. We identify variations in macroinvertebrate community distribution between groundwater-fed channels from different sources, describing patterns of flow in an alluvial terrace system in Denali National Park, Alaska using isotopic tracers and chloride to characterise the source water composition of 7 groundwater springs. Significant source variations were determined, from perennial channels of snow and rainfall origins, to glacially-sourced ephemeral streams. Variations corresponded with macroinvertebrate distribution; diversity and abundance were greatest at sites sourced predominantly from snow and rainfall, also containing greater organic matter concentrations. Only here were *Chelifera* collected, with higher abundances of *Baetis bicaudatus* and *Zapda*. Ceratopogonidae were found only in less diverse glacially sourced upwellings, also containing a higher relative abundance of Chironomidae. Receding glaciers due to global change may severely affect less diverse glacially-sourced groundwater fed communities; impacts upon more diverse snowmelt and rainfall-sourced systems may be less significant.

Crowder, **L. B.**, Duke University, Beaufort, USA, lcrowder@duke.edu

IMPLEMENTATION OF ECOSYSTEM-BASED MANAGEMENT IN US COASTAL AND MARINE ECOSYSTEMS: THE ROLE OF MARINE SPATIAL PLANNING

Ecosystem-based management was under active discussion 30+ years ago in the Great Lakes. It became a hot topic in marine systems in the early to mid-2000s. In this talk I will review current and evolving approaches to management of marine ecosystems and outline the transition necessary from the current sectoral approach to management toward a more integrated approach. In June 2009, President Obama charged the Interagency Ocean Policy Task Force to outline a plan for an updated National Ocean Policy and a Framework for Coastal and Marine Spatial Planning. Here I outline national and international approaches to MSP and how we can build upon these experiences. The way forward will require integration and synthesis of information from both natural and social sciences as well as law, economics, and governance.

Crowl, **T. A.**, Utah State University, Logan, USA, facrowl@gmail.com
Covich, A. P., University of Georgia, athens, USA, alanc@uga.edu

ANALYSIS OF SHRIMP UPSTREAM MIGRATION USING AGENT-BASED MODELING

Agent-based models (ABM) are emerging as an accessible and useful method for understanding complex biological interactions at all scales. These models employ

a bottom up modeling structure in which individual organisms interact with each other and their environment. Model simulations can identify emergent behaviors that result from indirect effects and other dynamics operating at higher levels of hierarchical organization. We developed an agent based modeling platform to examine how colonization of headwater streams by an amphidromous shrimp (Atya lanipes) might influence patterns in adult shrimp distributions across a river network on the island of Puerto Rico. We modeled a variety colonization scenarios based on hypotheses regarding behavioral choices modeled as rule sets. Model outputs were compared to our long-term distribution observations. Adult distributions are a reflection of localized processes, such as habitat stability and avoidance of predatory shrimp. By applying our approach of modeling migration within a particular river network to a variety of taxa and systems, we might improve our understanding of how migratory behaviors scale up to landscape level patterns in species distributions.

Cuellar, **R**. **P**., University of North Carolina - Greensboro, Greensboro, USA, rpcuella@uncg.edu
Hershey, A. E., University of North Carolina - Greensboro, Greensboro, USA, aehershe@uncg.edu
Pollard, L. D., University of North Carolina - Greensboro, Greensboro, USA, ldpollar@uncg.edu

LONG-TERM RETENTION OF 15N IN AN ARCTIC BEADED STREAM

Many arctic streams are characterized by a pattern of large pools (beads), formed by freeze-thaw activity, that are separated by narrow channels, resembling beads on a string. Beads may be significant sites of N retention in arctic streams, but their role is not well studied. During the summer of 2009, we studied a beaded stream downstream of an arctic lake that had been experimentally enriched with 15N during the previous four summers, but received no new 15N in 2009. There was a general pattern of decreasing del 15N in beads with increasing distance from the lake outlet, which suggests that significant N retention occurred over the previous 4 seasons. Del 15N of seston was correlated with that of FBOM in beads and with FBOM at bead inlets and outlets. Furthermore, over a 17-day period, there was no significant change in del 15N with downstream distance. These data suggest that beaded streams are highly retentive of N, and that retention occurs over relatively long time scales.

Cullis, **J**. **D**., University of Colorado, Boulder, USA, james.cullis@colorado.edu
McKnight, D. M., Institute for Arctic and Alpine Research, Boulder, USA, diane.mcknight@colorado.edu

DETERMINING A REMOVAL THRESHOLD FOR *DIDYMOSPHENIA GEMINATA*

Previous studies in Boulder Creek, CO, have shown that maximum shear stress is a significant factor in determining the abundance of the nuisance diatom *Didymosphenia geminata*. The aim of this study was to investigate this observation further in order to determine a possible threshold for the removal of *D. geminata*. Coverage was monitored at a number of study sites in Boulder Creek on a bi-weekly basis over two consecutive summers. The results indicated that a removal threshold does exist and that this is best described by Shield's stress, which is the ratio of the maximum average bed shear stress to the average bed particle size. The critical level of Shield's stress is similar to that required for the initiation of bed disturbance. Spatial variations due to channel characteristics and variations in bed particle size result in spatial variation in the removal of *D. geminata* between sites and within a stream reach for a given discharge. These results have implications for considering the potential to use managed flood releases from reservoirs to control future growth of this nuisance species.

Custer, **K**. **W**., Wright State University, Dayton, USA, custer.4@wright.edu
Burton, G. A., University of Michigan, Ann Arbor, USA, burtonal@umich.edu
Fetters, K., Wright State University, Dayton, USA, fetters.15@wright.edu
Hummel, S., Wright State University, Dayton, USA, hummel.12@wright.edu
Weller, R., Wright State University, Dayton, USA, weller.20@wright.edu

EFFECTS OF SEDIMENT CHARACTERISTICS ON NICKEL BIOAVAILABILITY AND BENTHIC COMMUNITIES

Nickel spiked sediments exposures have shown decreased invertebrate survival, growth, and community structure when compared to reference exposures. Benthic community responses are affected by both metal bioavailability and sediment physical characteristics. The objectives of this study were to evaluate indigenous benthic community responses in the presence of Ni spiked sediments while considering the physical preference of the sediments. Two sediment types were spiked with Ni and placed *in situ* for 28d in three streams (southwest Ohio, central Michigan). Total taxa, total abundance, and % Trichoptera decreased in Ni spiked sediments after 28d. Higher sediment Ni resulted in an increase in % dominant taxon and % tolerant. Silt/clay sediments had lower EPT taxa, %EPT, % Ephemeroptera, and %Trichoptera than the sandy/gravel sediments. The presence of Ni in sediments appeared to affect colonization of benthic invertebrates, as did sediment type.

Daggett, **C**. **T**., University of Maine, Orono, USA, cdaggett22@gmail.com
Saros, J. E., University of Maine, Orono, USA, jasmine.saros@maine.edu

NUTRIENT LIMITATION PATTERNS IN BOREAL LAKES OF THE U.S.: IMPLICATIONS FOR ESTABLISHING CRITICAL LOADS OF ATMOSPHERIC NITROGEN DEPOSITION

Atmospheric nitrogen (N) deposition can lead to eutrophication or acidification effects on aquatic ecosystems. The type of effect is determined, in part, by which nutrient limits algal production. We investigated nutrient limitation patterns in boreal lake ecosystems in two regions of the U.S., the Northeast and the Midwest, to assess potential effects of N deposition in these areas. Lakes were selected in national parks (Acadia in the Northeast and Isle Royale in the Midwest) that are ranked as Class I wilderness areas, where understanding the effects of atmospheric pollutants is a high priority for these relatively remote lakes. Nutrient enrichment experiments using N, phosphorus (P), and N&P were conducted in two lakes in each park. Results of the experiments indicate co-limitation by N&P in Acadia lakes and N-limitation in Isle Royale lakes. This suggests that N deposition may lead to eutrophication of lakes on Isle Royale, whereas acidification effects may dominate in Acadia lakes. Current experiments are focused on quantifying the critical N load leading to these different effects across the two regions.

Dahm, **C**. **N**., Delta Science Program, Sacramento, USA, cdahm@deltacouncil.ca.gov
Mueller-Solger, A., Delta Science Program, Sacramento, USA, amueller@deltacouncil.ca.gov

INTERACTIONS BETWEEN AQUATIC SCIENCE AND MANAGEMENT IN THE CALIFORNIA BAY-DELTA

The Delta Science Program (formerly the CALFED Science Program) and the Interagency Ecological Program (IEP) both support producing the scientific information needed for management of the San Francisco Estuary including the California Delta and San Francisco Bay (Bay-Delta). These programs share a mission to provide the best possible, unbiased scientific information for water and environmental decision-making in the Bay-Delta system. The Delta Science Program supports research, synthesizes scientific information, facilitates independent peer-review, and coordinates and communicates science to a broad audience. The IEP is a multi-agency program that coordinates the collection and analysis of data by its member agencies and university partners to effectively comply with permit terms requiring ecological monitoring; identify impacts of human activities on fish and wildlife resources; and interpret information produced by the program. The IEP also provides an organizational structure and program resources for planning, coordination, and integration of estuarine studies. Examples of current scientific needs to support management decisions include setting flow criteria, monitoring threatened and endangered species, evaluating multiple stressors on aquatic foodwebs, and determining the impacts of altered hydrodynamics on aquatic species.

Dailer, **M**. **L**., University of Hawaii, Honolulu, USA, dailer@hawaii.edu
Smith, C. M., University of Hawaii, Honolulu, USA, celia@hawaii.edu

USING NITROGEN ISOTOPE SIGNATURES OF DEPLOYED MACROALGAE TO DETERMINE THE POTENTIAL DISPERSION OF WASTEWATER EFFLUENT ACROSS A CORAL REEF IN MAUI, HAWAI'I, USA

Anthropogenic nutrient sources on Maui include agricultural fertilizers, cesspools and wastewater effluent from injection wells. $d^{15}N$ signatures of intertidal macroalgae were used to map the presence of N sources in coastal environments around Maui. The highest signature of 43.3 ‰ was found to the south of the Lahaina Wastewater Reclamation Facility[1]. Subsequent experiments with deployed macroalgae (0.5 m from the benthos) were conducted in this area for seven day periods to determine the presence of the wastewater effluent across the adjacent coral reef (up to 100 m from shore and 3 m depth). These

deployments detected the wastewater effluent in the shallow region of the study area with the highest signatures of 33.1 to 50.1 ‰ recovered from samples deployed over freshwater seeps and suggested that the effluent flows from the seeps to the south[1]. However, these deployments only addressed the presence of effluent at the benthos. Ongoing experiments employing a three-dimensional array of macroalgae stratified from the surface to the benthos aim to provide a model of effluent dispersion across the reef and throughout the water column at Kahekili. [1]Dailer M. L., R. S. Knox, J. E. Smith, M. Napier, and C. M. Smith. 2010. Using d^{15}N values in algal tissue to map locations and potential sources of anthropogenic nutrient inputs on the island of Maui, Hawai'i, USA. Mar. Pollut. Bull., doi:10.1016/j.marpolbul.2009.12.021

Daily, **J**. **P**., U.S. Geological Survey, Kearneysville, USA, jdaily@usgs.gov
Hitt, N. P., U.S. Geological Survey, Kearneysville, USA, nhitt@usgs.gov
Smith, D. R., U.S. Geological Survey, Kearneysville, USA, drsmith@usgs.gov
Snyder, C. D., U.S. Geological Survey, Kearneysville, USA, csnyder@usgs.gov

EFFECT OF SAMPLE SIZE ON THRESHOLD DETECTION IN FRESHWATER BIOASSESSMENT

It is often hypothesized that freshwater communities exhibit threshold responses to stressors. Testing this hypothesis can involve regressing retrospective community data across a stress gradient and comparing the fit of linear and nonlinear models. Quantile regression has been found to be appropriate for modeling ecological data and comparing linear and nonlinear responses. However, the amount of data available for quantile regression is rarely uniform across stress gradients. Thus, it is important to identify if inferences of nonlinear responses may be sensitive to the distribution of data (i.e., the sample size) in high-quality and low-quality sites. First, we identified a spurious nonlinear response when analyzing macroinvertebrate community data with unequal sample size across a generalized stress gradient in the mid-Atlantic highlands, USA (USEPA EMAP data). Second, we simulated linear stress-responses in the Shenandoah National Park (NPS Vital Signs data) and evaluated error rates associated with quantile piecewise linear regression techniques. We concluded that sample size may bias threshold estimation methods and provided recommendations for minimizing this potential effect in freshwater bioassessment.

Dalton, **C**. **M**., Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, NY, USA, cmd273@cornell.edu
Ellis, D., Connecticut Department of Environmental Protection, Old Lyme, CT, USA, David.Ellis@ct.gov
Post, D. M., Department of Ecology and Evolutionary Biology, Yale University, New Haven, CT, USA, david.post@yale.edu

THE IMPACT OF DOUBLE-CRESTED CORMORANT (PHALACROCORAX AURITUS) PREDATION ON ANADROMOUS ALEWIFE (ALOSA PSEUDOHARENGUS) IN SOUTH-CENTRAL CONNECTICUT, USA

The decline of anadromous alewife (*Alosa pseudoharengus*) threatens an important recreational and commercial fishery. While the cause of this decline is uncertain, predators could be trapping alewives at low abundance by preying on them during spawning migrations. Here we investigate the impact of predation by Double-crested Cormorants (*Phalacrocorax auritus*) on spawning adult alewives in south-central Connecticut, USA. We use a bioenergetic model together with estimates of cormorant diets and cormorant and alewife population sizes to estimate the consumption of alewives by cormorants both in Bride Lake, Connecticut and regionally. We find that cormorants are important predators of spawning adult alewives at Bride Lake but do not have a notable impact on alewife mortality or population size. We also find that cormorants have little effect on alewife populations across south-central Connecticut because few alewives are consumed away from Bride Lake, a result that we confirm with stable isotope analysis. We conclude that cormorants are important predators for anadromous alewives but do not pose an immediate threat to the recovery of regional alewife stocks.

Dang, **G**. **T**., University of North Carolina at Chapel Hill, Chapel Hill, USA, gdang@email.unc.edu
Cory, R. M., University of North Carolina at Chapel Hill, Chapel Hill, USA, rmcory@email.unc.edu
Paerl, H. W., University of North Carolina at Chapel Hill Institute of Marine Science , Morehead City, USA, hpaerl@email.unc.edu

CHARACTERIZING QUANTITY AND QUALITY OF FLUORESCENT DOM FROM THE NEUSE RIVER ESTUARY SPATIALLY AND TEMPORALLY

The Pamlico Sound is the second largest estuarine system in the US, and the Neuse River Estuary (NRE) is its largest tributary. The Sound is sensitive to nutrient over enrichment, owing to its unique geomorphology and hydrology which lead to a long residence time for nutrient assimilation. Land use change and hurricane activity have altered the nutrient loading dynamics of the system, and have led to accelerated eutrophication, increased numbers of algal blooms, hypoxia and fish-kills. This system is largely nitrogen limited, but the role of dissolved organic nitrogen (DON), a fraction of the dissolved organic matter (DOM) pool, in fueling productivity remains unclear. Using absorbance and excitation-emission matrix (EEM) spectroscopy combined with parallel factor analysis (PARAFAC), we evaluated absorbance and fluorescence based proxies for DON/DOM in the NRE approximately biweekly at 11 stations spanning the estuary. Based on spatial and temporal variation in fluorescent DOM and DON in relation to other water quality parameters, we identified variability in sources of fluorescent DOM and DON, and deduced the importance of biogeochemical processes controlling their production and removal in this system.

Danielson, **T**. **J**., Maine Department of Environmental Protection, Augusta, ME, USA, thomas.j.danielson@maine.gov
Loftin, C. S., University of Maine, Cooperative Fish and Wildlife Research Unit, Orono, ME, USA, cynthia.loftin@maine.edu
Tsomides, L., Maine Department of Environmental Protection, Augusta, ME, USA, leon.tsomides@maine.gov
DiFranco, J. L., Maine Department of Environmental Protection, Portland, ME, USA, jeanne.l.difranco@maine.gov
Connors, B., Maine Department of Environmental Protection, Portland, ME, USA, beth.connors@maine.gov

STREAM ALGAL MODEL FOR PREDICTING ATTAINMENT OF MAINE'S BIOLOGICAL CRITERIA AND WATER QUALITY STANDARDS.

Maine's water quality standards include four classes (AA, A, B, and C) of streams and rivers with different environmental goals and expectations. Maine currently relies on a discriminant analysis model using benthic macroinvertebrate data to predict the likelihood of a stream or river attaining biological criteria of its assigned class. We developed a second model with benthic algal data to predict class attainment. Five professional biologists independently interpreted algal community data and metrics with respect to Maine's narrative biological criteria and the U.S. Environmental Protection Agency's Biological Condition Gradient framework. The biologists independently assigned an attained class (i.e., AA/A, B, C, or non-attainment) to each sample (n=230) and later convened to assign consensus classes. We developed a discriminant analysis model to replicate professional judgment using a combination of novel variables and variables from the literature. The model correctly predicted class attainment of 95% of samples in the training set (n=150) and 93% of samples in the validation set (n=80). Adding the algal bioassessment will improve Maine's ability to detect environmental degradation and diagnose stressors.

Datry, **T**., Cemagref, Lyon, France, thibault.datry@cemagref.fr
Larned, S. T., NIWA, Christchurch, New Zealand, s.larned@niwa.co.nz
Le Goff, G., Cemagref, Lyon, France, guillaume.legoff@cemagref.fr
Philippe, M., Cemagref, Lyon, France, michel.philippe@cemagref.fr

BENTHIC AND HYPORHEIC ASSEMBLAGES ALONG A FLOW PERMANENCE GRADIENT IN A FRENCH TEMPORARY RIVER.

Temporary rivers are abundant and widespread, but ecological knowledge about these systems is poor compared to perennial rivers; quantitative models that link flow intermittence and biodiversity are particularly scarce. In turn, the scarcity of intermittence-biodiversity models limits our ability to manage temporary rivers effectively. The Albarine River has a 20 km-long flow permanence (FP) gradient. We measured discharge monthly in 2008-2009 at 13 sites. We used these measurements to calibrate an empirical hydrologic model and estimate long-term flow levels and intermittence metrics at each site. We sampled benthic and hyporheic invertebrates at each site on three dates. Multivariate analyses indicated that invertebrate assemblages varied with FP. Several intermittence metrics (e.g., frequency and duration of dry events) explained a significant amount of the variation in invertebrate assemblage structure. Few invertebrate taxa were restricted to the highly intermittent (low FP) sites. Instead, assemblages at low FP sites were subsets of assemblages at high FP and perennial sites. Current work is focused on terrestrial invertebrate assemblages in dry

riverbeds, and comparisons of FP-biodiversity relationships from multiple rivers in France and New Zealand.

Davies, **J**. **M**., Saskatchewan Watershed Authority, Saskatoon, Canada, johnmark.davies@swa.ca

Hanley, P. T., Saskatchewan Watershed Authority, Regina, Canada, terry.hanley@swa.ca

CLIMATE VARIABILITY: HIGH WATER AND HIGH STRESS IN A PRAIRIE ENDORHEIC WATERSHED

Evaluation of potential impacts to lakes from climate variability requires an understanding of ecosystem function. Further effort is required to translate this understanding into science-based management options. Risk assessment provides a means of transferring physical and biological system based knowledge into a management decision making processes. This approach is being taken in an endorheic watershed presently experiencing high water levels after successive years with high runoff. Ecosystem changes resulting from climate variability can be magnified in endorheic watersheds and amplified further if individual water bodies have distinct water chemistries and are themselves located within semi-closed drainage basins that connect under high water conditions. The endorheic watershed in this study has within it lake surface waters ranging from freshwater to eusaline. Several saline lakes are also meromictic. This study is examining water balances, total and partitioned mass transfers and species' salinity thresholds including both acute tolerance and population adaptation. The need to translate science-based system processes to information for decision making is fundamental to adaptation policies and will form the basis of this talk.

Davies, P. E., Freshwater Systems, Hobart, Australia, p.e.davies@utas.edu.au

Cook, L. S., Freshwater Systems, Hobart, Australia,

Robinson, **W**. **A**., Charles Sturt University, Thurgoona, Australia, wayne.robinson@numbersman.com.au

Sloane, T., Freshwater Systems, Hobart, Australia,

Driessen, M., Department of Primary Industries, Water and Environment, Hobart, Australia,

STATUS OF TROUT-FREE WATERS IN THE TASMANIAN WILDERNESS WORLD HERITAGE AREA

The Tasmanian Wilderness World Heritage Area protects one of the last true wilderness regions and encompasses a greater range of natural and cultural values than any other region on Earth. The presence of exotic fish species in the TWWHA, represents an ongoing impact on and threat to a number of aquatic ecosystem values. In this project we assessed the status of trout-free waters in the eight coastal catchments of the TWWHA by developing and implementing a standard monitoring protocol and establishing a benchmark set of data. This presentation focuses on how depletion-sampling data from existing surveys in trout waters were used to develop the monitoring sampling protocol. In particular the analysis to assess capture efficiency, sampling effort required and the relationship between sampling effort and probability of detection. The survey found no trout in any coastal river catchment surveyed other than the New River, where a self-sustaining population has become established. The survey indicated a very low probability of occurrence of trout within this large coastal catchment region, despite the observation of sea run trout in estuarine/tidal environments by anglers.

Davis, **C**. **J**., Desert Research Institute, Reno, USA, clinton.davis@dri.edu

Fritsen, C. H., Desert Research Institute, Reno, USA, chris.fritsen@dri.edu

ACCRUAL RATES AND COMMUNITY METABOLISM DURING A WINTER DIATOM BLOOM IN A MONTANE-DESERT RIVER

Ecological processes (e.g. primary production and biomass accumulation) are often assumed to be at their minima in the winter due to abiotic constraints (low temperatures and irradiances). However, a notable winter bloom of diatoms has been observed and documented in the Truckee River, CA-NV, USA over the past several years. Longitudinal standing stocks, accrual rates and community metabolism measures were undertaken to evaluate the relative magnitude of these processes and potential ramifications in regards to ecosystem energetics and material cycling. Standing stocks and accrual rates increased downstream, up to 0.10 doublings per day in conjunction with standing stocks >700 mg chlorophyll a m^{-2}. Autotrophic status (P/R >1) at all sites was indicated throughout most of the winter. Though the rates of accumulation may have been relatively low, the large accumulations of active periphyton produced a system exhibiting substantial positive net daily production rates (>500 mg C m^{-2} d^{-1}). This level of autochthonous carbon input into the stream underscores the importance of evaluating ecological processes during winter to truly understand the complete energetics and mass-balance of these systems.

Davis, **J**. **M**., Stream Ecology Center, Department of Biological Sciences, Idaho State University, Pocatello, USA, jmdavis@isu.edu

Baxter, C. V., Stream Ecology Center, Department of Biological Sciences, Idaho State University, Pocatello, USA, baxtcold@isu.edu

Crosby, B. T., Department of Geosciences, Idaho State University, Pocatello, USA, crosby@isu.edu

Pierce, J. L., Department of Geosciences, Boise State University, Boise, USA, jenpierce@boisestate.edu

Rosi-Marshall, E. J., Cary Institute of Ecosystem Studies, Millbrook, USA, rosimarshalle@caryinstitute.org

DO INDIRECT EFFECTS OF GLOBAL CLIMATE CHANGE ON FOREST, FIRE, AND FLOW DYNAMICS MEDIATE RESPONSES OF STREAM-RIPARIAN ECOSYSTEMS?

Responses of stream-riparian ecosystems to global climate change (GCC) are driven by direct shifts in temperature and precipitation. However, in the western U.S., GCC is predicted to alter forests through changing dynamics of wildfire and beetle outbreaks. Because stream-riparian ecosystems are coupled to the uplands via material and energy flows, shifting terrestrial disturbance regimes may affect these ecosystems. We hypothesize that in some ecoregions indirect effects of GCC (e.g., on forest, fire, and flow dynamics) mediate structural and functional responses of stream-riparian ecosystems. We predict that these effects may yield greater change than would be expected based solely on temperature and precipitation shifts. We assess direct and indirect effects for the Salmon River, which is projected to experience shifts from snow to rain-driven hydrology and increased frequency and extent of wildfire and beetle outbreaks. Qualitative modeling and a literature review show how changes in terrestrial disturbance regimes may alter GCC effects on consumers and carbon export via changes in algal production and organic matter inputs. Therefore, predictions of GCC effects should incorporate potential interactions associated with changing terrestrial disturbance regimes.

Davis, **J**. **A**., Monash University, Melbourne, Australia, Jennifer.Davis@sci.monash.edu.au

Brim Box, J., NRETAS, NT Government, Alice Springs, Australia, brimbox@gmail.com

McBurnie, G., Greening Australia, Alice Springs, Australia, glenis.mcburnie@nt.greeningaustralia.org.au

Duguid, A., NRETAS, NT Government, Alice Springs, Australia, Angus.Duguid@nt.gov.au

Brock, C., NRETAS, NT Government, Alice Springs, Australia, Chris.Brock@nt.gov.au

PERSISTENCE UNDER A DRYING CLIMATE – INSIGHTS FROM RELICTUAL STREAMS IN CENTRAL AUSTRALIA

A small number of permanent 'relictual' streams occur within the central Australian ranges. The region, characterised by low and unpredictable rainfall (<250mm per annum), high summer temperatures and high rates of evaporation (>3200mm per annum) is the driest in Australia. The streams, located within deeply shaded gorges, are supported by groundwater released from fractured rock aquifers near the bases of sandstone or quartzite outcrops. The streams contain elements of an aquatic invertebrate fauna, with Gondwanan affinities, that appears to have persisted since the last wet phase in central Australia (~18,000 years ago). Comparison of records from an exploratory scientific expedition, the Horn Expedition, undertaken in 1894, and surveys conducted in 1986, 1994 and 2008, indicate that these small, lotic ecosystems persist despite the recent impacts of European settlement. This can be attributed to the remote and inaccessible nature of the sites and the protection and management afforded by national parks. Characterisation of the hydrological and ecological processes supporting these sites has provided insight into the impacts of a warming and drying climate.

Davis, **J**. **C**., Aquatic Restoration and Research Institute, Talkeetna, USA, arri@mtaonline.net

Davis, G. A., Aquatic Restoration and Research Institute, Talkeetna, USA, arri@mtaonline.net

Snyder, E. B., Grand Valley State University, Allendale, USA, snydeeri@gvsu.edu

THE INFLUENCE OF STREAM CROSSING STRUCTURES ON THE DISTRIBUTION OF REARING JUVENILE PACIFIC SALMON

Roads and railroads often cause barriers to fish migration at stream crossing locations by modifying channel geometry causing rapid vertical drops or increased water velocities. Vertical drops or increased water velocities often exceed the leaping ability or the sustained or burst swimming speeds of juvenile anadromous salmon and resident fish. Adult salmon migration barriers can result in the absence of anadromous fish from stream systems and reduce the availability of nutrients and carbon; however, the effects of juvenile salmon migration barriers on fish distribution and stream ecosystems is unclear. We tested for differences in juvenile Pacific salmon relative abundance upstream and downstream of crossing structures in moderate sloped and low-sloped wetland streams. Crossing structures affected both upstream and downstream movement of juvenile salmon and the distribution of rearing fish between these two stream types. These changes in the relative abundance of juvenile salmon could influence other components of the stream ecosystem and could be used to evaluate the influence of rearing juvenile salmon abundance on stream structure and functional processes.

De Bruyn, **W**. **J**., Chapman University, Orange, USA, debruyn@chapman.edu

Clark, C. D., Chapman University, Orange, USA, cclark@chapman.edu

Pagell, L., Chapman University, Orange, USA,

PRODUCTION AND DESTRUCTION OF FORMALDEHYDE, ACETALDEHYDE AND ACETONE IN SOUTHERN CALIFORNIA COASTAL WATERS

Low molecular weight carbonyl compounds are produced photochemically from chromophoric dissolved organic matter (CDOM) in natural waters but production/destruction rates, mechanisms and net flux across the air-water interface are not well known. Ambient concentrations of formaldehyde, acetaldehyde and acetone measured in Southern California coastal water samples were 26 ± 24, 9 ± 4 and 8 ± 3. A diel study showed cycling but no clear photochemically dominated production. Photoproduction was measured in the laboratory as a function of optical properties and irradiation time. Rates decreased linearly with decreasing absorption coefficient (a in m-1 at 300 nm; measure of CDOM levels), with substantial variability in low a beach waters. Apparent quantum yields (Θ) were unchanged for a = 2-16 m-1, but increased x5 for beach waters with low a. Θ increased linearly with increasing spectral slope for beach waters and exposure to natural sunlight, consistent with enhanced production efficiency with photobleaching of CDOM. Θ trends with oxygen and molecular reaction probes suggest a combination of direct photolysis and singlet oxygen quenching as primary production mechanisms. Preliminary biological destruction rates are reported.

De Jager, **N**. **R**., USGS, La Crosse, USA, ndejager@usgs.gov

DEPARTURE FROM QUARTER-POWER SCALING OF AQUATIC HABITAT RICHNESS-AREA AS AN INDICATOR OF ANTHROPOGENIC CONSTRAINTS ON RIVERSCAPE ORGANIZATION

Most ecosystems exhibit regularities that take the form of scaling laws. Such laws can provide a measure of ecosystem organization and give insights into the processes that structure ecosystems (anthropogenic or other). In this study, we fit the familiar power function R=cA^z to increasing aquatic habitat richness (R) with increasing area (A) for the Upper Mississippi and Illinois rivers. Using photo-interpreted maps of the distribution of 11 aquatic habitats, we centered focal landscapes (i.e. windows) of various sizes (1-100 ha) on each of 19.3 million aquatic pixels and estimated habitat richness within each landscape. Variation in c and z was associated with modifications to the geometry of the rivers and floodplains. Estimates of c were low (<1.6) where % of the floodplain impounded exceeded 10%. Estimates of z were lowest (~0.11) where impoundment exceeded 60% of the floodplain and increased to ~0.25 with increases in the % area in secondary channels. Thus, variation in the parameter estimates c and z appear to be useful coarse-scale indicators of the impacts of river engineering on the structural diversity of these rivers.

De Jong, **G**. **D**., GEI Consultants, Inc., Denver, USA, gdejong@geiconsultants.com

Canton, S. P., GEI Consultants, Inc., Denver, USA, scanton@geiconsultants.com

TERRESTRIAL INVERTEBRATE CONTRIBUTIONS IN MONSOON FLASH FLOODS IN THE SOUTHWESTERN UNITED STATES

Flash floods in the southwestern United States can create overland flows, which wash terrestrial invertebrates into streams. We conducted a study using 15 ephemeral stream sites in the Santa Cruz River, Río Puerco, and Huerfano River watersheds, located respectively in Arizona, New Mexico, and Colorado, to investigate the aquatic fauna that colonize after flash flood events. Sampling of invertebrate populations was conducted at each site following monsoon rain events and continued daily until water was no longer present. We collected a total of 86 distinct taxa of aquatic macroinvertebrates but also collected >140 distinct taxa of terrestrial invertebrates as "by-catch." Terrestrial organisms were more abundant in the initial flush (65% of individuals and 75% of biomass), but the proportion of terrestrial taxa decreased from 65% to about 50% as aquatic invertebrates began to colonize the ephemeral resource. The initial flush of waters was relatively violent and destructive to the terrestrial organisms, but new, intact individuals continued to contribute to the proportion present. This study demonstrates the role of terrestrial invertebrates in the important aquatic-terrestrial interface in southwestern arid ecosystems.

Death, **R**. **G**., Massey University, Palmerston North, New Zealand, r.g.death@massey.ac.nz

Astorga, A., University of Oulu, Oulu, Finland, anna.astorga@oulu.fi

Paavola, R., University of Oulu, Oulu, Finland,

Muotka, T., University of Oulu, Oulu, Finland, timo.muotka@oulu.fi

Death, F., Massey University, Palmerston North, New Zealand, f.death@massey.ac.nz

Chakraborty, M., Massey University, Palmerston North, New Zealand, Manas.Chakraborty@horizons.govt.nz

LATITUDINAL GRADIENTS IN NEW ZEALAND STREAM INVERTEBRATE DIVERSITY

There has been considerable research on what environmental and biological factors affect the α-diversity of stream invertebrate communities. However, there has been limited corresponding work on determinants of β-diversity. We sampled 120 headwater streams along a latitudinal gradient in relatively pristine areas of New Zealand. Fifteen streams in each of eight regions from Northland to Fiordland were sampled. Of the numerous habitat and GIS variables examined as potential drivers, α-diversity was most closely linked with stream stability and canopy cover. However β-diversity was most closely linked with latitudinal gradient increasing from North to South.

Decker, **J**. **K**., Louis Calder Center – Biological Field Station, Fordham University, Armonk, USA, jismith@fordham.edu

Truhn, K., Louis Calder Center – Biological Field Station, Fordham University, Armonk, USA, find_kam@yahoo.com

Wehr, J. D., Louis Calder Center – Biological Field Station, Fordham University, Armonk, USA, wehr@fordham.edu

Richardson, W. B., USGS Upper Midwest Environmental Sciences Center, La Crosse, USA, wrichardson@usgs.gov

Houser, J. N., USGS Upper Midwest Environmental Sciences Center, La Crosse, USA, jhouser@usgs.gov

NUTRIENT CONTROLS ON PHYTOPLANKTON PRODUCTION IN THE UPPER MISSISSIPPI RIVER

Physical constraints (e.g. light) on phytoplankton in rivers are well known, but less is known of limitation by nutrient supply. We identified nutrients limiting phytoplankton growth in the Upper Mississippi River (UMR), a productive floodplain river. *In situ* bioassays were conducted in which ambient river water was enriched with nutrients (N, P, NP, Fe, and Si) during three seasons at each of three sites along a hydrological connectivity gradient: main channel, flow-through backwater, and single-connection backwater. The degree of limitation (Δr) was calculated for all treatments where biomass (Chl-*a*) was significantly different from the control. During spring and fall, N was found to be limiting in backwaters (Δr = 0.22 and 0.30 at single-connection, Δr = 0.34 and 0.55 at flow-through) and N and P had an additive effect in the spring (Δr = 0.46 at single-connection, Δr = 0.45 at flow-through). In summer, backwaters experienced co-limitation of N and P, with P being most limiting at the most isolated site (Δr = 0.13). Results demonstrate that, even in productive and turbulent systems like the UMR, nutrients can limit production.

Deemer, **B**. **R**., Washington State University Vancouver, Vancouver, USA, bridget.deemer@email.wsu.edu

Harrison, J. A., Washington State University Vancouver, Vancouver, USA, john_harrison@vancouver.wsu.edu

THERMAL STRATIFICATION IMPACTS EFFICIENCIES OF MICROBIAL NITROGEN REMOVAL IN A EUTROPHIC RESERVOIR

The microbially mediated removal of biologically available nitrogen (N) in aquatic systems helps to alleviate aquatic N pollution, but is also associated with the production of N2O, a powerful greenhouse gas. Water column stratification can significantly change bottom water chemistry and is thus expected to impact sediment N2 and N2O production rates. We studied changes in hypolimnion N2 and N2O concentrations during thermal stratification in a small eutrophic reservoir. Accumulation rates of these gases under the thermocline served as a proxy for sediment production rates. Sediment incubation experiments and hypolimnion NO3- data show that, over the course of the summer, progressive nitrate depletion at the sediment-water interface limited N2 production and associated N removal. As rates of N2 production dropped off, rates of N2O production increased resulting in decreasing N2:N2O ratios as the summer progressed ($p<0.05$, $R2=0.61$). These findings have important implications for how we model the transport of N through aquatic systems. Our findings also suggest that dam spills may sufficiently destabilize the water column to alleviate sediment NO3- limitation and increase N2:N2O ratios.

Della Croce, **P**., Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, USA, patrick.dellacroce@gmx.ch

Poole, G. C., Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, USA, gpoole@montana.edu

EFFECTS OF TOPOLOGY, STRAYING RATES, AND STOCKING DURATION ON THE SPREAD OF TROUT HYBRIDIZATION ACROSS A STREAM NETWORK

Recent studies addressing the issue of hybridization between native cutthroat trout (Oncorhynchus clarki sp.) and introduced rainbow trout (O. mykiss) across the northern Rocky Mountains indicate a direct relationship between rates of hybridization (H) within a subpopulation (e.g. spawning ground) and the stream distance (D) separating that subpopulation from the closest source of hybridization (e.g. non-native fish stocking location). However, the relationship between D and H is rarely quantified and the effects of network topology on H are typically ignored. We have developed and applied an agent-based model that tracks the lineage, breeding location, and mate selection of each individual fish in a population across generations, thus simulating the movement of non-native genes among spawning locations within a stream network. The model considers D along with network topology in determining the movements of stocked and straying fish. Model results suggest that stream network topology increases the variability of predicted gene distributions and influences the relationship between D and H. However, the importance of topology varies depending on underlying model assumptions such as stocking duration and spawning site fidelity.

Delong, **M**. **D**., Winona State University, Winona, USA, mdelong@winona.edu

Thorp, J. H., University of Kansas, Lawrence, USA, thorp@ku.edu

Thoms, M. C., University of New England, Armidale, Australia, martin.thoms@une.edu.au

TROPHIC NICHE DIMENSIONS OF FISH COMMUNITIES AS A FUNCTION OF HISTORICAL HYDROLOGICAL CONDITION OF PLAINS RIVERS

We used carbon and nitrogen stable isotope ratios of fish communities over the past century to assess changes in total niche space and species packing as a function of historical hydrological conditions in the Missouri and Kansas rivers. A hydrological index was generated using daily stage height and discharge over the period of record against a pre-dam reference condition. Community-wide measures of trophic dimensions were calculated for pre-dam and multiple post-dam periods. Total niche space, range of basal resources entering the food web, and increased species packing within 15-yr of the start of operation of the last dam built on the Missouri coincided with a decline in magnitude of peakflow and modification of the pre-dam annual hydrograph by maintaining prolonged high flows during the summer navigation season. Changes in niche measures were more protracted in the Kansas, reflecting the cumulative addition of tributary impoundments over time and subsequent loss of flow variability. This study demonstrates that while the nature of responses may differ slightly, modification of hydrological conditions influences energy flow in rivers and has ramifications for overall system productivity.

Demarty, **M**., Environnement Illimité, Montréal, Canada, maud.demarty@envill.com

Bastien, J., Environnement Illimité, Montréal, Canada, julie.bastien@envill.com

Tremblay , A., Hydro Québec, Montréal, Canada, Tremblay.Alain@hydro.qc.ca

GREENHOUSE GASES FROM BOREAL HYDROELECTRIC RESERVOIRS FROM QUEBEC AND MANITOBA, CANADA

Carbon dioxide (CO2) and methane (CH4) are greenhouse gases (GHG) emitted from both natural aquatic ecosystems and manmade reservoirs. The role of GHG emissions from freshwater reservoirs and their potential contribution in increasing atmospheric GHG concentrations is actually well discussed worldwide. To our knowledge, there are fairly few emission measurements available for freshwater reservoirs on a global basis. This communication presents data of GHG flux measurements taken on reservoirs of various ages and sizes as well as on adjacent lakes and rivers from Canadian boreal ecosystems. GHG emissions were either directly measured with a floating chamber, or calculated from partial pressure measured by automated systems. Our results indicate an increase of GHG emissions rapidly after flooding and a return to values of natural systems within 10 years or less (faster for CH4 than for CO2. Springtime GHG emissions (following ice cover season) would represent up to 30% of the annual GHG mass balance. Based on 15 years of data, GHG emissions from boreal reservoirs would only represent 1 to 5% of a thermal power plant of equivalent generation capacity.

Demi, **L**. **M**., University of Maine, School of Biology and Ecology, Orono, USA, lee.demi@umit.maine.edu

Simon, K. S., University of Maine, School of Biology and Ecology, Orono, USA,

Coghlan, S. M., University of Maine, Department of Wildlife Ecology, Orono, USA,

Saunders, R., National Marine Fisheries Service, Maine Field Station, Orono , USA,

Anderson, D., University of Maine, School of Biology and Ecology, Orono , USA,

ANADROMOUS ALEWIVES IN LINKED LAKE-STREAM ECOSYSTEMS: CAN TROPHIC INTERACTIONS IN LAKES INFLUENCE STREAMS?

Anadromous alewives can alter zooplankton communities in lakes dramatically via size selective predation. The extent to which this trophic interaction alters the downstream flow of energy and nutrients to outlet streams is unknown. We studied eight pairs of lakes and outlet streams that differed in accessibility to alewives. In each lake, abundance and concentration of zooplankton, seston, phytoplankton, and nutrients were characterized during spring and summer. These data were compared to corresponding measures of seston flux from lakes to streams. Zooplankton size decreased during the summer only in lakes with alewives. Zooplankton biomass generally decreased across all lakes, though there was some variation associated with lake trophic state. The flux of large, phosphorous-rich seston particles to streams progressively decreased in alewife systems, but remained relatively unchanged in those inaccessible to alewives. The export of small, phosphorous-poor seston particles was not influenced by alewives. The observed changes in seston quantity and quality are being related to the community composition and abundance of stream invertebrates. Our results indicate that strong trophic interactions in lakes have the potential to influence stream ecosystems

DeMots, **R**. **L**., University of South Dakota, Vermillion, USA, rachel.demots@usd.edu

Satyshur, C. D., University of South Dakota, Vermillion, USA, cdsatyshur@hotmail.com

Soluk, D. A., University of South Dakota, Vermillion, USA, daniel.soluk@usd.edu

EGGS TO ADULTS: A CAPTIVE REARING PROGRAM FOR AN ENDANGERED DRAGONFLY (SOMATOCHLORA HINEANA).

To facilitate recovery and reintroduction, a captive rearing program was initiated for the federally endangered Hine's emerald dragonfly (Somatochlora hineana). Egg collection and hatching methods have been successful with approximately 25% of larvae hatched in 2007 and 2008 surviving. Egg-reared and wild-caught larvae were housed individually in controlled environments where temperature and feeding regimes mimicked those in the habitat. Annual survivorship estimates of all larvae participating in the captive rearing program ranged from 82-96% during 2003-2009. Some larvae were placed in cages in the field

that gave them access to natural food sources, temperatures and light-regimes. This allowed a comparison between growth rates of wild and laboratory-held individuals. Survivorship ranged from 66-100% in all years for final instar larvae emerging in field enclosures. Emergence period of captive larvae consistently overlapped with that of wild individuals. The standardization of successful rearing methods for S. hineanea from eggs to adults has had many expected and unexpected benefits, in that it allows augmentation of low productivity sites, testing of habitat quality in restored areas, and reintroduction into extirpated areas possible.

Dempsey, **C**. **M**., Lehigh University, Bethlehem, USA, cmd307@lehigh.edu
Morris, D. P., Lehigh University, Bethlehem, USA, dpm2@lehigh.edu

THE ROLE OF PHOSPHORUS LIMITATION IN REGULATING MICROBIAL RESPIRATION IN STREAMS

Dissolved organic carbon (DOC) is an important source of energy in lotic systems. DOC varies in quality and quantity according to the river continuum concept. Streams higher in a watershed tend to have more refractory, allochthonous carbon and streams lower in a watershed have more labile, autochthonous DOC. It is thought that phosphorus addition to stream samples will increase microbial respiration, productivity, and growth efficiency. Phosphorus limitation may indicate that microbial communities are not reaching their full potential in terms of productivity, biomass, and efficiency, which could limit organisms higher in trophic status. This study utilized once through plug flow bioreactors and batch cultures to assess changes across a variety of water quality and nutrient parameters that will help determine the possibility of phosphorus limitation to microbial activity. Effects of phosphorus limitation were only observed at a single site, suggesting that a secondary limiting nutrient may affect microbial activity at the other sampling sites. Phosphorus limitation was not observed in the batch cultures suggesting that the high biomass and community complexity of bioreactors play an important role in processing DOC.

Denis, **K**., University Of Mons, Mons, Belgium, Kevin.Denis@umons.ac.be
Grosjean, P., University Of Mons, Mons, Belgium, philippe.grosjean@umons.ac.be

ORIGINAL METHOD TO OPTIMIZE GROUPS IN AUTOMATIC PLANKTON CLASSIFICATION, APPLIED TO NORTH SEA PHYTOPLANKTON USING ZOO/PHYTOIMAGE

We present here an original method to calculate optimal set of taxonomical groups with automatic plankton classifiers in order to achieve the best trade-off between higher recognition rate and higher taxonomical separation. Groupings can be modulated to keep pools of related groups together or to isolate target species (e.g., toxic algae) as much as possible. At the end of the process, an interactive dendrogram graphically presents how the initial taxonomical groups are progressively pooled together, and it is possible to select the final level of groupings by clicking on the plot. As a practical application, an initial classifier of North Sea phytoplankton, able to discriminate 33 taxa with an accuracy of 70%, was optimized with the proposed method to separate 22 groups with an accuracy of 87%. We have also shown that, for several classification algorithms, post-processing of the original classification with our method yields higher recognition rate than direct classification into the final groups. That method will be available in Zoo/PhytoImage (http://www.sciviews.org/zooimage).

Denton, **M**., University of Nevada, Reno, Reno, USA, mariannedenton@sbcglobal.net
Chandra, S., University of Nevada, Reno, Reno, USA, sudeep@cabnr.unr.edu
Wittmann, M. E., University of California, Davis, Incline Village, USA, mwittmann@ucdavis.edu
Caires, A., University of Nevada, Reno, Reno, USA, acaires@cabnr.unr.edu

BENTHIC COMMUNITY CHANGES DUE TO THE ESTABLISHMENT OF THE ASIAN CLAM, *CORBICULA FLUMINEA*, IN LAKE TAHOE

The invasive species, *Corbicula fluminea* (Asian clam), has established high-density populations in the littoral zone of the southeastern portion of Lake Tahoe. First observed in 2002 in low densities, current high-density clam populations (>2000/m^2) may affect benthic macroinvertebrates via competition for nutrients and space. *C. fluminea* may also influence benthic communities by coupling pelagic and benthic environments through feeding strategies, and processes of bioturbation and biodeposition. Additionally, the shells of dead *C. fluminea* may provide refuge and substrate for other benthos. We assessed the impacts of *C. fluminea* establishment on macroinvertebrate density, species diversity and richness. Preliminary findings suggest that as *C. fluminea* densities increase, other molluskan taxa decrease (*Pisidium*: p=0.033, r^2 =0.96; Gastropoda: p>0.005, r^2=0.44). While some benthos remained unaffected, i.e., Chironomidae and Oligochaeta, Shannon diversity showed an overall negative response to increasing populations of *C. fluminea* (p>0.001, r^2=0.44). These results suggest that *C. fluminea* do affect overall trends in benthic biodiversity where populations have established.

DESCLOUX, **S**., University of Lyon 1, LYON, France, stephane.descloux@edf.fr
DATRY, T., CEMAGREF, LYON, France, thibault.datry@cemagref.fr
MARMONIER, P., University of Lyon, LYON, France, pierre.marmonier@univ-lyon1.fr

EFFECT OF BENTHIC AND HYPORHEIC CLOGGING ON INVERTEBRATE DISTRIBUTION

Streambed clogging induced by fine particles is nowadays considered as a major environmental concern throughout the world. The hyporheic zone (HZ) experiences intense surface-groundwater hydrological exchanges, supports significant biogeochemical processes and harbours rich and diverse invertebrate communities. Nevertheless, the ecological effects of streambed clogging were rarely studied for benthic and HZ communities together. The objectives of this study were i). to determine the influence of sediment clogging on benthic and hyporheic invertebrate assemblages and ii). to identify species associated with clogged and unclogged reaches. We assessed streambed clogging using freeze-coring technique and we determined surface and subsurface water chemistry and sampled benthic and hyporheic invertebrates. The results demonstrate that clogging modified the composition and structure of both benthic and hyporheic invertebrate assemblages. For instance, clogging reduced by 10% benthic and by 25% hyporheic taxonomic richness and by a factor 3 benthic and hyporheic densities. Some taxa were preferentially found in clogged (Baetidae) and other in unclogged reaches (Harpatocoidae). These results demonstrate that the HZ is very vulnerable to clogging. A biotic index traducing clogging conditions and including the vertical dimension of the streambed could be proposed.

Desotelle, **M**. **D**., W. K. Kellogg Biological Station/ Michigan State University, Hickory Corners, USA, desotell@msu.edu
Hamilton, S. K., W. K. Kellogg Biological Station/ Michigan State University, Hickory Corners, USA, hamilton@kbs.msu.edu

THE EFFECTS OF IMPOUNDMENTS ON AQUATIC ENERGY SOURCES IN THE KALAMAZOO RIVER, MICHIGAN

In medium sized rivers where impoundments are common, increased phytoplankton production results in higher densities of filter feeders and potentially changes the energy source of aquatic food webs. This study examined how shifts in benthic algal and phytoplanktonic production above and below an impoundment moved through aquatic food webs using natural abundance stable isotope ratios. Initially, I tested this hypothesis by collecting algae and macroinvertebrates from above and below a medium sized impoundment in the Kalamazoo River, Michigan from May until October 2008. Hydropsychidae caddisflies and Heptageniidae mayflies collected directly downstream of the impoundment tended to have the most depleted carbon isotope ratios, which suggested that phytoplankton was an important subsidy to the food web. Invertebrates in reaches above and further downstream of the impoundment had less depleted carbon isotope ratios that were closer to the expected terrestrial organic matter signal. However, benthic algae could have the same carbon isotope signal and be an important energy source. This work will proceed to further understand how impoundments, which change the availability of basal food resources, affect medium sized river food webs.

Desrosiers, M., CEAEQ, Ministère du Développement durable, de l'Environnement et des Parcs, Québec, Canada, melanie.desrosiers@mddep.gouv.qc.ca

USSEGLIO-POLATERA, **P**., Université Paul Verlaine, Laboratoire LIEBE, Metz, France, usseglio@univ-metz.fr

ARCHAIMBAULT, V., Cemagref - Groupement de Lyon, Lyon, France, virginie.archaimbault@cemagref.fr

PINEL-ALLOUL, B., Université de Montréal, GRIL, Département de Sciences Biologiques, Montréal, Canada, bernadette.pinel-alloul@umontreal.ca

METHOT, G., Université de Montréal, GRIL, Département de Sciences Biologiques, Montréal, Canada,

USING MACROINVERTEBRATE FUNCTIONAL TRAITS FOR ASSESSING SEDIMENT QUALITY IN THE ST. LAWRENCE RIVER

How macroinvertebrate respond to human disturbances can be characterized following two major approaches. The traditional taxonomic approach has been extensively used. Since the nineties, another approach based on functional traits has experienced and offer a better understanding of community-environment relationships and functioning of ecosystems facing human impacts. In this study, we assessed sediment quality in a large river in North America by exploring the relationships between chemical contamination and benthic community structure using the functional trait approach. This study was carried out in the St-Lawrence River, an essential waterway exposed to many anthropogenic stresses such as industrial and municipal wastewater or agricultural activities. Macroinvertebrates were collected in 59 sites. Organic, inorganic contaminants and sediments characteristics (grain size, organic matter, nutrient, etc) were measured in the whole sediment. Seventeen biological or ecological traits of taxa were coded, taking into account regional climate and ecosystem specificities. The goals of this study were: (1) to describe spatial patterns in functional traits of macroinvertebrate communities; (2) to determine relationships between trait combinations and taxonomic structure and (3) to link macroinvertebrate assemblages and trait combinations to environmental conditions and sediment quality.

Devereux, **R**., US Environmental Protection Agency, Gulf Breeze, USA, devereux.richard@epa.gov

Beddick, D. L., US Environmental Protection Agency, Gulf Breeze, USA, beddick.david@epa.gov

Lehrter, J. C., US Environmental Protection Agency, Gulf Breeze, USA, lehrter.john@epa.gov

Yates, D. F., US Environmental Protection Agency, Gulf Breeze, USA, yates.diane@epa.gov

THE POTENTIAL FOR SUBOXIC AMMONIUM OXIDATION IN LOUISIANA CONTINENTAL SHELF SEDIMENTS

Sediment nutrient fluxes can contribute to Gulf of Mexico hypoxia. Cores collected from four Louisiana continental shelf stations during three cruises (April-September 2006) contained porewater nitrate (mean = 3.3 &microM) in most of the sediment fractions analyzed (0-18 cm). In cores (n = 5) collected from one station in September when overlying water DO was 0.64 mg L^{-1}, porewater nitrite peaked (0.49 &microM) in 10-12 cm fractions corresponding with peak ammonium levels (363 &microM). Porewater manganese (92 &microM) and Fe^{2+} (228 &microM) were highest in 0-2 cm and 4-6 cm sediments, respectively. Sulfate reduction rates were 71.0 and 34.0 nmol ml^{-1} d^{-1} 0-2 and 4-10 cm beneath the sediment surface, respectively. Nitrate and nitrite in these sediments could either have been entrained by mixing, or originated as end products of ammonium oxidation. The porewater Mn and Fe^{2+} profiles, low concentration of dissolved oxygen in the overlying water, and measurable sulfate reduction support a conclusion of suboxic ammonium oxidation, most likely coupled to manganese or iron oxide reduction. However, suboxic ammonium oxidation would likely represent a small fraction of the total.

Devlin, **S**. **P**., Wright State University, Dayton , USA, devlin.2@wright.edu

Vadeboncoeur, Y., Wright State University, Dayton, USA, yvonne.vadeboncoeur@wright.edu

Vander Zanden, M. J., University of Wisconsin, Madison, USA, mjvanderzand@wisc.edu

BACTERIAL PRODUCTION AND ABUNDANCE IN LITTORAL SEDIMENTS OF OLIGOTROPHIC LAKES: THE ROLE OF BENTHIC PRIMARY PRODUCTION AND ALLOCHOTHOUS CARBON.

Much of what is known about bacterial dynamics in lakes has been derived from pelagic studies, while few studies investigate littoral bacteria. Littoral sediments in oligotrophic lakes range from sand to highly organic mud comprised of allochthonous carbon from exogenous sources or autochthonous benthic primary production. The ratio of benthic primary production to benthic OM content (BPPr:OM) provides an integrated index of the source and amount of benthic OM available for bacteria. We measured benthic bacterial production (BP) and abundance (BA) in the littoral zones of four oligotrophic NTL-LTER lakes with varying sediment types each season over the course of one year. Seasonal variation in bacterial production was driven by a positive relationship between BP and temperature (t =5.274 4, p<-.0001). Differences in source and amount of sediment organic matter drive among lake variation in BP and BA along a BPPr:OM gradient. Autochthonous organic matter content of littoral sediments could regulate bacterial dynamics and impact ecosystem processes such as nutrient recycling and trophic linkages to organic carbon pools.

Diefenderfer, **H**. **L**., Pacific Northwest National Laboratory, Sequim, USA, heida.diefenderfer@pnl.gov

Borde, A. B., Pacific Northwest National Laboratory, Sequim, USA, amy.borde@pnl.gov

Coleman, A. M., Pacific Northwest National Laboratory, Richland, USA, andre.coleman@pnl.gov

ECOLOGICAL CHARACTERIZATION OF REMNANT *PICEA SITCHENSIS* TIDAL FRESHWATER WETLANDS ON THE COLUMBIA RIVER

In the Pacific Northwest, only a small poorly documented fraction of the Sitka spruce (*Picea sitchensis*) wetlands once dominating the coastal fog belt remains. Results from some of the largest tidal freshwater examples indicate swamps occur at 1-4 m NAVD88, most vertically accreting (mean rate 0.53 cm/yr). Spruces attain large statures, rooting on LWD up to 5 m NAVD88 in association with *Gaultheria shallon* and *Vaccinium parvifolium;* microtopography is hummocky. Subdominant trees are *Alnus rubra, Thuja plicata,* with a well-developed shrub layer. Observed plant species richness was 74. Mean quarterly litterfall was highest October-January (342 g/m^2), lowest April-July (43 g/m^2). Channel cross-sectional area is correlated with total channel length and watershed area. In-channel fluxes are moderated by LWD/beaver dams: a forced step-pool channel type. Channel substrates are fines (TOC 3.1%) dense with nematodes and oligochaetes; floodplains also contain coarse sands/gravels (TOC 5.2%). Habitats are used by anadromous fishes: out-migrating salmonids and spawning-run eulachon (*Thaleichthys pacificus*). Fallout traps contained 58 taxa (half present in juvenile salmon diets), and small neuston samples 46. The flood regime and water properties were also described.

Dieter, **D**., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, Daniela.Dieter@igb-berlin.de

von Schiller, D., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, DanielvonSchiller@igb-berlin.de

Gelbrecht, J., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, gelbr@igb-berlin.de

Tockner, K., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, Tockner@igb-berlin.de

FLOW INTERMITTENCY EFFECTS ON LEAF LITTER DECOMPOSITION IN MEDITERRANEAN STREAMS

Flow intermittency is a common feature of Mediterranean streams. However, its effects on ecosystem processes are not yet well understood. During extended periods of drought, desiccation of streams is concomitant with peak leaf input from riparian vegetation, which represents a major energy source. In contrast to perennial streams, however, leaves that fall during the no-flow period may decompose in residual and often anoxic pools, or lay on the dry streambed exposed to photodegradation by sunlight before surface flow recovery. We hypothesized that this preconditioning alters leaf chemistry, affects its palatability, and modifies the subsequent decomposition in the flowing stream. In order to test this hypothesis, we simulated preconditioning of *Populus tremula* L. leaves by wet-anoxic conditions and UV-VIS irradiation in the laboratory. We subsequently measured decomposition rates of these preconditioned leaves in selected intermittent low order Mediterranean streams using the litter bag technique. Our results showed how flow intermittency alters the chemistry of leaves and leaf leachates, and to what extent these changes controlled the subsequent breakdown rates, leading to an altered carbon turnover in intermittent streams.

Dillon, **K**. **S**., Univ of Southern Mississippi, Dept of Coastal Sciences, Ocean Springs, MS, USA, kevin.dillon@usm.edu

Howden, S. D., Univ of Southern Mississippi, Dept of Marine Science, Stennis Space Center, MS, USA, stephan.howden@usm.edu

Gundersen, K., Univ of Southern Mississippi, Dept of Marine Science, Stennis Space Center, MS, USA, Kjell.Gundersen@usm.edu

Hoffmeyer, E. R., Univ of Southern Mississippi, Center for Fisheries Research, Gulf Coast Research Lab, Ocean Springs, MS, USA, eric.hoffmayer@usm.edu

Martin, K., Univ of Southern Mississippi, Dept of Marine Science, Stennis Space Center, MS, USA, kevin.martin@usm.edu

Brunner, C. A., Univ of Southern Mississippi, Dept of Marine Science, Stennis Space Center, MS, USA, charlotte.brunner@usm.edu

EARLY ONSET OF SEASONAL BOTTOM WATER HYPOXIA IN THE MISSISSIPPI BIGHT

In 2008, seasonal bottom water hypoxia in the Mississippi Bight was observed much earlier than normal. At peak coverage the hypoxia event's areal extent was four times larger than observed in 2006 and extended further south with a maximum thickness of 12 m. Nutrient concentrations were highest in bottom waters: NH_4 appeared to be the most abundant DIN species during extreme 2008 hypoxic event while NO_3 was the more prevalent DIN form during the more typical 2009 hypoxic event. DOC and DON concentrations in surface waters were similar from year to year and were consistently and significantly higher than those found bottom waters. Temporal data from 2008 suggests that the hypoxic area was dynamic, changing in size or shifting in response to local currents and tides. Data from 2009 show the degree of hypoxia in the Mississippi Bight was much smaller than the previous year despite increased riverine flow which suggests that an additional freshwater nutrient source existed in 2008 and/or the physical conditions were more favorable for intense water column stratification during the larger hypoxic event of 2008.

Dimova, **N**. **T**., Florida State University/USGS Santa Cruz, Santa Cruz, USA, ndimova@usgs.gov

Burnett, W. C., Florida State University, Tallahassee, USA, wburnett@fsu.edu

Swarzenski, P. W., U.S. Geological Survey, Santa Cruz, USA, pswarzen@usgs.gov

Anders, R., U.S. Geological Survey, San Diego, USA, randers@usgs.gov

GROUNDWATER DISCHARGE INTO FLORIDA AND CALIFORNIA LAKES AS REVEALED BY MODELING RADON-222 TEMPORAL RECORDS

We use the temporal distribution of 222Rn (t1/2=3.8 d) in water to model groundwater seepage rates in two contrasting lake systems in Florida and California. The approach presented here is based on first principles of a radon mass balance using a single-box model. Model assumptions include steady-state groundwater fluxes and uniform distribution of the geochemical tracer throughout the water column. Comparison of the seepage rates obtained from this method at Lake Haines in central Florida with independent, simultaneous seepage work showed very good agreement. While the average depth of Lake Haines is about 2 m, Lake Arrowhead in the Sierras of southern California is much deeper, with an average depth of 36 m and a maximum depth just under 60 m. Nonetheless, our first investigation in January 2010 to Lake Arrowhead indicated a non-stratified water column. Such uniformity will likely not be the case during the summer when conditions for strong pycno- and thermocline formation are favorable. Thus a revision of the radon one-box radon mass balance model needs to be attempted to adequately describe the groundwater dynamics of this mountainous system.

Dinsmore , **K**. **J**., Centre for Ecology & Hydrology, Penicuik, United Kingdom, kjdi@ceh.ac.uk

Billett, M. F., Centre for Ecology & Hydrology, Penicuik, United Kingdom, mbill@ceh.ac.uk

Smart, R. P., University of Leeds, Leeds, United Kingdom, R.P.Smart@leeds.ac.uk

Holden, J., University of Leeds, Leeds, United Kingdom, J.Holden@leeds.ac.uk

Baird, A. J., University of Leeds, Leeds, United Kingdom, A.J.Baird@leeds.ac.uk

Chapman, P. J., University of Leeds, Leeds, United Kingdom, P.J.Chapman@leeds.ac.uk

PEATLAND GHG RELEASE VIA THE AQUATIC PATHWAY; FINDINGS FROM THE 'UK CARBON CATCHMENTS' NETWORK

Peatlands represent major stores of terrestrial carbon; their drainage waters are highly and consistently supersaturated in both CO_2 and CH_4, and release significant amounts of GHG's to the atmosphere. The 'UK Carbon Catchments' are a network of 4 peatland sites where we aim to quantify individual carbon budgets by measuring and combining various flux terms, including aquatic export and evasion. Here we present a complete 2-year GHG budget from 'Auchencorth Moss', one of the Scottish sites, alongside preliminary results from the remaining 3 catchments. The results show losses via aquatic evasion equating to 12% of the net ecosystem exchange CO_2-equivalent uptake. We also present recent research from the 'Moor House' catchment which indicates an additional aquatic flux pathway which has yet to be quantified. Natural soil pipes in peatland systems not only contribute significantly to total stream discharge, but can transport very high concentrations of GHGs (<18.9 mg CO_2-C L^{-1}; <700 µg CH_4-C L^{-1}) to the peat surface. We present evidence which suggests pipe outlets may represent a further aquatic hotspot for GHG release from peat catchments.

Ditzler, **K**. **E**., University of Maine, Orono, USA, kristin.ditzler@umit.maine.edu

Saros, J. E., University of Maine, Orono, USA, jasmine.saros@maine.edu

Simon, K. S., University of Maine, Orono, USA, ksimon@maine.edu

Kinnison, M. T., University of Maine, Orono, USA, michael.kinnison@umit.maine.edu

McGowan, S., University of Nottingham, Nottingham, United Kingdom, suzanne.mcgowan@nottingham.ac.uk

IMPACTS OF WHITE PERCH INTRODUCTIONS ON LAKE PLANKTON: COMBINING PALEOLIMNOLOGICAL AND WHOLE-LAKE BIOMANIPULATION APPROACHES

Introduction and removal of strictly planktivorous fish in lakes can alter plankton communities via cascading interactions in food webs. Less is known about the large-scale and long-term effects of introduction of fish with more generalist feeding habits. Both whole-lake biomanipulation and paleolimnological approaches were used to analyze the responses of plankton communities to the introduction of white perch (Morone americana), a fish that often numerically dominates fish assemblages and switches from strict planktivory to omnivory during ontogeny. Results from a lake-scale perch removal show a decrease in zooplankton body size that is paired with an increase in cladoceran ephippia size in the sediment at the time of introduction. Paleolimnological analyses of additional lakes demonstrate a decrease in algal production, inferred from fossil pigments, following white perch introduction. These results are counter to predictions from a top-down trophic cascade as may be expected from the introduction of strictly planktivorous fish. This study highlights the importance of trophic interactions in structuring lake food webs and the utility of combining approaches that span spatial and temporal scales to investigate complex trophic interactions in lakes.

Diver, **T**. **A**., Univeristy of New Mexico, Albuquerque, USA, tdiver@unm.edu

Osborne, M. J., University of New Mexico, Albuquerque, USA, mosborne@unm.edu

Turner, T. F., University of New Mexico, Albuquerque, USA, turnert@unm.edu

GENETIC DIVERSITY OF NON-NATIVE FISHES EXCEEDS NATIVES IN THE PECOS RIVER NM BECUASE OF MULTIPLE INTRODUCTIONS FROM GENETICALLY RICH SOURCE POPULATIONS

The Pecos River in New Mexico supports a diverse community of fishes compared to other arid-land streams in the southwestern US. Relatively high alpha diversity results from an intact native fish fauna coupled with non-native species. We assessed nucleotide diversity for three native and two introduced fishes at the protein-encoding mtDNA ND4 gene. Contrary to expectation, diversity (as measured by θ) was higher for recently introduced species Notropis girardi and Hybognathus placitus compared to native Macrhybopsis aestivalis, Notropis jemezanus, and Notropis simus pecosensis. We tested whether increased levels of genetic diversity in non-natives resulted from multiple introductions from genetically divergent sources. In this study, samples from the introduced Pecos River population of N. girardi were compared to samples collected throughout the native range in New Mexico and Oklahoma. Nucleotide sequence data indicated that the Canadian River is the likely source population of the introduced population and that introduced individuals harbor nearly all genetic variation present at the source population. Increased genetic diversity may allow non-natives to persist and thrive despite presumed local adaptation and competitive advantage of natives.

Dixon, **T**. **C**., Colorado School of Mines, Golden, USA, tdixon@mines.edu
Vermilyea, A. W., University of Alaska, Southeast, Juneau, USA, awvermilyea@uas.alaska.edu
Voelker, B. M., Colorado School of Mines, Golden, USA, voelker@mines.edu

HYDROGEN PEROXIDE DYNAMICS IN AN AGRICULTURAL HEADWATER STREAM: EVIDENCE FOR SIGNIFICANT BIOLOGICAL PRODUCTION

Hydrogen peroxide (H2O2) is known to play key roles in aquatic systems, including metal redox cycling and degradation of organic matter into bioavailable forms. Although biological production of H2O2 has been observed in culture studies, the significance of this process to the H2O2 budget in freshwater systems remains unknown. In this study, we added O18-labeled H2O2, H2(18)O2, to novel in-stream mesocosm systems exposed to light and dark periods. By measuring total H2O2 and H2(18)O2 in tandem, we were able to obtain absolute rates of H2O2 production and decay when both were occurring simultaneously. Our results indicate light-dependent biological production, continuing in the dark, at rates up to several-fold the abiotic photo-production rates. We also observed a large role of the sediment-water interface in dictating H2O2 concentrations. This investigation is the first to characterize absolute rates of freshwater H2O2 production in situ, and evidences biological production as the dominant control on the H2O2 budget in the agricultural headwater stream studied.

Doering, **M**., EAWAG, Duebendorf, Switzerland, michael.doering@eawag.ch
Uehlinger, U., EAWAG, Duebendorf, Switzerland, uehlinger@eawag.ch
Tockner, K., IGB, Berlin, Germany, tockner@igb-berlin.de

HYPORHEIC EXCHANGE, ECOSYSTEM PROPERTIES AND ECOSYSTEM PROCESSES AT TWO SPATIAL SCALES IN A LARGE RIVER FLOODPLAIN (TAGLIAMENTO RIVER, NE ITALY)

We examined the response of physico-chemical habitat variables, periphyton abundance (AFDM) and hyporheic respiration (chamber method) to hyporheic exchange measured as vertical hydraulic gradient (VHG) in a large-scale losing (29km; average decrease 2.5 $m^3s^{-1}km^{-1}$) and gaining reach (12.5km; average increase 0.3 $m^3s^{-1}km^{-1}$) and in small-scale riffle head and tail sequences nested in each reach along a large alluvial river (Tagliamento River, NE Italy). Between the losing (VHG 0.67±0.55) and gaining reach (VHG 0.03±0.23), we found distinct differences in physico-chemical habitat variables (e.g. NO_3-N 0.75±0.05 vs. 1.03±0.32 mg/l), AFDM (12.0±12.2 vs. 21.3±18.9 gm^{-2}) and hyporheic respiration (0.42±0.19 vs. 0.26±0.15 mgO_2kg $sediment^{-1}h^{-1}$ at 20°C) reflecting the hyporheic exchange pattern in each reach. However, these parameters did not respond to hyporheic exchange at small-scale riffle heads (VHG -0.20±0.24) and riffle tails (VHG 0.18±0.19). Averaging the data for small-scale riffle heads and tails separately for the losing and gaining reach, the same pattern partly emerged as observed at the large-scale losing and gaining reach. Our results suggest that hyporheic exchange was a major factor influencing ecosystem properties and processes hierarchically across spatial scales.

Doledec, **S**., University Lyon 1, Villeurbanne, France, sylvain@biomserv.univ-lyon1.fr
Feio , M. J., Institute of Marine Research, University of Coimbra, Coimbra, Portugal, feiomaria@gmail.com

INTEGRATING INVERTEBRATE TRAITS INTO PREDICTIVE MODELS: AN ALTERNATIVE FOR STREAM BIOASSESSMENT

Predictive models (e.g. RIVPACS) assess river biological integrity through observed vs. predicted taxonomic composition. We converted the predicted and the observed taxonomic lists of 165 sites variously affected by human pressures into traits-by-sites arrays and compared the response of OE taxonomic richness, OE trait categories difference (TCD) and OE trait profile dissimilarity (TPD). We found that all OEs indicated general degradation, organic contamination, connectivity and morphological changes; additionally OE TPD and OE TCD responded to connectivity loss and changes in natural hydrological regime; OE TPD also indicated changes in natural land use; none of the community measures responded to changes in riparian vegetation. Organic contamination and general degradation were correlated with several traits whereas gill respiration changed specifically with organic contamination and differences associated to dead animals as food and deposit feeders as feeding habits were influenced by the presence of artificial water bodies. In conclusion, the predicted to observed trait composition differences proved to be effective in classifying streams ecological integrity with the advantage of giving indirect information on ecosystem functioning impairment.

Dolph, **C**. **L**., University of Minnesota, St. Paul, USA, dolph008@umn.edu
Huff, D. D., University of Minnesota, St. Paul, USA,
Chizinski, C. J., University of Minnesota, St. Paul, USA,
Vondracek, B., Minnesota Fish and Wildlife Cooperative Research Unit, U.S. Geological Survey, St. Paul, USA,

IMPLICATIONS OF CONCORDANCE FOR ASSESSING AQUATIC COMMUNITIES AT THREE NESTED SPATIAL SCALES IN MINNESOTA, USA

Despite the large number of studies evaluating concordance between aquatic communities in various geographic contexts, very few studies have examined how patterns in community concordance relate to the patterns in community condition portrayed by the biotic indices used to monitor aquatic systems. We analyzed fish and macroinvertebrate data from 705 stream sites in Minnesota, USA to determine the level of concordance between the two assemblages across three nested spatial scales (statewide, ecoregion, and watershed). We also built predictive (RIVPACS) models for the two assemblages and evaluated whether concordant communities exhibited similar trends in the loss of taxa relative to reference conditions across all three scales. Finally, we evaluated the importance of various environmental variables in structuring the composition of both communities. Significant concordance between fish and macroinvertebrate communities occurred across all three scales, but concordance at a given scale was not consistently associated with significant relationships between fish and invertebrate O/E scores at that same scale. Fish and macroinvertebrate communities were largely controlled by different environmental variables, although stream size was frequently an important variable in structuring both communities.

Donald, **D**. **B**., University of Regina, Regina, Canada, donald1d@uregina.ca
Bogard, M. J., University of Regina, Regina, Canada, bogard2m@uregina.ca
Finlay, K., University of Regina, Regina, Canada, Kerri.Finlay@uregina.ca
Leavitt, P. R., University of Regina, Regina, Canada, Peter.Leavitt@uregina.ca

COMPARATIVE EFFECTS OF UREA, NITRATE, AND AMMONIUM ON PHYTOPLANKTON AND MICROCYSTIN LEVELS IN A EUTROPHIC LAKE

Eutrophication is a widespread problem facing many freshwater ecosystems. The role of phosphorus in controlling phytoplankton growth is well known, but there is uncertainty surrounding the importance of nitrogen inputs to phosphorus rich systems. To determine the effects of different nitrogen forms (urea, nitrate, ammonium) on phytoplankton abundance, community composition and toxicity, we conducted replicated mesocosm (3000 L) experiments, in a phosphorus rich (~100 ug L^{-1}) lake, for 3 weeks in July, August and September of 2008. Relative to the control, all nitrogen treatments increased algal abundance by 100-300%; however, the responses of major algal groups varied by nitrogen species. In addition, concentrations of the cyanobacterial toxin microcystin were elevated 100-600% by nitrogen amendments. Comparison between treatments revealed that nitrate stimulated toxin production in July and August, while ammonium did so in September. Urea however, elevated microcystin levels throughout the summer. In general, high microcystin concentrations were associated with the cyanobacterial genera *Microcystis* and *Planktothrix*. This provides evidence that nitrogen pollution can degrade water quality in phosphorus rich systems by stimulating the growth of non N_2-fixing, but highly toxic, cyanobacteria.

Dong, **X**. **L**., Arizona State University, Tempe, USA, xiaoli.dong@asu.edu
Grimm, N. B., Arizona State University, Tempe, USA, nbgrimm@asu.edu

EIGHT YEARS OF WETLAND EXPANSION FOLLOWED BY CATASTROPHIC LOSS IN THE PROBABLE FLOOD OF RECORD OF SYCAMORE CREEK, ARIZONA

Desert drainages of the American Southwest historically supported desert wetlands (cienegas). Cienegas reestablished in Sycamore Creek in 2001, and have persisted as an alternative stable state owing to density-dependent stabilization by wetland vegetation. We measured length and width of all patches >2x2m and recorded presence/absence at 50-m intervals of four indicator wetland-plant species over 12 km of mainstem Sycamore Creek in June 2009. Cienegas occupied 24% of the channel length, compared to 18% in 2004. Cienega patches (n=130) averaged 22.6m in length, compared to 78.6m in December 2004. This difference in size may reflect expansion and fragmentation of cienegas or seasonal change. Although just one fourth of the stream length was occupied by large cienega patches, indicator species were present at >60% of 603 sites, indicating potential for future cienega development. A catastrophic flood in January, 2010 likely exceeded the record peak discharge in 1970. Surveying

previous cienega locations in February 2010, we found virtual elimination all cienega patches, leaving a homogeneous, gravel-bed stream (the alternative state). This event provides opportunity to investigate resilience and catastrophic shifts in stream ecosystems.

Donner, **K. C.**, Idaho State University, Pocatello, USA, evolveh2o@gmail.com
Baxter, C. V., Idaho State University, Pocatello, USA, baxtcold@isu.edu
Seegert, S. Z., Great Lakes Fishery Commission, Ann Arbor, USA, sarah.e.zahn@gmail.com
Rosi-Marshall, E., Cary Institute of Ecosystem Studies, Millbrook, USA, rosimarshalle@caryinstitute.org
Kincaid, D., Cary Institute of Ecosystem Studies, Millbrook, USA, dustinkincaid@gmail.com
Kennedy, T. A., USGS Grand Canyon Monitoring and Research Center, Flagstaff, USA, tkennedy@usgs.gov
Cross, W. F., Montana State University, Bozemann, USA, wyatt.cross@montana.edu
Rogers, R. S., Arizona Game and Fish Department, Flagstaff, USA, srogers@azgfd.gov
Hall, R. O., University of Wyoming, Laramie, USA, bhall@uwyo.edu

QUALITY MATTERS: LOW DIVERSITY OF HIGH QUALITY FOOD ITEMS MAY AMPLIFY POTENTIAL FOR COMPETITION BETWEEN NATIVE AND NON-NATIVE FISHES IN A LARGE REGULATED RIVER

Interactions with non-native fishes have contributed to the decline of native Colorado River fishes. The impacts of predation by non-natives are well documented, but competition with non-natives for food may also be contributing to native fish declines. To evaluate the potential for such exploitative competition, we quantified diets for the fish assemblage in 5 segments of the Colorado River in the Grand Canyon. We sampled the diets of 12 species seasonally during 2007 and 2008. We combined diet composition, estimates of fish production, and diet item assimilation efficiency (*AE*) to estimate flows of organic matter to fish from different resources. Diet items whose *AE* is low (*Cladophora*, leaves, etc.) constituted 60-75% of material consumed by these assemblages. 30-50% of assemblage level fish production was supported by a few high quality diet items (Simuliidae, Chironomidae). Dietary overlap, reliance on a small number of high quality prey items, and seasonal variation in prey availability amplifies potential for competitive interaction between native and non-native fishes. Conversely, among these fishes trophic generalists are common, which may buffer competitive interactions if food resources are limiting.

Downing, **J. A.**, Iowa State University, Ames, USA, downing@iastate.edu

CONTINENT-SCALE MODELS OF AQUATIC SYSTEMS: A THREE-STEP KEY TO ACCURATE GLOBAL BUDGETS

Many have implied that continental aquatic systems are simply continental plumbing that delivers materials from the terrestrial to the marine parts of the biosphere. Lentic and lotic ecosystems process materials at rates that can greatly exceed those in terrestrial or marine systems, however, which makes them essential foci for inventories of global budgets. I will show that rates of aquatic processing on continents need only be 33- and 115-times greater than those in terrestrial and marine environments to dominate global budgets. Therefore, continent- and global-scale models and theories are needed that inform an accurate understanding of the role of aquatic ecosystems in major processes. I give an overview of three essential pieces to such models: scaling rules, predictive relationships, and probabilistic protocols to constrain predictions. I also discuss how the role of aquatic systems is changing due to altered abundance, configuration, eutrophication, climate, hydrology, and other basic characteristics. I accentuate the important global role of continental waters and therefore beg for continent- and global-scale models that accurately represent the broad role of lotic and lentic waters in key global cycles.

Doyle, **R. D.**, Baylor University, Waco, USA, Robert_Doyle@baylor.edu
Forbes, M. G., Baylor University, Waco, USA, Maggie_Forbes@baylor.edu
Scott, J. T., University of Arkansas, Fayetville, USA, jts004@uarc.edu

SPATIAL PATTERNS OF PLANKTONIC PRODUCTION AND RESPIRATION: A TEST OF RESERVOIR ZONATION THEORY

We found spatial patterns of planktonic production and respiration which were opposite of that predicted by reservoir zonation model. Zonation is understood as one of the main features that distinguish reservoirs from lakes and Thornton's heuristic model describing the riverine, transition and lacustrine zones is widely referenced. The model predicts phytoplankton P:R ratios will be less than unity in riverine zones due to low productivity limited by turbidity and enhanced respiration driven by allocthonous inputs. Plankton P:R ratios in the transition and lacustrine zones should increase due to improved light conditions and associated autotrophy. We characterized 16 longitudinal gradients in eight Texas reservoirs. At each site we measured planktonic production and respiration as well as the physical and water quality conditions. Our results confirmed reservoir zonation theory in that the transition zone had P:R ratios close to unity. However P:R ratios in the riverine zones were generally greater than unity and P:R ratios in the lacustrine zone were always below unity independent of lake trophic status. The overall net heterotrophy of reservoirs has significant implications for global carbon balances.

Doyle-Morin, **R. A.**, Cornell University/Lawrence University, Ithaca, USA, rad26@cornell.edu
Hairston, Jr., N. G., Cornell University, Ithaca, USA, ngh1@cornell.edu

THE BIOLOGICAL BARRIER: ASSESSING THE ROLE INTERSPECIFIC INTERACTIONS PLAY IN BUFFERING AGAINST INVADER ESTABLISHMENT IN A GREAT LAKES EMBAYMENT ECOSYSTEM

External connectivity can be particularly strong for embayment systems that are not only linked to the surrounding landscape through their watersheds, but also have a physical connection to an adjacent larger-bodied lake. This additional connection makes Great Lakes embayments especially vulnerable to the spread of invasive species, particularly given the high exchange flow processes documented between these systems. We experimentally analyzed the resistance of an embayment, Sterling Pond, to the establishment of an invasive species from Lake Ontario, even though a clear invasion pathway (upwelling-driven exchange flow) had been observed. We demonstrate that this system contained a number of internal factors that buffered against the establishment of novel species, even for organisms, (e.g. Polyphemus pediculus), that appear to be ideally adapted to the macrophyte-dominated Sterling Pond environment. Developing a clear understanding of the connection these systems have to their external environment can help us better comprehend the role these embayments play as essential intermediaries between their watersheds and the larger lake ecosystem.

Drenner, **R. W.**, Texas Christian University, Fort Worth, USA, r.drenner@tcu.edu
Chumchal, M. M., Texas Christian University, Fort Worth, USA, m.m.chumchal@tcu.edu
Wente, S. P., US Environmental Protection Agency, Arlington, USA, spwente@gmail.com

MERCURY CONTAMINATION OF LARGEMOUTH BASS IN TEXAS

Mercury (Hg) is a toxic metal that is a hazardous to humans and wildlife. Hg is found in all aquatic food webs due to widespread atmospheric Hg deposition. To evaluate Hg contamination of largemouth bass (*Micropterus salmoides*) in Texas, we compiled a data set of mercury concentrations in 3,369 largemouth bass from 204 water bodies. Our database includes original data generated in our lab and data from state and federal sources. Hg concentrations in bass were corrected for the effect of fish length, and we examined average mercury concentrations standardized to a 46-cm TL bass for each water body. Fifty-two percent of water bodies contained 46-cm TL bass with Hg above the EPA fish consumption advisory level (300 ng/g wet weight). Water bodies in the South Central Plains ecoregion in east Texas had significantly higher concentrations of Hg in bass than the three ecoregions found in central Texas. The South Central Plains ecoregion is an area of elevated deposition of Hg and sulfate. Sulfate promotes movement of Hg into food webs by stimulating production of methyl Hg by sulfate-reducing bacteria.

Droscha, **K. L.**, Michigan State University, East Lansing, USA, droscha2@msu.edu
Soranno, P. A., Michigan State University, East Lansing, USA, soranno@msu.edu

THE EFFECT OF AGRICULTURAL TYPE AND SPATIAL CONNECTIVITY ON LAKE NUTRIENTS

The effects of agriculture on freshwater nutrients have been well-studied. Most studies confirm that streams surrounded by high percentages of agriculture have elevated total phosphorus and nitrogen. However, agricultural extent alone has not always explained large amounts of variation in lake nutrients. In this study, we ask whether examining spatial connectivity and agricultural

type will improve models to predict lake nutrients. We examine this question for lake total phosphorus and total nitrogen in 543 Michigan lakes. For each lake, we delineated catchments and quantified agricultural types (row crop vs pasture) based on different levels of connectivity to the lakes. We measured connectivity using two approaches. One approach was based on equidistant buffers around inflowing streams and each lake, and another approach was based on topographically-based flow-distances. We found that relationships between land use and lake nutrients were about equal between the two measures of connectivity, but that row crop was the best predictor of lakes nutrients. This study helps direct future research to more accurately quantify landscape connectivity and extent for predicting lake nutrients.

Drummond, **J. D.**, Northwestern University, Evanston, USA, j-drummond@u.northwestern.edu

Geleskie, S. R., Stroud Water Research Center, Avondale, USA, sgeleskie@stroudcenter.org

Newbold, J. D., Stroud Water Research Center, Avondale, USA, newbold@stroudcenter.org

Packman, A. I., Northwestern University, Evanston, USA, a-packman@northwestern.edu

THE EFFECTS OF PARTICLE SIZE AND FORM ON POC DEPOSITION RATES AND DOWNSTREAM TRANSPORT IN STREAMS

Deposition in the benthic region extends the residence time of particulate organic carbon during downstream transport. To study how particle size, form, and composition influence deposition and resuspension behavior, we injected multiple types of fine POC and inorganic particles into streamside flumes at the Stroud Water Research Center. Two flumes had pre-developed benthic biofilms and two flumes were biofilm-free. A total of 20 injections were performed with 5 types of particles including DTAF-labeled Lycopodium spores (30µm), DTAF-labeled seston from the adjacent White Clay Creek (<15um), biofilm-harvested algae (<15µm), hollow glass spheres (12µm), and synthetic fluorescent polystyrene latex particles (5µm). Alternate methods for measuring the concentration of these diverse particles were compared including flow cytometry, direct microscopic counts, chlorophyll, total suspended solids, and particulate organic matter. The presence or absence of a biofilm had no consistent effect on particle deposition velocity. Natural particles and polystyrene particles deposited at a similar rate, wheras glass spheres deposited more slowly. These preliminary results suggest that, for particles <15µm, surface properties influence deposition more strongly than either density or size.

Duberg, J., Stockholm University, Stockholm, Sweden, jonduberg@hotmail.com

Ogonowski, **M.**, Stockholm University, Stockholm, Sweden, martin@ecology.su.se

Hansson, S., Stockholm University, Stockholm, Sweden, sture.hansson@ecology.su.se

INTRASPECIFIC DIFFERENCES IN DIEL VERTICAL MIGRATION REVEALED BY CARBON AND NITROGEN COMPOSITION: A STUDY OF TWO MYSID SPECIES IN A BALTIC COASTAL AREA

As a trade-off between occupying a habitat with favourable feeding/growth conditions and avoiding predators, many pelagic animals undertake diel vertical migrations (DVM). The Baltic Sea mysid shrimps *Mysis relicta* Lovén and *Mysis mixta* Liljeborg exhibit this behaviour. However, studies in both the Baltic and North American freshwater lakes show a two-layered night-time vertical distribution, with one portion of the population close to the bottom. This can reflect the presence of two groups of mysids with diverging migration patterns or can be the result of an unsynchronised DVM. Nitrogen and carbon isotopic compositions and the C:N ratio in pelagic and bottom dwelling mysids collected at night in the Baltic showed differences between the groups, in particular *Mysis relicta*. This implies that a portion of each population swims up into the pelagic zone at night, while others migrate to a much lesser extent. Since the differences were seen in muscle tissue, with a slow turnover rate, the result can not be explained by unsynchronised DVM or inter-night variation in behaviour. The results imply the presence of intraspecific groups with alternative DVM strategies.

Ducharme-Riel, V., Université du Québec à Montréal, Montreal, Canada, veronique.riel@hotmail.com

del Giorgio, **P. A.**, Université du Québec à Montréal, Montréal, Canada, del_giorgio.paul@uqam.ca

Prairie, Y., Université du Québec à Montréal, Montréal, Canada, prairie.yves@uqam.ca

WINTER AND HYPOLIMNETIC CO2 DYNAMICS IN QUÉBEC LAKES: CONTRIBUTION TO THE ANNUAL CO2 BUDGET, AND LINKS TO RESPIRATORY QUOTIENT AND SOURCES OF ORGANIC CARBON

Here we compare the whole-lake accumulation of CO2 during winter ice-cover, to that in the hypolimnion during summer stratification, in a wide range of lakes in temperate and boreal lakes in Québec, and we explore the relative importance of these two seasonal components to the annual lake CO2 budget. We further assessed the coupling between O2 and CO2 dynamics, and used Keeling based on changes in 13C-DIC to assess potential sources of organic matter fuelling winter under-ice, and summer hypolimnetic biological CO2 production. We show that winter CO2 accumulation was remarkably similar across lakes, and on average larger than hypolimnetic CO2 accumulation; together they accounted for on average over 30 % of the annual CO2 budget in across lakes. There was a close coupling between O2 and CO2 dynamics, which suggests that much of this CO2 accumulation is biologically-derived, with benthic processes accounting for over 60% of winter CO2 fluxes. Interesting, Keeling plots show that the sources of OM fuelling this CO2 accumulation are drastically different between winter under-ice and summer hypolimnia.

Duff, **J. H.**, US Geological Survey, Menlo Park, USA, jhduff@usgs.gov

Snyder, D. T., US Geological Survey, Portland, USA,

Carpenter, K. D., US Geological Survey, Portland, USA,

Lee, K. K., US Geological Survey, Portland, USA,

Avanzino, R. J., US Geological Survey, Menlo Park, USA,

Triska, F. J., US Geological Survey, Menlo Park, USA,

PHOSPHORUS AND NITROGEN LEGACY IN A RESTORATION WETLAND DURING DROUGHT: IMPLICATIONS FOR WETLAND MANAGEMENT

The effects of sediment, ground-water, and surface-water processes on the timing, quantity, and mechanisms of N and P fluxes were investigated in the Wood River Wetland, Klamath Falls, Oregon, 5–7 years after restoration. High concentrations of total P (22 mg L-1) and total N (30 mg L-1) accumulated in standing water of the closed-basin wetland when water temperature, air temperature, and evapotranspiration peaked. By August, less than 10% of the wetland area was covered with water. High positive benthic fluxes of soluble reactive P and NH4+-N were measured in June and August, averaging 46 and 24 mg m-2 d-1, respectively. Surprisingly, a wetland mass balance simultaneously indicated a net loss of P and N by assimilation, denitrification, or solute repartitioning. If climate change results in warmer, drier conditions in Upper Klamath Basin, limited water resources might be common. High nutrient concentrations pose a risk for water quality management. Improved water quality in dry years will require careful shifts in timing and magnitude of water inputs and outflows to optimize effective restoration.

Duffy, **M. A.**, Georgia Institute of Technology, Atlanta, GA, USA, duffy@gatech.edu

Housley, J. M., Georgia Institute of Technology, Atlanta, GA, USA,

Penczykowski, R. M., Georgia Institute of Technology, Atlanta, GA, USA,

Caceres, C. E., University of Illinois, Urbana, IL, USA,

Hall, S. R., Indiana University, Bloomington, IN, USA,

SCARED SICK: CHAOBORUS PREDATORS INCREASE SUSCEPTIBILITY OF DAPHNIA TO A VIRULENT PATHOGEN

Parasitism is increasing worldwide, and, at the same time, predators are being extirpated. Are these two patterns related? The "healthy herds" hypothesis suggests they may be – predators, by eating sick individuals, may reduce prey disease burden. However, ecologists increasingly recognize that, in addition to direct consumptive effects, predators can have strong indirect effects on prey. Here, we study these indirect effects. We tested for effects of Chaoborus kairomones on the susceptibility of Daphnia dentifera to the virulent yeast, Metschnikowia bicuspidata. We found that, rather than "keeping the herds healthy", predators increased disease in their prey. Daphnia exposed to

Chaoborus kairomones were 33% more likely to be infected than control hosts. In addition, for some host genotypes, parasites are able to produce more infectious stages ("spores") in the predator kairomone treatments, which would further increase disease burdens in the host populations. These data help explain a previously reported pattern: epidemics are more likely in lakes with higher densities of Chaoborus. Overall, our results show that predators can have strong indirect effects on host-parasite interactions that can reverse the "healthy herds" phenomenon.

Duhaime Johannie, **J**., University of Ottawa, Ottawa, Canada, jduha048@uottawa.ca
Morin, A., University of Ottawa, Ottawa, Canada, Antoine.Morin@uottawa.ca

COMPARING TOTAL AND EFFECTIVE IMPERVIOUSNESS AS PREDICTORS OF STREAM IMPAIRMENT

Stormwater runoff, is considered the leading cause of stream ecological alteration in urban areas. Many previous studies have used the imperviousness of a watershed as a measure of urban impact. Recent findings suggested that the effective imperviousness, the proportion of impervious area directly connected to the stream by stormsewer pipes, constitutes a better correlate of urban impairment than total imperviousness. However, the degree to which these findings apply to other systems or geographic regions is unknown. In the present study, the use of these predictors has been compared by assessing the ecological status of fish and macroinvertebrate community. Twenty nine streams in the region of Ottawa were selected to represent different magnitudes of total and effective imperviousness. Results are showing a high correlation between the two variables (r = 0.97) in highly urbanized areas. The controversy concerning the use of total or effective imperviousness as a predictor of stream impairment might not apply to all urban landscape or might apply only to sub-urban regions.

Dulaiova, **H**., University of Hawaii, Honolulu, USA, hdulaiov@hawaii.edu
Gonneea, M. E., Woods Hole Oceanographic Institution, Woods Hole, USA,
Henderson, P. B., Woods Hole Oceanographic Institution, Woods Hole, USA,
Charette, M. A., Woods Hole Oceanographic Institution, Woods Hole, USA,

LARGE SCALE ASSESSMENT OF SGD FROM RADON SURVEYS

Various forms of the coastal radon balance have been used to calculate submarine groundwater discharge (SGD) for over a decade, but no models have been applied to convert large scale radon surveys into SGD fluxes. Radon surveys have only been used as a qualitative tool to find SGD hot spots or discharge patterns along long stretches of coastlines. We created a mass balance model that is generally applicable in different coastal environments and allows for a conversion of surface water radon activity to groundwater discharge fluxes. Using this approach we calculated SGD rates along the periphery of Waquoit Bay, MA, a small bay with restricted circulation, and Boston Harbor, MA. Our results compared very well with existing groundwater discharge estimates. We also evaluated the contribution of each term in the radon balance to the final uncertainty of the derived SGD fluxes. The major sources of uncertainty were losses of radon by mixing (flushing of the bay), apparent high radon transported from upstream locations, and variability in the groundwater composition.

Dunham, J. B., U.S. Geological Survey, Corvallis, USA, jdunham@usgs.gov

LOW-FLOW DEMOGRAPHY AND SPECIES INTERACTIONS IN SMALL STREAMS: IMPLICATIONS FOR FISH AND FORESTRY INTERACTIONS

We describe demographic processes and species interactions that influence coastal cutthroat trout in small streams that are part of an effort designed to evaluate forest harvest impacts in the Trask Watershed, an industrial forest located in northwest Oregon, USA. Spatial variation in recruitment, individual growth, survival, and movement were quantified during summer low flows for three years (2007-2009). The phenology of recruitment varied substantially among sites and years. Movement during summer was limited and varied inconsistently among sites. Individual growth and survival showed consistent size-related patterns, with variability in growth showing more consistent differences among sites in different years. Processes driving these patterns are challenging to identify, but companion studies of instream cover selection, and seasonal diets of trout and other fishes suggest a strong role for the role of predators, species interactions, and seasonal food limitation. Based on these findings, we find a process-based understanding of forestry impacts may prove more useful than traditional trend-based monitoring and impact assessments.

Dunn, **S**. **T**., St. Olaf College, Northfield, USA, dunns@stolaf.edu
Marty, M. J., St. Olaf College, Northfield, USA, micahjmarty@gmail.com
Wilkinson, G. M., St. Olaf College, Northfield, USA, wilkinso@stolaf.edu
Hinrichs, A. P., St. Olaf College, Northfield, USA, hinricha@stolaf.edu
Schade, J. D., St. Olaf College, Northfield, USA, schade@stolaf.edu
Schmidt, S. N., St. Olaf College, Northfield, USA, schmidts@stolaf.edu

FACTORS INFLUENCING METHANE PRODUCTION ALONG AN ENVIRONMENTAL GRADIENT IN RESTORED WETLANDS

Wetlands are key landscape features in the global carbon cycle, but methanogenesis (the production of methane) has been shown in previous studies to be difficult to predict due to high spatial and temporal variation among relevant characteristics. Our objective in this study was to gain insight into spatial patterns in methanogenesis and its drivers, and to understand how these change over time and space. We conducted both field and laboratory assays to determine the impacts of soil moisture on methanogenesis and found that only one of three sites sampled consistently showed a significant positive relationship between soil moisture and methane production across multiple assays. This same site also showed a significant relationship between the soil organic content and methane production across those same assays. However, when all three sites and assays are taken together, the soil density and ammonification rates became significant with methane production, but the soil moisture or organic content became insignificant, suggesting that there are extremely complex interactions between the various drivers of methane production that are occurring in and between these wetland systems.

Dunne, **J**. **A**., Santa Fe Institute, Santa Fe, USA, jdunne@santafe.edu

FRONTIERS OF MARINE FOOD WEB DATA, ANALYSIS, AND MODELING: EXAMPLES FROM THE ANTARCTIC AND THE NORTH PACIFIC

Most currently used food web datasets have many flaws such as uneven resolution and underrepresentation of diversity. New, more highly and evenly resolved datasets with enriched information are starting to be compiled, providing exciting opportunities for novel research. Many of these datasets come from marine systems. I will highlight two datasets, a 492 species food web of the Antarctic Weddell Sea with diverse trait information for each species (e.g., stable isotope values), and a 172 species food web for an Aleutian intertidal ecosystem which includes human hunter-gatherers as a node and also has trophic interaction data at spatial scales from the quadrat to the archipelago. These datasets, in conjunction with methods for studying complex systems such as network analysis, non-linear dynamical modeling, information theory, agent-based modeling, and Bayesian approaches are allowing investigation of ecological network structure and dynamics with a level of detail and rigor not previously possible. If time allows, I will also discuss marine and freshwater paleofoodweb datasets and analyses that are pushing our understanding of aquatic ecosystem organization and function back through deep time.

Dupuis, **A**. **P**., Fisheries and Oceans Canada, Winnipeg, Canada, alain.dupuis@dfo-mpo.gc.ca
Paterson, M. J., Fisheries and Oceans Canada, Winnipeg, Canada,
Turner, M. A., Fisheries and Oceans Canada, Winnipeg, Canada,
Findlay, D. L., Fisheries and Oceans Canada, Winnipeg, Canada,
Mills, K. H., Fisheries and Oceans Canada, Winnipeg, Canada,

THE ROLE OF DIRECT AND INDIRECT STRESSORS ON ZOOPLANKTON: A CASE STUDY FROM A WHOLE-LAKE ACIDIFICATION EXPERIMENT

In lake ecosystems, it is often difficult to determine the relative contributions and interactions of direct and indirect stressors on biota. Identification of key mechanisms driving change in disturbed lakes is needed to make predictions and to understand processes related to biological response during stress and recovery. We studied zooplankton populations during a long-term (1982-2004) whole-lake acidification and recovery experiment in Lake 302S at the Experimental Lakes Area, Ontario, Canada. Our approach was to use both empirical data and a mechanistic model to tease apart the relative impacts of direct H^+ toxicity effects and of indirect acidification effects on zooplankton population response. Indirect impacts of acidification in Lake 302S include changes to thermal conditions, increased light penetration, changes in phytoplankton dominance from chrysophytes to dinoflagellates, changes in inter-specific competition, and planktivory from fish and *Chaoborus* larvae. We suggest that zooplankton population density was affected by H^+ toxicity but that the altered bottom-up and top-down trophic relationships also played an important role in determining stress and recovery trajectories.

Durance, I., Cardiff School of Biosciences, Cardiff, United Kingdom, stoidp@cardiff.ac.uk
Ormerod, **S. J.**, Cardiff School of Biosciences, Cardiff, United Kingdom, ormerod@cardiff.ac.uk

EVIDENCE FOR THE ROLE OF CLIMATE IN THE LOCAL EXTINCTION OF A COOL-WATER TRICLAD

We tested three hypotheses to explain the local extinction of one of two sympatric planarians (Crenobia alpina and Phagocata vitta) during a 25 year study of Welsh headwaters involving: 1) long-term chemical change; 2) inter-specific competition; 3) climatic variation. Coexistence between C. alpina and P vitta was confined to high prey abundance and summer temperatures < 12.5 C, while P. vitta dominated at higher temperature, greater discharge and lower prey-abundance. The loss of C. alpina then coincided with the largest ever positive amplification of the North Atlantic Oscillation in 1989-1994, accompanied by increased stream temperature, increased winter discharge, summer droughts and reduced prey abundance. We suggest that inter-specific competition acted in concert with this prolonged climatic event to favour P. vitta over C. alpina. Our data illustrate how extreme climatic variations can affect small, fluctuating populations. However, this case study demonstrates the difficulty of identifying unequivocally the exact climatic processes causing extinction where i) evidence is confined to weak inference; ii) there are non-linear responses to climatic events and iii) there are complex interactions between climatic and ecological processes.

Dye, **S. E.**, U.S. EPA Region 4, Athens, GA, USA, dye.sue@epa.gov
Decker, C. D., U.S. EPA Region 4, Athens, GA, USA, decker.chris@epa.gov

WHAT CONTROLS ALGAL BIOMASS IN SANDY-BOTTOM STREAMS? IMPLICATIONS FOR THE DEVELOPMENT OF STREAM NUTRIENT CRITERIA.

Few studies have examined epipsammic periphyton response to nutrient enrichment or light availability in lotic systems, even though sand may be the predominant substrate available for benthic algal growth in heavily disturbed areas. We investigated whether epipsammic algae can respond to increased nutrients and light, despite limitations caused by flow disturbance and substrate instability. We sampled sandy substrate under open and closed canopies in eight streams within the Piedmont ecoregion of northeastern Georgia. Algal biomass was significantly higher in open vs. full canopy transects in all streams, but was not positively related to nutrient concentrations. Although nutrients in some study streams were at levels which can cause abundant algal growth in rocky-bottom streams, algal biomass in study streams was substantially lower. With many U.S. States currently using narrative stream nutrient criteria based on "nuisance levels" of algae, this disconnect between nutrient concentrations and algal biomass has important implications for nutrient criteria development in sandy-bottom streams. Although there may not be "nuisance levels" of algae in sandy stream reaches, nutrient concentrations could be high enough to cause ecological imbalances downstream.

Dyer, **F. J.**, eWater Cooperative Research Centre and the Institute for Applied Ecology, University of Canberra, Canberra, Australia, fiona.dyer@canberra.edu.au

PREDICTING ECOLOGICAL RESPONSE TO LAKE WATER LEVEL VARIATION: THE CASE FOR HARVESTING WATER FROM URBAN LAKES

Constructed urban lakes provide important water quality and flood management services to urban areas. They are also highly valued by local communities for the recreational, aesthetic and conservation function they provide in an otherwise biologically impoverished environment. The values associated with urban lakes are intrinsically linked to their ecological functioning which is, in part, driven by the hydrological regimes they experience. Drought in Australia has pressured harvesting water from urban lakes and ponds, fundamentally changing the frequency, duration and timing of the inundation experienced by the lakes edges. Changing the water regime of a lake will introduce conditions that existing aquatic communities may not have the physiological or life cycle traits to survive and thus adversely affect the ecological functionality provided by the lakes. Historical data, field observations and information from published case studies have been incorporated into a Bayesian network model to predict the ecological responses of the lake edge communities. Modelling indicates that water level variation can be increased considerably without adverse effect and, if carefully managed, may diversify the aquatic communities at lake margins.

Dzialowski, **A. R.**, Oklahoma State University, Stillwater, USA, andy.dzialowski@okstate.edu

ZEBRA MUSSELS ALTER PLANKTON RESPONSES TO NUTRIENT ENRICHMENT IN EXPERIMENTAL MESOCOSMS

The impacts of nutrient enrichment on aquatic ecosystems have been well documented. Less well known, however, is how these impacts vary in response to additional stressors. One such stressor that may alter how ecosystems respond to nutrient enrichment is the invasive zebra mussel. Experimental mesocosms (80 L) were used to determine how nutrient enrichment impacted algal biomass and zooplankton community structure in both the presence and absence of zebra mussels. Nutrient enrichment generally resulted in increases in algal biomass; however, these effects were at least partially negated in mesocosms that also had zebra mussels. In contrast, zebra mussels did appear to promote the growth of attached algae in some mesocosms. The effects of nutrient enrichment on zooplankton community structure also varied depending on whether zebra mussels were either present or absent in the mesocosms. Combined, these results suggest that zebra mussels have the potential to alter how plankton respond to nutrient enrichment in invaded ecosystems. However, additional studies are needed to verify these results under more natural conditions.

Ebersole, **J. L.**, US EPA, Corvallis, USA, ebersole.joe@epa.gov
Wigington, P. J., US EPA, Corvallis, USA, wigington.jim@epa.gov
Leibowitz, S. G., US EPA, Corvallis, USA, leibowitz.scott@epa.gov
Comeleo, R. L., US EPA, Corvallis, USA, comeleo.randy@epa.gov

HYDROLOGIC LANDSCAPE REGIONS FOR PREDICTING AND GENERALIZING THE REFUGE FUNCTION OF INTERMITTENT AND EPHEMERAL STREAMS

Intermittent and ephemeral (IE) streams can provide important functions within stream networks. Understanding the relative benefit provided to downstream waters is needed to better inform watershed management. Although the potential functions of IE streams are relatively well known, predicting and generalizing the relative contributions of these streams remains a challenge. To address this need, we explored the potential for IE streams to provide summer thermal refuge for coldwater fish in two basins in northeast Oregon. We surveyed IE streams at their confluence with warm (<18°C) perennial streams in both basins in late July 2008 and 2009 to identify potential thermal refuges. The occurrence of potential thermal refuges at confluence zones differed markedly between basins. Differences in streamflow characteristics, water temperature, and geomorphology among sites were associated with geologic and climatic setting. We propose that Hydrologic Landscape Regions (Leibowitz et al, this session), designed to capture variation in geologic and climatic factors influencing stream hydrology, may provide a useful template for both predicting and generalizing the potential refuge functions of IE streams.

Eby, **L. A.**, University of Montana, Missoula, USA, lisa.eby@umontana.edu
Roach, J. W., Symbiotic Software, Missoula, USA,

THE EVER-CHANGING FACE OF FISH COMMUNITIES IN THE ROCKY MOUNTAIN WEST: IMPLICATONS FOR ECOSYSTEM SERVICES

Across the globe, exotic fish populations have been established in freshwater systems to enhance recreational fisheries. Stocked fishes are often top predators that may replace native predators, increase species richness, and/or extent food-chain length. Due to large declines in the abundance and range of many native inland trout species, aquatic restoration activities have proliferated in attempts to push fish communities back towards a native species assemblage. The direct effects of restoration activities on fish communities may be monitored, but ecosystem consequences are seldom quantified. As societal values and fish management objectives evolve, we need to determine how these altered food-webs and cross-ecosystem linkages impact nutrient retention, fisheries production, and other key ecosystem services. In this talk, we highlight the major community shifts occurring in the Rocky Mountain region and their potential effects on ecosystems. As conservation goals focus more and more on ecosystem services, fish ecologists must address the relative role of native versus nonnative species assemblages as drivers of ecosystem processes, as well as, how our modification of food-web structure produces ecosystem-level effects.

Edgerton, **J**. **M**., Kent State Univeristy Department of Biological Sciences, Kent, OH, USA, jedgerto@kent.edu

Baxter, A. M., Kent State University Department of Biological Sciences, Kent, OH, USA, abaxter4@kent.edu

Johnson, L. T., Indiana University School of Public and Environmental Affairs, Bloomington, IN, USA, latjohn@indiana.edu

Royer, T. V., Indiana University School of Public and Environmental Affairs, Bloomington, IN, USA, troyer@kent.edu

Leff, L. G., Kent State University Department of Biological Sciences, Kent, OH, USA, lleff@kent.edu

BACTERIAL RESPONSES TO CARBON ENRICHMENTS IN A HEADWATER AGRICULTURAL STREAM

Excess nitrogen is a water quality problem in many agricultural regions. Denitrification can reduce in-stream nitrogen loads if labile carbon is available. Labile carbon can influence denitrification rates by altering denitrifier community structure and/or function. In this study, Sugar Creek in Shirley, Indiana was enriched with acetate and formate to 5 mg C/L over five days in 2009. Sediment samples for microbial analysis were collected before and after enrichment. Molecular methods included terminal restriction fragment polymorphism of nosZ (nitrous oxide reductase), quantification of bacterial abundance using qPCR for 16S rRNA genes, and quantification of nosZ. All samples contained nosZ and preliminary analysis revealed between 19 and 32 peaks from T-RFLP. Bacterial density based on DAPI counts ranged from 5.63x106 to 1.03x107 cells/g dry mass pre-enrichment, and from 5.09x106 to 9.55x107 cells/g dry mass post-enrichment. In spite of this modest increase in numbers, carbon enrichment resulted in visible growth of "sewage fungus" (putatively the bacterium, Sphaerotilus). Understanding bacterial responses to carbon additions will elaborate connections among carbon availability, community structure, and denitrification efficiency, revealing elements that underlie an essential ecological process.

Edmonds, **J**. **W**., University of Alabama/Biological Sciences, Tuscaloosa, USA, jwedmonds@bama.ua.edu

Ansorge, K. E., University of Alabama/Biological Sciences, Tuscaloosa, USA, keansorge@crimson.ua.edu

Gee, K. N., University of Alabama/Biological Sciences, Tuscaloosa, USA, kngee@crimson.ua.edu

Jarnigan, J. R., University of Alabama/Biological Sciences, Tuscaloosa, USA, jrjarnigan@crimson.ua.edu

Ward, A. K., University of Alabama/Biological Sciences, Tuscaloosa, USA, award@as.ua.edu

RESPONSE OF MICROBIAL COMMUNITY COMPOSITION TO WETLAND LEGACIES IN STREAM NETWORKS

Beaver dams create wetlands that are fundamentally different from other wetlands. Their geomorphic position in the landscape, short persistence at a particular location, and close association with human management make them dynamic, but understudied as a component of low-gradient stream networks in the southeastern US. In these ecosystems beavers create a mosaic of patches that vary in time since dam failure and conversion of the wetland back to a stream configuration. This work relates beaver dam demise in a Coastal Plain stream (Payne Creek) to bacterial community composition in benthic sediments. We used a molecular "fingerprint" analysis (T-RFLP) to test the prediction that the influence of beaver-created wetlands on sediment bacterial communities is evident as long as two decades after a wetland drains. Significant differences in samples from 3 stream reaches, collected 9 times from January-October, 2009, suggest this wetland legacy is present, likely mediated through differences in organic matter abundance and bioavailability. Metagenomic data will be used to substantiate these findings and suggest functional differences between stream microbial communities within and outside reaches once occupied by beaver wetlands.

Edwards, **B**. **A**., University of Toronto, Toronto, Canada, brie.edwards@utoronto.ca

Jackson, D. A., University of Toronto, Toronto, Canada, don.jackson@utoronto.ca

Somers, K. M., Ontario Ministry of the Environment, Dorset, Canada, keith.somers@ontario.ca

INVESTIGATIONS INTO THE EFFECTS OF DECLINING CALCIUM ON FRESHWATER CRAYFISH

The inland waters of the Precambrian Shield are facing an emerging ecological threat due to ongoing declines of various essential nutrients, especially calcium. It is believed that organisms with high calcium requirements, such as crustaceans, may be the first indicators of the negative effects of this phenomenon on aquatic ecosystems. However, very little is known about the calcium requirements of such organisms, or how the availability of calcium may shape community composition and species distributions. Here we detail the development of field- and laboratory-based research into the potential impacts of calcium declines on an important crustacean taxon, the freshwater crayfish. Previous work documenting significant declines of crayfish in the Shield region has indicated that calcium declines may be a contributing threat. Investigations in the field relate the amount of calcium acquired in the exoskeleton of adult crayfish of different species to a range of calcium availabilities in lakes. Laboratory experiments are also being undertaken to investigate the threshold calcium requirements for growth and survival of juvenile crayfish, and again to relate calcium availability to calcium acquisition. We provide overviews of both our field- and lab-based findings.

Eggert, **S**. **L**., USDA Forest Service, Grand Rapids, MN, USA, seggert@fs.fed.us

Moerke, A. H., Department of Biology, Lake Superior University, Sault Ste. Marie, WI, USA, amoerke@lssu.edu

Stelzer, R. S., Department of Biology and Microbiology, University of Wisconsin, Oshkosh, WI, USA, stelzer@uwosh.edu

Kolka, R. K., USDA Forest Service, Grand Rapids, MN, USA, rkolka@fs.fed.us

INVERTEBRATE COMMUNITIES ASSOCIATED WITH WOOD IN HEADWATER STREAMS OF THE HURON MOUNTAINS, MI

Wood serves as an important habitat for macroinvertebrates in stream ecosystems, particularly in sediment-impacted streams. We quantified wood standing crops and invertebrate biomass associated with wood, sand, and cobble-riffle habitats in the headwaters of the Salmon Trout River and Elm Creek in the Huron Mountains of Michigan's upper peninsula during 2006-2007. Although relatively pristine, the streams have been impacted by the input and transport of sand from past land use (agriculture and logging) in Elm Creek and recent disturbances associated with logging and mining in the Salmon Trout River. Small wood made up 32-39% of the total wood standing crop (3.8 – 9.9 kg AFDM/m2) in Elm Creek and the Salmon Trout River, respectively. Invertebrate taxa richness was similar among habitats, although small wood supported 5-10 taxa not found in sand habitats. Proportionately, invertebrate biomass on wood in the Salmon Trout was dominated by large shredders (e.g. Pteronarcys) > gatherers > predators > filterers > scrapers, whereas biomass on wood in Elm Creek was dominated by small gatherers (e.g. Chironomidae) > scrapers > predators > filterers > shredders.

Ejarque, **E**., University of Barcelona, Department of Ecology, Barcelona, Spain, elisabet.ejarque@ub.edu

Butturini, A., University of Barcelona, Department of Ecology, Barcelona, Spain, abutturini@ub.edu

LONGITUDINAL CHANGES IN DISSOLVED ORGANIC CARBON QUANTITY AND QUALITY RELATED TO HYDROLOGICAL CONDITIONS IN A MEDITERRANEAN FLUVIAL SYSTEM

Dissolved organic carbon (DOC) in fluvial systems has been found to be closely related to hydrology in quantitative terms. However, little is known about the qualitative changes it undergoes during its transport along a river continuum. In order to test how contrasted hydrological conditions may differently shape DOC compositional variations along a river, the Mediterranean catchment of La Tordera (870 km2) was sampled along its main channel (60 km). Six samplings were conducted under a range of hydrological states, from flood to drought. DOC was characterised by analysing its concentration and optical properties. Under flood conditions humic substances dominate DOC composition and its optical properties remain invariable irrespective of space, suggesting that solute transport dominates over local processing. Conversely, as the river dries up, the relevance of protein-like substances increases, and a spatial patchiness of DOC optical properties emerges. This implies that local processes become more influent than transport in defining DOC dynamics. These results indicate that the hydrological conditions determine the magnitude of variation of DOC quality across space, where the driest conditions entail a maximal manifestation of DOC heterogeneity.

Eklöf, **J**. **S**., Groningen University, Groningen, Netherlands, j.eklof@rug.nl
van der Heide, T., Groningen University, Groningen, Netherlands, t.van.der.heide@rug.nl
Donadi, S., Groningen University, Groningen, Netherlands, s.donadi@rug.nl
van der Zee, E., Groningen University, Groningen, Netherlands, els.vanderzee@nioz.nl
Eriksson, B. K., Groningen University, Groningen, Netherlands, b.d.h.k.eriksson@rug.nl

INTERACTIONS BETWEEN SCALE-DEPENDENT DISTURBANCE AND COUNTERACTING ECOSYSTEM ENGINEERING SHAPE AN INTERTIDAL ECOSYSTEM

Ecosystem engineers shape landscapes by modifying the environment. Such habitat modification can result from positive engineering feedbacks, but also from counteracting feedbacks by competitors. Since engineering effects typically exceed engineers spatial- temporally, the spatial structure of engineered ecosystems should be controlled by an interaction between the scale of disturbance and the strength of feedbacks. Here, we investigated how these factors shape an intertidal landscape characterized by alternating hummocks (low tide elevations) with seagrass (*Zostera noltii*), and hollows (low tide pools) with a bioturbating worm (*Arenicola marina*). In summer, seagrasses excluded worms on hummocks but invaded hollows regardless of worm presence and hollow size. In autumn, waterfowl grazing selectively removed colonizing seagrasses in 1 m^2 clearings, and in 0.25 m^2 clearings where worms had been added. This effect was caused by erosion – in the large clearings due to lack of seagrass stabilization, in the medium by lack of seagrasses exacerbated by worm bioturbation – which formed hollows large enough to facilitate grazing. In summary, we demonstrate that scale-dependent effects of disturbance interact with ecosystem engineering feedbacks, to maintain hummocks and hollows as alternative states.

Eller, **K**. **T**., Florida State University, Tallahassee, USA, eller@ocean.fsu.edu
Fitzhugh, L. M., Florida State University, Tallahassee, USA,
Chanton, J. P., Florida State University, Tallahassee, USA,
Burnett, W. C., Florida State University, Tallahassee, USA,

EVALUATION OF RADIUM ISOTOPE SAMPLING METHODS AND APPLICATION FOR DETERMINING RESIDENCE TIME IN A NON-RIVER DOMINATED ESTUARY

Radium isotopes (^{224}Ra, ^{223}Ra, ^{228}Ra, ^{226}Ra) have proven useful for determining the residence time of waters within a river dominated estuary on the Florida Gulf coast. The objectives of this study were two-fold: 1) to determine whether this approach could be applied in a non-river dominated estuary near Panama City, Florida and 2) to determine the relationship between two sampling methods. The methods tested include grab sampling, where 55-65 liters of water are pumped across Mn-fibers, versus deploying the fibers on moorings for extended periods. Samples were collected throughout 2009 including a 24-hour tidal experiment specifically designed to investigate the relationship between the sampling methods. The grab samples and mooring activity ratios strongly agreed. The tidal experiment revealed that the moorings represent an average radium activity over the entire deployment period; proving it as a useful value for calculating residence time. The isotope ratios were generally low and relatively indistinguishable across the estuary. Without a strong isotopic signature from a dominate freshwater source, the use of radium isotopes to determine residence time is difficult to apply.

Elliott, **J**. **A**., Centre for Ecology and Hydrology, Lancaster, United Kingdom, alexe@ceh.ac.uk

CLIMATE CHANGE AND PHYTOPLANKTON IN LAKES: WILL THE FUTURE BE BLUE-GREEN?

Over recent years, there has been much speculation about how the predicted changes in climate will impact on freshwater ecosystems. Of particular concern is how Cyanobacteria species (blue-green algae) will be affected and the consequences for water quality. Here, this issue is examined using a well-tested process-based phytoplankton community model (PROTECH). The simulation results of several studies on UK lakes are presented and the relative importance of climate and local factors, such as nutrient status, are evaluated. Particular focus is given to the Cyanobacteria and how these results could apply to temperate region lakes in general.

Ellis, **B**. **K**., The University of Montana, Flathead Lake Biological Station, Polson, USA, bonnie.ellis@umontana.edu
Stanford, J. A., The University of Montana, Flathead Lake Biological Station, Polson, USA, jack.stanford@umontana.edu

MARINE NUTRIENT SUBSIDY IN NORTH PACIFIC RIM RIVERS

We examined the role of marine derived nutrients (MDN) on productivity and biodiversity in 5 North Pacific Rim rivers that have variable salmon runs. The rivers also vary in water chemistry (brown, clear) and geomorphology (complex, simple). Stable nitrogen isotopes were used to examine trophic structure while natural abundances of stable carbon isotopes were used to trace the flow of organic matter from primary producers to consumers. Marine nitrogen (N) and carbon (C) subsidy was stronger in streams receiving greater runs of salmon and was significantly higher following high returns of pink salmon. One of the major differences observed between food webs of rivers with robust salmon runs and those with few salmon was the lack of a marine signal in the invertebrates of rivers with low salmon runs. Preliminary observations suggest there are major differences in the processing of carcasses in rivers of different hydrogeomorphology and that MDN influence was significantly higher in complex systems. We concluded that food webs are strongly influenced by MDN but the outcome is moderated by the ecological setting.

Eloranta, **A**. **P**., University of Jyvaskyla, Jyvaskyla, Finland, antti.eloranta@jyu.fi
Siwertsson, A., University of Tromso, Tromso, Norway, anna.siwertsson@uit.no
Knudsen, R., University of Tromso, Tromso, Norway, rune.knudsen@uit.no
Kahilainen, K. K., University of Helsinki, Helsinki, Finland, kimmo.kahilainen@helsinki.fi
Jones, R. I., University of Jyvaskyla, Jyvaskyla, Finland, roger.i.jones@jyu.fi
Praeble, K., University of Tromso, Tromso, Norway, kim.praebel@uit.no
Amundsen, P. A., University of Tromso, Tromso, Norway, per-arne.amundsen@uit.no

RESOURCE PARTITIONING BETWEEN ARCTIC CHARR, EUROPEAN WHITEFISH AND EUROPEAN GRAYLING IN SUBARCTIC LAKES

Introduction of European whitefish (*Coregonus lavaretus* L.) has resulted in serious decline or local extinction of native Arctic charr (*Salvelinus alpinus* L.) populations in many subarctic lakes across northern Europe. In some lakes, however, substantial populations of these two species naturally co-occur, often together with European grayling (*Thymallys thymallus* L.). We combined stable carbon and nitrogen isotope mixing models and conventional diet and habitat analyses to study resource partitioning of Arctic charr populations coexisting with whitefish and grayling in four subarctic lakes at different altitudes (381-540 m a.s.l.) in northern Norway. Preliminary results indicate that these species generally segregated into distinct trophic niches with whitefish typically dominating in the pelagic niche, grayling in the littoral niche, and charr in the sublittoral and profundal niches. However, in the uppermost lake, charr was the most abundant species, dominating in all habitats and even having a more pelagic niche than whitefish. Resource partitioning patterns and possible mechanisms behind the stable coexistence of the three species are discussed.

Elosegi, **A**., The University of the Basque Country, Bilbao, Spain, arturo.elosegi@ehu.es
Antón, A., The University of the Basque Country, Bilbao, Spain, alvaro.anton@ehu.es
Díez, J. R., The University of the Basque Countryy, Bilbao, Spain, joseramon.diez@ehu.es
Flores, L., The University of the Basque Country, Bilbao, Spain, lflores004@ikasle.ehu.es
García-Arberas, L., The University of the Basque Country, Bilbao, Spain, loreto.garcia@ehu.es
Rallo, A., The University of the Basque Country, Bilbao, , ana.rallo@ehu.es

RESTORING LARGE WOOD IN BASQUE MOUNTAIN STREAMS: EFFECTS ON ECOSYSTEM STRUCTURE AND FUNCTIONING

Following a BACI design, large wood was introduced into 4 stream reaches in the Basque Country, Spain, to restore habitat quality and ecosystem functioning, and to reduce sediment inputs into a downstream reservoir. Control and experimental reaches (100 to 400 m long) were monitored for two years before, and two years after wood addition. Introduction of wood increased channel width and depth, as well as hydraulic and nutrient retention. These effects decreased with time in the largest streams, as floods rearranged some of the

wood structures, but remained in the small streams. The areal cover of fine sediments increased, producing agradation of stream channels, and deposition of gravel bars up to 1 m deep. Benthic storage of organic matter increased 2- to 70-fold, and reach-scale breakdown was enhanced. Density and taxa richness of benthic invertebrates increased, and fish biomass increased up to 6 fold, especially in winter. The results showed the importance of large wood for the structure and functioning of forested headwater streams, and that it can produce large effects in a very short time.

El-Sabaawi, **R**. **W**., University of Victoria , Victoria, U.S. Virgin Isles, rana@uvic.ca
Thomas , S. A., University of Nebraska , Lincoln, U.S. Virgin Isles, sthomas5@unlnotes.unl.edu
Flecker, A. S., Cornell, Ithaca, USA, asf3@cornell.edu
Dodds , w. k., Kansas State, Manhattan, USA, wkdodds@k-state.edu
Fraser, D., Siena College, Loudonville, USA, FRASER@siena.edu
Gilliam , J., North Carolina State, Raleigh , USA, james_gilliam@ncsu.edu
Heatherly , T. N., University of Nebraska, Lincoln , USA, heatherly75@yahoo.com
Lamphere, B. A., North Carolina State, Raleigh , USA, brad_lamphere@ncsu.edu
Marshall, M. C., University of Georgia, Athens, USA, trinidad@uga.edu
Pringle, C., University of Georgia , Athens, USA, cpringle@uga.eda
Reznick, D. N., University of California, Riverside, USA, david.reznick@ucr.edu
Lopez-Sepulcre, A., University of California, Riverside, USA, andresls@ucr.edu
Zandonà, E.,Drexel University, Philadelphia, USA, ez34@drexel.edu

QUANTIFYING ECOLOGICAL AND EVOLUTIONARY EFFECTS ON TROPHIC FLOWS IN NEOTROPICAL STREAMS

Life history evolution can occur on time-scales similar to ecological processes. As they evolve, changes can occur in the ways animals alter their environments, thus causing feedbacks on evolutionary trajectories. Here we use whole-stream additions of 15N-NH4 to characterize potential changes in trophic flows in response to life history evolution of guppies (Poecilia reticulata) and Rivulus hartii under ambient and enhanced authochthonous production. We present trophic flows from the first three years of an experiment that manipulates production and fish evolution using canopy manipulations and guppy introductions. We compare and contrast several modeling approaches to estimating trophic fluxes (exponential decay, box "ecosystem" models, and mass balance models). Opening the canopy enhanced N fluxes in grazers, scrapers and predators, but not shredders. Juvenile R. hartii were more responsive to enhanced autochtonous production than larger R. hartii, while the introduction of P. reticulata altered patterns of N flux in some invertebrate taxa. We discuss these findings in light of eco-evolutionary feedbacks, with emphasis on how different methods of modeling N flux can be used to address ecological and evolutionary questions.

Elser, **J**. **J**., Arizona State University, Tempe, USA, j.elser@asu.edu
Kyle, M., Arizona State University, Tempe, USA,
Peace, A. L., Arizona State University, Tempe, USA,
McCrackin, M. L., Arizona State University, Tempe, USA,
Wojewodzic, M., University of Oslo, Oslo, Norway,
Andersen, T., University of Oslo, Oslo, Norway,
Hessen, D. O., University of Oslo, Oslo, Norway,

EFFECTS OF ATMOSPHERIC N DEPOSITION ON PLANKTON NUTRIENT LIMITATION: DOES AIR POLLUTION MAKE JUNK FOOD IN LAKES?

One legacy of CR Goldman has been his work on the joint roles of N and P in controlling phytoplankton production in lakes. In this study we show that atmospheric N deposition is associated with accentuated P limitation in lake districts receiving elevated N deposition in both Colorado and Scandinavia. Furthermore we tested if these shifts have affected higher trophic levels by altering food quality (since it is known that P-limited phytoplankton are poor quality food and can induce direct P limitation of zooplankton). We used a newly developed, highly sensitive analysis for the inducible enzyme alkaline phosphatase (AP). AP activity has recently been shown to be up-regulated in P-limited Daphnia, as it is in phytoplankton and bacteria. Consistent with the hypothesized effect of N deposition on zooplankton P limitation, AP levels (normalized to protein) are significantly higher in zooplankton in high deposition lakes, especially for Holopedium and Daphnia. These data are the first to indicate that elevated N deposition may have negative effects on lake trophic dynamics by generating stoichiometric imbalance at the zooplankton-phytoplankton interface.

Encalada, **A**. **C**., IMAR-CMA, University of Coimbra, Coimbra, Portugal, andreae@ci.uc.pt
Canhoto, C. M., IMAR-CMA, University of Coimbra, Coimbra, Portugal, ccanhoto@ci.uc.pt
Graca, M. A., IMAR-CMA, University of Coimbra, Coimbra, Portugal, mgraca@ci.uc.pt

DECOMPOSITION IN A TROPICAL RAINFOREST STREAM: FEWER DECOMPOSERS OR HARDER LEAVES?

We compared breakdown rates of leaves differing in quality (N:P ratios, lignin and phenols) in an Amazonian tropical stream in Ecuador. We used three tropical tree species Inga sp., Triplaris sp. and Sygia sp. and one temperate tree Alnus glutinosa, and coarse and fine mesh bags to discriminate between microbial and invertebrate decomposition. Samples were incubated in the stream and recovered after 7, 14, 28, 56 and 94 days to allow estimation of litter decay rates. We analyzed invertebrate shredders associated with coarse mesh bags. Among the tropical species, Triplaris decomposed faster than Inga and Sygia and none of them showed significant differences in breakdown rates between coarse and fine mesh bags. Invertebrates had a higher relative contribution to litter disappearance compared to microbial decomposers for Alnus leaves. Moreover, Alnus leaves decomposed faster and its bags had more shredders than any of the tropical leaves. Decomposition rates of the different species were positively related to initial N leaf content and shredders abundance, and negatively to leaf hardness and phenolic content, which supports the notion that litter quality controls decomposition rates.

Engelhardt, C., Research Institute Senckenberg, Gelnhausen, Germany, engelhardt197@googlemail.com
Haase, P., Research Institute Senckenberg, Gelnhausen, Germany, peter.haase@senckenberg.de
Pauls, **S**. **U**., University of Minnesota, St Paul, USA, pauls497@umn.edu

FROM THE WESTERN ALPS ACROSS CENTRAL EUROPE: POSTGLACIAL RECOLONISATION OF THE TUFA STREAM SPECIALIST RHYACOPHILA PUBESCENS (INSECTA, TRICHOPTERA)

Dispersal rates result from dispersal capacity, dispersal behaviour, and connectivity of occupied habitat. Dispersal of species that are highly specialised to a certain habitat is limited by habitat availability. Species inhabiting very stable environments may adopt a sedentary life-style. Both factors should lead to strong genetic differentiation in highly specialised species inhabiting stable environments. We examined the genetic population structure and phylogeography of a highly specialised freshwater insect that occurs in very stable habitats: tufa springs. Using range-wide mtCOI sequence and AFLP data from 333 individuals of Rhyacophila pubescens we inferred Pleistocene refugia and postglacial colonisation routes, and examined ongoing local differentiation. Our results showed intraregional differentiation with a high number of locally endemic haplotypes, that we attributed to habitat specificity and low dispersal rates of R. pubescens. We observed high levels of genetic diversity south of the Alps and genetic impoverishment north of the Alps. An assignment test and estimates of migrants placed the refugium and the source of the colonisation in the Dauphiné Alps (SW Alps). We also demonstrated that specialisation to a stable environment promoted a behavioural shift to decreased dispersal, leading to greater local population differentiation than in less specialised aquatic insects.

Engman, **A**., University of Puerto Rico, San Juan, Puerto Rico, gusengman@gmail.com
Ramirez, A., University of Puerto Rico, San Juan, Puerto Rico, alonso.ites@gmail.com

THE EFFECTS OF FLOW REDUCTIONREDUCED FLOW ON LEAF DECOMPOSITION RATES IN A TROPICAL URBAN STREAM

Leaf decomposition is an important ecosystem process that may be impaired in urbanized watersheds where flow regime is altered. Leaf breakdown occurs in part due to physical fragmentation caused by stream flow. We assessed the effects of reduced flow on leaf litter breakdown in a highly urbanized stream in the San Juan metropolitan area, Puerto Rico. We designed a leaf bag experiment using plastic tube enclosures to reduce flow effects and cylinders made of plastic mesh (1cm openings) as controls. Percent mass loss was quantified over a 90 d period (10 intervals). Leaf breakdown was significantly faster in controls ($k = 0.011$) than in reduced flow ($k = 0.007$) treatments ($p = 0.02$). Differences in total leaf mass were greatest on sampling dates following large spates in discharge after storm and flood events. Results suggest that, in this urban stream, physical factors resulting from altered flow regimes can influence leaf

decomposition rates negatively. Impairment of this ecosystem process is likely to have detrimental consequences for the stream food web as well as organic matter processing at larger scales.

Enrich-Prast, **A**., University Federal of Rio de Janeiro, Rio de Janeiro, Brazil, aenrichprast@gmail.com
Marotta, H., University Federal of Rio de Janeiro, Rio de Janeiro, Brazil, humbertomarotta@gmail.com
Barroso-Santos, M. C., University Federal of Rio de Janeiro, Rio de Janeiro, Brazil, mcbs_rj@ibest.com.br

NHX EMISSIONS FROM AN EUTROPHIC TROPICAL LAKE

NHx can be release from lakes to the atmosphere and can cause acid rain and increase in nitrogen concentrations in the surrounding environments. NHx emissions have been mostly described for wastewater treatment plant and very few aquatic environments. Our aim was to assess NHx emissions rates to the atmosphere from an urban impacted coastal lagoon (Lagoa Rodrigo de Freitas, RJ, Brazil) and to evaluate what are the main regulating factors of this emission. NHx concentrations were measured by colorimetric methods and air-water NHx fluxes were estimated based on differences of liquid and gas phases. NHx concentrations doubled within a short-term of hours, and changed in some orders of magnitude along the last two decades. Air-water NHx fluxes variations on a short or long time scale were higher than changes in NHx concentrations, as it is also influenced by wind, salinity and temperature changes.

Ensign, **S**. **H**., University of North Carolina at Chapel Hill, Chapel Hill, NC, USA, ensign@email.unc.edu
Piehler, M. F., University of North Carolina at Chapel Hill, Chapel Hill, NC, USA, mpiehler@email.unc.edu
Doyle, M. W., University of North Carolina at Chapel Hill, Chapel Hill, NC, USA, mwdoyle@email.unc.edu

THE INFLUENCE OF CHANNEL GEOMORPHOLOGY ON RIPARIAN SHADING AND PRIMARY PRODUCTION IN TIDAL FRESHWATER RIVERS OF THE SOUTHEASTERN UNITED STATES

A geomorphic characteristic of tidal freshwater rivers of the southeastern U.S. is a rapid increase in channel width and a concomitant decrease in shading by riparian vegetation. This study investigated the spatial and temporal patterns in water column irradiance and phytoplankton growth along the tidal river continuum of two blackwater rivers in North Carolina. Solar radiation, tree canopy photographs, water column light attenuation, and channel depth were used to calculate water column irradiance. Chlorophyll a was measured as a proxy for phytoplankton biomass, and photosynthesis-irradiance response curves were developed from 14-C uptake experiments. From March through June, average water column irradiance doubled every 2-3 km in the upper tidal zone due to a 30% decrease in riparian canopy cover and a 3-fold increase in channel width. Peak chlorophyll a also occurred within this portion of both rivers, reaching a maximum of 45 ug/L. Maximum photosynthetic rates occurred at 250 uMoles PAR/m2/s, which was approximately the midday average water column irradiance. While blackwater rivers generally have low primary production, the tidally-influenced channel geomorphology causes a hot-spot of phytoplankton growth.

Entrekin, **S**. **A**., University of Central Arkansas, Conway, USA, sentrekin@uca.edu
Evans-White, M. A., University of Arkansas, Fayetteville, USA, mevanswh@uark.edu
Troutman, T., University of Central Arkansas, Conway, USA, tylertroutman@yahoo.com
Lowry, M., University of Central Arkansas, Conway, USA, msl06001@cub.uca.edu

EFFECTS OF NATURAL GAS DRILLING ON ORGANIC MATTER DYNAMICS IN SMALL STREAMS IN ARKANSAS

Natural gas drilling is increasing across the U.S. as gas reserves become more accessible through improved drilling technology. Arkansas currently has over 2000 new, active natural gas wells concentrated in the Fayetteville-Shale region of north central Arkansas. Wells are in close proximity to small streams, but few studies have examined whether installation of gas wells increases stream sedimentation by increasing road density, land clearing, reservoir creation, and pipeline construction. We delineated 12 catchments draining 1st to 3rd order streams along a gradient of 0 to 14 wells per 1000 hectares and land cover dominated by pasture (14% to 46%) and forest (39% to 81%). Turbidity and benthic and suspended sediments were quantified in spring and autumn 2009. Preliminary analysis indicates a positive relationship between turbidity and well density (p=0.02, r2=0.59) in spring, but no relationship between well density and benthic and suspended sediment in spring or autumn. We continue to measure organic matter transport at high and base flows in autumn and spring. Our broad-scale sampling approach will document the influence of drilling activities on sedimentation and associated ecological function.

Epstein, **D**. **M**., Utah State University, Logan, USA, davepstein@gmail.com
Wurtsbaugh, W. A., Utah State University, Logan, USA, wayne.wurtsbaugh@usu.edu

NITROGEN TRANSPORT THROUGH A SUBALPINE LAKE: BULL TROUT LAKE WHOLE ECOSYSTEM 15N TRACER STUDY

Lakes have historically been underappreciated and neglected as critical nutrient processors in their greater watersheds, having little effect on nutrient transformation (Sickman et al. 2003). Alpine lake ecosystems may rely heavily upon spring nutrient inputs from their upper watersheds to fuel production through the year. In order to better understand nitrogen dynamics in a stream-lake-stream linkage, isotopically enriched nitrate ($^{15}NO3$) was injected at multiple sites within the Bull Trout Lake (BTL) watershed in the Sawtooth Mountains of Idaho. Subsequently, the flow of the heavy isotope (^{15}N) was followed through the lake ecosystem throughout the growing season. Here we report on nitrogen (N) cycling in the seston, epiphytes, macrophytes, sedimenting particles, zooplankton and benthic invertebrate pools in BTL. Nitrate was rapidly assimilated by the seston before being transferred to primary consumers and benthic sediments (via sedimentation). Benthic autotrophs (epiphytes and macrophytes) were less enriched than seston, but due to their high biomass, took up a significant portion of the ^{15}N. The whole-lake enrichment experiment highlighted the importance of both pelagic and littoral zone processes and quantified rates of N transport through the stream-lake ecosystem.

Thompson, E. M., Sars International Centre, Bergen, Norway, Eric.Thompson@sars.uib.no
Bouquet, J., Sars International Centre, Bergen, Norway, Jean-Marie.Bouquet@sars.uib.no
Dupont, S., University of Goteburg, Goteburg, Sweden, sam.dupont@marecol.gu.se
Lobon Rius, C., University of Oviedo, Oviedo, Spain, carlalobon.uo@uniovi.es
Novac, A., Sars International Centre, Bergen, Norway, Aliona.Novac@bio.uib.no
Nejsrtgaard, J. C., UniEnvironment , Bergen, Norway, Jens.Nejstgaard@bio.uib.no
Bosak, S., University of Zagreb, Zagreb, Croatia, sbosak@biol.pmf.hr
Jakobsen, H., Technical University of Denmark, Charlottenlund, Denmark, hhj@aqua.dtu.dk
Isal, A., Technical University of Denmark, Charlottenlund, Denmark, jandro.isla@googlemail.com
Dutz, J., Technical University of Denmark, Charlottenlund, Denmark, jdu@aqua.dtu.dk
Romanova, N., P.P.Shirshov Institute of Oceanology, Moscow, Russia, romanova-nadya@yandex.ru
Sazhin, A., P.P.Shirshov Institute of Oceanology, Moscow, Russia, andreysazhin@yandex.ru
Troedsson, C., Uni Environment, Bergen, Norway, Christofer.Troedsson@bio.uib.no

EFFECTS OF OCEAN ACIDIFICATION AND TEMPERATURE INCREASE ON PLANKTONIC, TUNICATE, OIKOPLEURA POPULATION DYNAMICS AT LABORATORY AND MESOCOSM SCALES

Atmospheric CO2 is projected to double by 2100, resulting in elevated temperatures and ocean acidification (OA). A lack of multifactorial studies means limited knowledge on the combined effects of these pressures on ecosystem structure and function. Laboratory data suggest that increasing temperature and decreasing pH, mimicking expected changes, may differentially impact major zooplankton groups. Filter-feeding appendicularians ingest smaller food than copepods, by-passing the microbial loop, and directly transferring bacteria and nanoplankton to higher trophic levels. They are also vectors of global vertical carbon flux through trapping of prey in their frequently discarded houses. We obtained mono-factorial laboratory data suggesting that OA positively affects fitness parameters in Oikopleura through decreased generation time, faster growth, increased survival and egg

production. To assess these effects in more complex natural ecosystems we have conducted a pilot mesocosm experiment use a 2x2x3 factorial design to assess effects of temperature, pCO2 and phytoplankton regimes on zooplankton population dynamics. Data will be presented showing the extent to which OA and temperature modulation of Oikopleura fitness parameters noted in the laboratory are also observed at the mesocosm scale

Szkokan-Emilson, E. J., Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury, ON, Canada, erikjohn@rogers.com

Gunn, J., Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury, ON, Canada,

Watmough, S., Trent University, Peterborough, ON, Canada,

WETLAND-SOURCED ORGANIC MATTER AS A SUBSIDY FOR RECOVERING LITTORAL INVERTEBRATE COMMUNITIES IN METAL-STRESSED WATERSHEDS

Watersheds with productive wetland and forest cover provide a steady flow of organic materials and nutrients to receiving lakes. Littoral zone ecotones are the focal point of this concordance, and littoral benthic invertebrate communities in small, oligotrophic lakes are highly dependent on watershed subsidies. Many anthropogenically-impacted watersheds are heavily depleted of hydrologically active organic matter and nutrient sources, which appears to delay the recovery of downstream ecosystems. This study used nine catchments and associated streams in a smelter-impacted watershed to investigate the importance of terrestrial sources of organic matter to recovering littoral invertebrate communities. The proportion of fine (< 250 um) organic matter (FPOM) in exported particulate material increased with wetland area (almost 50% of the variation in FPOM explained). Diversity of littoral benthic invertebrates increased with FPOM, and proportional and total amount of FPOM explained over 75% of the variation in diversity. Wetlands and other areas of organic soil appear to play a key role in the recovery of aquatic communities in such severely stressed lakes should probably be the focus of much of the early remedial work.

Eskinazi-SantAnna, **E. M.**, Federal University of Ouro Preto, Ouro Preto, Brazil, eskinazi@iceb.ufop.br

Freitas, L. D., Federal University of Ouro Preto, Ouro Preto, Brazil, lucianadfreitas@gmail.com

ZOOPLANKTON COMMUNITY STRUCTURE AND ENVIRONMENTAL CONDITIONS IN BRAZILIAN MOUNTAIN LAKES (MINAS GERAIS STATE)

Zooplankton community structure from three shallow ponds (Seca, Negra and Capela lakes) was studied in different temporal scales: seasonal and diurnal at Itacolomi State Park, Ouro Preto, Southeast Brazil. We studied zooplankton community, biotic phytoplankton biomass and abiotic (turbidity, nutrient concentrations, pH,) and morphometric (depth, area) characteristics of the ponds. Our results indicate that the ponds differ substantially in their zooplankton community structure, and that these differences are strongly related to differences in trophic structure and biotic interactions. Ponds were characterised by microzooplankton (high abundances of rotifers) low chlorophyll-a concentrations and cyclopoid copepods were present only during the clear water phase. Our results show that ponds shows high temporal dynamic and may differ strongly in zooplankton community composition, and that these differences are related to differences in habitat diversity (macrophyte cover and morphometric characteristics).

Essington, **T. E.**, University of Washington, Seattle, WA, USA, essing@uw.edu

Olson, R., Inter-American Tropical Tuna Commission, La Jolla, CA, USA,

Allain, V., Secretariate for the Pacific Community, Noumea, New Caledonia,

THE IMPORTANCE OF CANNIBALISM IN REGULATING A PELAGIC MESO-PREDATOR

Skipjack tuna are abundant and productive meso-predators in tropical high-seas ecosystems, supporting some of the largest fisheries in the world. In the western pacific "warm pool", they exhibit very high rates of cannibalism, particularly near floating objects that are used by purse seine fishing vessels to facilitate capture. Here, we used a novel age- and size-structured model to ask whether cannibalism might be an important population regulating mechanism. We linked growth and consumption models to an equilibrium age structured population model to gauge the fraction of juvenile skipjack that survive the period when they are vulnerable to cannibalism. Cannibalism is a major source of mortality for juvenile skipjack in all but a limited number of possible parameter configurations. The fraction of skipjack tuna that survive the period when they are most vulnerable to cannibalism ranges from <1 to 20%. The low survivorship indicates a strong potential for cannibalism to regulate recruitment. Variation in year class strength might derive from processes that amplify or dampen he spatio-temporal overlap of juvenile skipjack with adults.

Ettema, **N. R.**, Grand Valley State University, Allendale, USA, ettemani@gvsu.edu

Davis, J. C., Aquatic Restoration and Research Institute, Talkeetna, USA, arri@mtaonline.net

Davis, G. A., Aquatic Restoration and Research Institute, Talkeetna, USA, arri@mtaonline.net

Snyder, E. B., Grand Valley State University, Allendale, USA, snydeeri@gvsu.edu

ECOSYSTEM METABOLISM AS AN INDICATOR OF RIVER ECOSYTEM HEALTH ON THE LITTLE SUSITNA RIVER, ALASKA.

When assessing river ecosystem health, many researchers note that structure (physical and biological characteristics) is not necessarily linked to river function (metabolism, nutrient spiraling, decomposition). The inclusion of functional metrics into monitoring programs should provide a more robust assessment. Ecosystem metabolism is often favored because it quantifies important functional attributes including autochthonous energy production and total energy consumption. Here, we used ecosystem metabolism and macroinvertebrate rapid bioassessment to evaluate effects of boat-generated turbidity on river health. Ambient dissolved oxygen concentrations were monitored continuously at upstream "reference" and downstream "impact" sites during the summer of 2008. Macroinvertebrates were sampled monthly using a D-frame net at reference and impact sites. Reference sites were consistently autotrophic during summer months, but impact sites showed a 55% reduction in gross primary production resulting in heterotrophic conditions. Decreased productivity at impact sites is best explained by elevated turbidity and sedimentation. Macroinvertebrate assemblages showed no clear differences between locations although a strong seasonal shift was observed. Results illustrate a disconnect between structure and function as well as the sensitivity of ecosystem metabolism to disturbance.

Evans-White, **M. A.**, University of Arkansas, Fayetteville, USA, mevanswh@uark.edu

Entrekin, S. A., University of Central Arkansas, Conway, USA, sentrekin@uca.com

TAXONOMIC VARIATION IN BODY C, N, AND P OF CHIRONOMIDS

Chironomids often cycle significant quantities of organic matter through high biomass and growth rates in aquatic ecosystems. However, most ecosystem-level studies only split the family by predators (Tanypodinae) and all other genera (Non-Tanypodinae) despite high species and functional diversity within the family. We need to determine if chironomid carbon (C), nitrogen (N), and phosphorus (P) contents vary at a lower taxonomic level to provide accurate estimates elemental flows through aquatic ecosystems. We collected Chironomidae taxa from several sites within a 300-m reach in a forested and an agricultural stream and measured %C, %N, %P, C:N, C:P, and N:P for each genera sampled. Percent N was significantly lower for *Dicrotendipes* (mean ± 1SE = 8.4 ± 0.3%) than for Tanypodinae (10.2 ± 0.4%; p=0.06), but other Non-Tanypodinae had similar %N to Tanypodinae. Percent C (range = 40.2-45.7%), C:N (range=5.2-6.2), %P (range=0.3-0.5%), and C:P (range=210-415) did not significantly differ among genera (p>0.10) or between Tanypodinae and Non-Tanypodinae (p>0.10). Our data suggest that separating Chironomidae into only Tanypodinae and Non-Tanypodinae groups may not accurately reflect nitrogen content.

Faggotter, **S. J.**, Australian Rivers Institute, Brisbane, Australia, S.Faggotter@griffith.edu.au

Burford, M. A., Australian Rivers Institute, Brisbane, Australia, M.Burford@griffith.edu.au

Balcombe, S. R., Australian Rivers Institute, Brisbane, Australia, S.Balcombe@griffith.edu.au

THE RELATIVE IMPORTANCE OF TOP-DOWN AND BOTTOM-UP CONTROL ON PRIMARY PRODUCTIVITY IN A DRYLAND-TROPICAL RIVER

The ecological integrity of northern Australia's pristine rivers are under increasing anthropogenic pressure from stressors such as water regulation and abstraction which impact on natural flow regimes. These flow alterations have the potential

to impact ecosystem function, including nutrient cycling and productivity. With the aim of better prediction of ecosystem responses to flow regime changes, this study examined the relative importance of top-down versus bottom-up control of primary productivity. The study site was located within a dryland river system in tropical northern Australia which is characterised by vast floodplains in the monsoon period and disconnected waterholes within the dry season. Chlorophyll a concentrations in the water column and periphyton increased over the dry season in a nutrient-depauperate system. Conversely, fish biomass was high soon after flooding but decreased substantially over the same period. Increased algal biomass may be the result of decreased grazing pressure and decomposition of grazers providing an additional nutrient source. The productivity of these systems is therefore sensitive to changes in water regimes, and increased nutrient loads.

Fairchild, **G**. **W**., West Chester University, West Chester, PA, USA, wfairchild@wcupa.edu

Brainard, A. S., West Chester University, West Chester, PA, USA, ab663737@wcupa.edu

Robinson, C., West Chester University, Avondale, PA, USA, portearth@aol.com

Coutu, G. W., West Chester University, West Chester, PA, USA, gwcoutu@wcupa.edu

ESTIMATING SEDIMENT RETENTION ASSOCIATED WITH CONSTRUCTED POND PROLIFERATION AT THE LANDSCAPE SCALE

Based on aerial photo interpretations at approximately 10-year intervals from 7 townships, the abundance of constructed ponds has increased nearly 20-fold since 1937 within the Brandywine Creek watershed (842 km^2) in southeast Pennsylvania. Rates of new pond construction averaged 0.2 ponds/km^2/yr, greatly exceeding rates of pond disappearance. Much of the proliferation during the mid-1900s was associated with farm pond construction, whereas many recent ponds have accompanied new housing developments. Current ponds are typically small (median area = 0.11 ha), and most are associated with first-order streams. We estimated annual rates of sediment accumulation in 10 of these ponds during summer 2009. Area-specific sediment retention rates (m^3/ha/yr) were significantly ($p = 0.014$) greater in ponds with stream inflows (n=5) than in ponds without inflows (n=5), and declined significantly ($p = 0.012$) with increasing pond area. The combined estimates of changing pond density and substantial sediment capture per pond suggest that ponds have become increasingly important in reducing sediment export to small streams within the watershed during the last 7 decades.

Faithfull, **C**. **L**., Umeå University, Umeå, Sweden, carolyn.faithfull@emg.umu.se

Vrede, T., Swedish University of Agriculture, Uppsala, Sweden, tobias.vrede@vatten.slu.se

Bergström, A. K., Umeå University, Umeå, Sweden, ann-kristin.bergstrom@emg.umu.se

DO THRESHOLDS EXIST FOR A SWITCH BETWEEN AUTOTROPHY AND HETEROTROPHY IN AQUATIC PELAGIC ECOSYSTEMS?

Primary (autotrophic) production by phytoplankton and bacterial (heterotrophic) production together constitute the total basal production in aquatic food webs. However, as yet no consensus has been reached as to what conditions (nutrient and carbon concentrations) determine when and where the pelagic zone will be dominated by heterotrophic or autotrophic production, and if there exists thresholds across which the system can switch. Here I present results from a meta-analysis of experimental studies manipulating nitrogen, phosphorus and carbon (in concert or alone) in both freshwater and marine systems and a literature review of in situ conditions in limnetic ecosystems covering a wider range in productivity. The objective is to resolve the most important factors (e.g. inorganic nitrogen and phosphorus, dissolved organic carbon) that regulate bacterioplankton and phytoplankton production in pelagic ecosystems.

Falke, **J**. **A**., NOAA-Fisheries, Corvallis, USA, jeffrey.falke@noaa.gov

Gido, K. B., Kansas State University, Manhattan, USA, kgido@ksu.edu

Fausch, K. D., Colorado State University, Fort Collins, USA, kurtf@warnercnr.colostate.edu

LINKING GROUNDWATER DYNAMICS TO HABITAT LOSS FOR THREATENED STREAM FISHES ACROSS SCALES IN THE WESTERN GREAT PLAINS, USA

Across the western Great Plains of North America, intensive groundwater pumping has led to decreased hydraulic conductivity between aquifers and streams, resulting in increased stream intermittency, habitat fragmentation, and habitat loss. These changes are concurrent with widespread declines of native stream fishes. Here we synthesize our research linking groundwater pumping to habitat loss and species declines in Great Plains streams. Across western Kansas and eastern Colorado, we found that changes in land cover, agronomic practices, and development of groundwater resources to support irrigated agriculture resulted in profound changes in stream hydrology. As a result, current fish communities in these basins share < 50% of the species recorded in historic collections, with differences driven by species extirpations and invasions. The greatest levels of community divergence over time occurred in western basins that experienced the most intense groundwater withdrawals. Within one of these basins, we found that population dynamics of a threatened species were driven by interactions among stream geomorphology, groundwater pumping, and climate. Our research shows that under current declines the future for these fish assemblages is bleak.

Farahi, **A**., National Park Service, Hawaii National Park, USA, Anne_Farahi@nps.gov

Jones, T., National Park Service, Hawaii National Park, USA, Tahzay_Jones@nps.gov

Brasher, A., U.S. Geological Survey Water Science Center, Moab, USA,

LONGITUDINAL DISTRIBUTION AND ABUNDANCE OF CRUSTACEANS AND MOLLUSKS IN THREE STREAMS IN THE NATIONAL PARK OF AMERICAN SAMOA.

Crustaceans and mollusks are monitored yearly in streams on the islands of Tau and Tutuila in American Samoa as part of the National Park Service Inventory and Monitoring program. In addition to species identification, water quality parameters and physical habitat data are measured at each site. We analyzed data collected in 2009 and found that species varied by island and stream, and were associated with longitudinal distance from the ocean and land use in the watershed. On Tau, the palaemonid Macrobrachium latimanus and the atyid Caridinia weberi were the most abundant crustaceans. On Tutuila, the palaemonid Macrobrachium australe dominated lower stream reaches while the smaller atyids Caridina weberi and Atyoida pilipes were abundant in the upper reaches. Macrobrachium lar was abundant in all three streams on both islands. The mollusk Septaria suffreni was found in only one stream on Tutuila while Clithon corona occurred at all sites we sampled. This data is collected as part of a long-term monitoring program to assess status and trends in key park resources, and will be used by park managers to evaluate management strategies.

Farmer , **L**. **A**., Austin Peay State University, Clarksville, TN, USA, farmerl@apsu.edu

Hamilton, S. W., Austin Peay State University, Clarksville, TN, USA, hamiltonsw@apsu.edu

EVALUATING MACROINVERTEBRATE COMMUNITY DIVERSITY IN PONDS UTILIZING TWO SAMPLING TECHNIQUES

Milan Army Ammunition Plant, located in West Tennessee, is a munitions production facility comprising 90.48 km2 of hardwood forest interspersed with agricultural fields. MLAAP's Integrated Natural Resources Management Plan couples previous research with ongoing studies to develop long-term sustainability plans for natural resources. Macroinvertebrates are among the taxa being studied. June 2009 began a research project comparing sampling techniques to assess macroinvertebrate diversity in pond communities. Funnel-trap and dip-net sampling methods were employed in 10 ponds. Four funnel-traps were set in each pond for two consecutive 48-hour periods during June and December. Dip-net samples were collected in June and November with two collectors sampling simultaneously for 30 minutes in each pond. Taxonomic analysis is incomplete; however, to date 5,447 individuals in 128 taxa have been collected. Current statistical analysis shows no significant difference in taxa richness or Shannon-Weaver diversity. Jaccard's Similarity Coefficient values are low, indicating collection of very different sets of taxa. Dip-net sampling required fewer people and person-hours to complete saving time and money. Dip-net samples added to taxa richness, particularly in the orders Coleoptera, Hemiptera and Odonata.

Fausch, **K**. **D**., Colorado State University, Fort Collins, USA, kurtf@cnr.colostate.edu
Baxter, C. V., Idaho State University, Pocatello, USA, baxtcold@isu.edu
Saunders, W. C., Colorado State University, Fort Collins, USA, csaunder@cnr.colostate.edu
Benjamin, J. R., Idaho State University, Pocatello, USA, benjijose@isu.edu
Lepori, F., Université Claude Bernard – Lyon 1, Villeurbanne, France, FABIO.LEPORI@adm.univ-lyon.fr

STRONG EFFECTS OF INTRODUCED SALMONIDS AND MULTIPLE STRESSORS PROPAGATE ACROSS HABITAT BOUNDARIES IN LINKED STREAM-RIPARIAN ECOSYSTEMS

Streams are strongly influenced by the landscapes they drain owing to their small habitat area and long ecotones with adjacent riparian zones. Likewise, streams and riparian habitats are strongly linked by fluxes of invertebrate prey that move in both directions across the aquatic-terrestrial boundary. As a result, effects of anthropogenic stressors in one habitat can propagate rapidly to the other. Here, we present results from three integrated sets of large-scale field experiments and comparative studies to measure the effects of multiple stressors on these linked stream-riparian ecosystems. Non-native trout invasions in Japan and the U.S. caused strong reductions in aquatic insect emergence to riparian predators like spiders and bats, demonstrating that stressors in streams can cascade across habitat boundaries to influence riparian consumers. Likewise, riparian deforestation and cattle grazing in these same regions had profound effects on terrestrial prey inputs that reduced fish diets, growth, and abundance. Small streams apparently have low resistance and resilience to common stressors, and single stressors can perturb ecosystems to their limits, so restoration will need to address multiple stressors simultaneously to be successful.

Febria, **C**. **M**., University of Toronto, Toronto, Canada, cmfebria@gmail.com
Beddoes, P., University of Ottawa, Ottawa, Canada,
Fulthorpe, R. R., University of Toronto Scarborough, Toronto, Canada,
Williams, D. D., University of Toronto Scarborough, Toronto, Canada, cmfebria@gmail.com

HYPORHEIC SEDIMENTS OF AN INTERMITTENT STREAM SUPPORT DYNAMIC BACTERIAL COMMUNITIES

We assessed bacterial community composition in the hyporheic sediments of an intermittent stream in southern Ontario, Canada. We collected in situ bacteria in 2007 and 2008 – considerably dry and wet years, respectively - and sought to correlate seasonal and spatial dynamics with environmental factors. Disturbance events impacted bacterial diversity on extremely rapid timescales (i.e., within days) and below-ground, across the sediment-water interface. Bacterial community composition was attributed to flooding and seasonal physicochemical parameters. Hyporheic sediments remained saturated throughout the study period, including when the streambed ran dry. During a drought period in 2008, bacterial communities were isolated in pools at the surface. Subsequently, upon flooding, bacterial community diversity (measured by operational taxonomic units, OTU, a proxy for phylotype) decreased dramatically to only a few OTUs. An overall decline of both common and rare bacterial taxa was observed. We revisited the hyporheic refuge hypothesis that predicts a migration of biota into sediments during periods of disturbance (i.e., drought) and determined that only 15% of all bacterial phylotypes were found in both sediment and water environments. Due to the tight coupling of intermittent streams to environmental factors, we stress the importance of understanding pore-scale dynamics and over longer time periods.

Feio, **M**. **J**., IMAR-CMA, Coimbra, Portugal, mjf@ci.uc.pt
Coimbra, C. N., IMAR-CMA, Coimbra, Portugal,
Graça, M. A., IMAR-CMA and University of Coimbvra, Coimbra, Portugal, mgraca@ci.uc.pt
Nichols, S. J., Institute for Applied Ecology, University of Canberra, Canberra, Australia,
Norris, R. H., Institute for Applied Ecology, University of Canberra, Canberra, Australia,

THE INFLUENCE OF EXTREME CLIMATIC EVENTS AND HUMAN DISTURBANCE IN MACROINVERTEBRATE COMMUNITIES OF A MEDITERRANEAN STREAM OVER 15 YEARS

In a Mediterranean temporary stream studied over 15 years, communities' structure varied naturally from year to year but the changes in species richness and equitability were much stronger and unpredictable in disturbed sites. The more diverse (reference) and the poorest communities were stable while communities affected by mild disturbance slowly decreased in species richness (slope = -0.07, R2=0.38), which can either be a response of the continuous stress and/or climate change. Communities at mildly disturbed sites were the only ones significantly correlated with climatic patterns. Extreme climatic events caused marked changes in the community composition (70-80% Bray-Curtis dissimilarity, for very low precipitation or winter temperatures). In both climatic and chemical contamination situations Orthocladinae and Simuliidae became dominant but the remaining taxa react differently to the climatic changes (SIMPER). Before species elimination due to either climate change or disturbance there is a shift in community equitability that may be used as an early warning for biodiversity loss. For monitoring purposes reference sites should continue to be sampled so that human disturbance can be assessed relative to an adjusted reference condition.

Feld, **C**. **K**., University of Duisburg-Essen, Essen, Germany, christian.feld@uni-due.de
Hering, D., University of Duisburg-Essen, Essen, Germany, daniel.hering@uni-due.de

DETECTION OF MULTIPLE STRESSORS AND THEIR IMPLICATIONS FOR RIVER RESTORATION

Both the detection of multiple stressors and the development of mitigation measures are currently of pivotal interest for European water managers. In particular, hydrological and morphological alterations, accompanied by catchment-scale land use, are considered to be major sources of impact in Central European rivers. The new monitoring programmes according to the Water Framework Directive thus attempt to address these different impacts, for instance, by using different organism groups: fish, benthic invertebrates, aquatic macrophytes, and algae. The identification of stressor-specific impacts and corresponding spatial scales, however, continues to be a challenge. The first part of the talk will address major stressors in Central Europe and the methods applied to assess their impact on riverine communities. The results presented are based on data from the pan-European research projects AQEM and STAR, and on additional data from Germany. The main focus will be on the questions of stressor hierarchy and relevant spatial scales. The second part will then highlight potential implications of the results for river basin management, in particular the lessons to be learned for effective river rehabilitation and restoration projects.

Feldman, **D**. **L**., Montana Dept of Environmental Quality, Helena, USA, dfeldman@mt.gov
Jessup, B., Tetra Tech Inc., Montpelier, USA, benjamin.jessup@tetratech.com

DESCRIBING SAMPLING VARIABILITY BIAS TO THE MACROINVERTEBRATE BIOMETRICS OF STREAM CONDITION IN MONTANA

The Montana Department of Environmental Quality (DEQ) currently uses macroinvertebrates as indicators of water quality (i.e., biometrics). However, these biometrics were built using data collected via different macroinvertebrate sampling protocols. The majority of samples in the DEQ database were either collected using: (a) the USEPA Environmental Monitoring and Assessment Protocol (EMAP) reach-wide; or (b) the traveling kick (Kick), riffle-focused approaches. Major differences in the biometric results caused by sampling method will impact determinations of water quality. The goal for this study was to determine if there were systematic biases on the biometric results caused by the two sampling methods. Statistical tests were used to analyze the data (Chi-square, Ordinations, Minimum Detectable Difference, and paired t-tests), and compare several biometrics. Though some metrics showed bias (higher richness in EMAP samples, higher EPT predominance in Kick samples), the multimetric indices did not. Metrics calculated from the Kick samples were somewhat more precise (repeatable) than those calculated from EMAP samples. The results of this study underscore the importance of understanding the effect caused by sampling methods on biological indicators on water quality assessments.

Fergus, **C**. **E**., Michigan State University, Department of Fisheries and Wildlife, East Lansing, USA, fergusca@msu.edu
Soranno, P. A., Michigan State University, Department of Fisheries and Wildlife, East Lansing, USA, soranno@msu.edu
Cheruvelil, K. S., Michigan State University, Deparment of Fisheries and Wildlife and Lyman Briggs College, East Lansing, USA, ksc@msu.edu
Bremigan, M. T., Michigan State University, Deparment of Fisheries and Wildlife, East Lansing, USA, bremigan@msu.edu

THE EFFECT OF LAND USE DISTURBANCE ON WETLAND RELATIONSHIPS WITH LAKE TP AND WATER COLOR

Both phosphorus (TP) and humic dissolved organic carbon (Col) are important regulators of lake trophic status. Studies have shown that wetlands in the landscape surrounding lakes affect both TP and Col. However, less research has examined how human disturbance affects wetland TP and Col relationships, which is what we do in this study. We hypothesized that disturbance will have a negative interaction effect with wetland effects on TP and Col. We analyzed lake and catchment data for 1805 lakes in Maine, New Hampshire, Michigan, and Wisconsin. We used mixed models to predict lake TP or Col from hydrogeomorphic and land use/cover variables using an information theoretic approach. We selected final models using AIC values and likelihood ratio tests. Wetlands were shown to be positively related to both Col and TP but had stronger relationships with Col. Human disturbance decreased the positive effects of wetlands on lake TP, but increased the positive effect of wetlands on color. These results suggest that disturbance alters wetland relationships with nutrient and color transport through different mechanisms.

Ferreira, **V**., IMAR-CMA & Dept Life Ciences, University of Coimbra, Coimbra, Portugal, veronica@ci.uc.pt
Canhoto, C., IMAR-CMA & Dept Life Ciences, University of Coimbra, Coimbra, Portugal, ccanhoto@ci.uc.pt
Chauvet, E., EcoLab - Laboratoire d'écologie fonctionnelle, Université de Toulouse, Toulouse, France, echauvet@cict.fr

DO CO2 AND TEMPERATURE INCREASES AFFECT LITTER DECOMPOSITION? A LABORATORY STUDY ACROSS TROPHIC LEVELS

Temperate woodland streams, where terrestrially derived organic matter fuels aquatic food webs, can be affected by increases in atmospheric CO2 concentrations, as these are predicted to lead to increases in water temperature and decreases in litter quality. Here, we assessed the individual and interactive effects of water temperature (5, 10, 15°C) and litter quality (>30% decreases in P concentration in leaves grown under elevated CO2 concentration, i.e. 580 ppm, compared with ambient ones, i.e. 380 ppm) on litter decomposition and associated fungi in microcosms, and on the consumption, growth, survival and body chemical composition of a stream detritivore (Sericostoma vittatum). All biological variables were stimulated at higher temperature for both litter qualities; in comparison the effects of litter quality were smaller and were found to be more pronounced at lower temperature. Our results suggest that biological activities and ecosystem processes will be mostly ruled by water temperature if future CO2-induced changes in litter quality remain small.

Ferrington Jr., **L**. **C**., Department of Entomology, University of Minnesota, Saint Paul, MN, USA, ferri016@umn.edu
Bouchard Jr., R. W., Department of Entomology, University of Minnesota, Saint PAul, MN, USA,

CHIRONOMIDAE EMERGENCE IN LARGE LAKES OF WESTERN MONGOLIA

Chironomidae emergence was documented during July/August 2004 and August 2005 in large lakes of western Mongolia with differing nutrient concentrations and conductivities. Emergence consisted of 61 species distributed among 35 genera across all lakes, but varied from 26 to 3 taxa/lake. A constrained, two parameter model relating emergence composition to Phosphorus (TP, range 7 - 2,635 µg/L) and conductivity (SC, range 41- >60,000 µS) was developed from data for 57 lakes. In lakes with SC < 4,350 µS emergence conformed well to Saether's Lake Trophic State Model, with transitions from Orthocladiinae to Chironomini as TP increased. Emergence in lakes with SC > 4,350 µS was shifted to genera with halobiontic species irrespective of TP concentration, with strongest shifts in lakes with SC from 10,000-26,391 µS. Emergence in lakes with SC >42,000 µS was dominated by taxa that are semi-aquatic as larvae (e.g., Smittia, Pseudosmittia, Limnophyes), or consisted of small species with rapid life-cycles (e. g., Corynoneura, Thienemanniella) that were encountered in low abundance and likely develop in isolated shoreline seeps where groundwater inputs create small areas with dilute ionic concentrations.

Fetzer, **W**. **W**., Cornell University, Ithaca, USA, wwf3@cornell.edu
Jackson, J. R., Cornell University, Ithaca, USA, jrj26@cornell.edu
Rudstam, L. G., Cornell University, Ithaca, USA, lgr1@cornell.edu

SHIFTING TROPHIC BASELINES: TEMPORAL TRENDS IN RESOURCE USE BY FISH FOLLOWING ECOSYSTEM CHANGES

Studies of lake food webs have historically focused on pelagic food-chains, with little attention to the role of benthic production. Oneida Lake, NY is a textbook example of cascading trophic interactions in pelagic food chains; however, changes in water clarity could increase the extent to which benthic food sources support production at higher trophic levels. Here, we evaluate how these ecosystem changes modify the resource base of young-of-the-year yellow perch (YOY), the primary link between primary consumers and fisheries in Oneida Lake. YOY are increasingly selecting littoral habitats, and the percent of autumn catch from shallow sites in the Cornell Biological Field Station's long-term sampling has increased from 51% pre-zebra mussel invasion (1964-1990) to 74% post-invasion (1991-2006). We used diet analysis and $\delta^{13}C$ and $\delta^{15}N$ stable isotope ratios to estimate the current and historic use of benthic and pelagic production by YOY. Results from Oneida Lake can be informative throughout the Great Lakes basin, highlighting the complexity of ecosystem responses to invasive species.

Fey, **S**. **B**., Dartmouth College, Hanover, USA, Samuel.b.fey@dartmouth.edu
Cottingham, K. L., Dartmouth College, Hanover, USA, Samuel.b.fey@dartmouth.edu

CLIMATE CHANGE AND THE SPREAD OF *DAPHNIA LUMHOLTZI*

Community level processes and indirect consequences are largely ignored in climate change research. We address these topics by exploring the role of climate change in the range expansion of *Daphnia lumholtzi* (Cladocera: Daphniidae) in the United States. *D. lumholtzi* first appeared in Texas in the early 1990's and has since expanded northwards. We seek to understand how both the predicted direct (e.g, increases in temperature) and indirect (e.g., increases in cyanobacteria) effects of climate change may facilitate or inhibit the expansion of *D. lumholtzi* , when also accounting for competitive interactions with native zooplankton populations. The results of a factorial field mesocosm experiment manipulating temperature (increased vs. ambient) and cyanobacteria (ambient vs. bloom) suggested that the relative density of *D. lumholtzi* was affected by both temperature and additions of cyanobacteria. Ongoing laboratory studies to corroborate these results will also explore temperature and cyanobacteria as determinants for the invasibility success of *D. lumholtzi* . These findings suggest that increased temperature, but not increased cyanobacteria, may facilitate the ability of *D. lumholtzi* to invade lakes in the future.

Fields, **D**. **M**., Bigelow Laboratory for Ocean Sciences, West Boothbay Hr, USA, dfields@bigelow.org
Shema, S. D., Bigelow Laboratory for Ocean Sciences, West Boothbay Hr, USA, sshema@bigelow.org
Woll, C. I., University of Alaska Fairbanks, Fairbanks, USA, clwoll@alaska.edu
Gillmore, A., Estrella Mountain Cmty. Coll., Avondale, USA, alexisgillmore@gmail.com
Milligan, A. J., Oregon State University, Corvallis, USA, milligaa@science.oregonstate.edu

DOES THE SILICIFIED WALL OF DIATOMS CONFER PROTECTION AGAINST COPEPOD GRAZING?

Many groups of marine protists are "armored" with thickened cell walls, coatings of scales, hard "cases" (tests, loricas), or latticework "skeletons". One of the inferred evolutionary functions of these mineral deposits is to deter grazing. However, to date there are no direct measurements of grazing rates on protists as a function of their mineral content. With the recent development of silica stains we directly test the relationship between the per cell minerals quota of 2 diatoms species (Thalassiosira sp.) and the ingestion rates of copepods. Mineral load were determined chemically (chemical digestion), visually (confocal microscopy) and photometrically (flow cytometry). Using well controlled algal rearing techniques, we grew phytoplankton cells with a 3 fold difference in silicification. Our results show that for small cells (T. pseudonana) the degree of silicification showed no effect on grazing rates by Acartia tonsa. For larger cells (T. weissflogii), we found

a significant effect of silica but only at high cell concentrations (above 10^4 cells/ml). These results support the hypothesis that silicification in some cases does confer protection against mesozooplankton grazing rates.

Fields, **L**., URI Graduate School of Oceanography, Narragansett, USA, lfields@gso.uri.edu
Nixon, S. W., URI Graduate School of Oceanography, Narragansett, USA, swn@gso.uri.edu
Granger, S., URI Graduate School of Oceanography, Narragansett, USA, granger@gso.uri.edu

BENTHIC METABOLIC RESPONSES TO LOW OXYGEN CONCENTRATIONS IN COASTAL ECOSYSEMS

Concentrations of oxygen in near-bottom coastal waters decrease linearly until hypoxic conditions (~3 mg/L) are reached. Once dissolved oxygen concentrations drop below this threshold, some sites show reduced benthic metabolism. In the late 1970's, sediment core incubations in mid-Narragansett Bay, Rhode Island revealed a decrease in metabolic rate as oxygen concentrations in the overlying water dropped below hypoxic conditions. Similar experiments in the Providence River estuary, a site that routinely experiences hypoxia, showed the opposite, with the rate of benthic metabolism remaining constant in oxygen concentrations as low as 1 mg/L. We recently incubated sediment cores from Block Island and Rhode Island Sounds, two inner-shelf systems that connect Narragansett Bay to the coastal ocean and do not experience hypoxia. Temperature and sediment composition were similar to the past studies. The benthos of both Sounds behaved similarly to those of mid-Narragansett Bay, and decreased their rate of metabolism at oxygen concentrations below 2 mg/L. These findings suggest that benthos in areas where hypoxia occurs frequently respond to decreases in oxygen differently than those in areas with infrequent or no hypoxic events.

Figueroa-Nieves, **D**., University of New Hampshire, Durham, USA, dpv3@unh.edu
McDowell, W. H., University of New Hampshire, , USA, bill.mcdowell@unh.edu
Ortiz-Zayas, J. R., University of Puerto Rico at Río Piedras, , Puerto Rico, jorgeortiz.ites@gmail.com
Martinez, G., University of Puerto Rico at Mayagüez, , Puerto Rico, tavomarti@hotmail.com

EFFECTS OF SEWAGE EFFLUENTS ON ECOSYSTEM METABOLISM IN STREAMS IN PUERTO RICO

This study investigated the effects of sewage effluents on stream metabolism in two streams in Puerto Rico receiving sewage effluent from waste water treatment plants (WWTP). Rates of gross primary production (GPP), community respiration (CR), GPP/CR ratio, and net ecosystem productivity (NEP) were determined upstream and downstream of the WWTP effluent using the open-system, one-station diurnal oxygen change method. Nutrient concentrations, stream discharge, light, and epilithic chlorophyll-a were measured. Stream nitrate, phosphate, ammonium and DOC concentrations were greatly increased due to sewage effluent. Rates of stream metabolism were unaffected by sewage effluents at one of the streams (Río Fajardo), however, both NEP and GPP were higher downstream of the effluent at a second stream (Río Bairoa). NEP was strongly correlated with nitrate and chlorophyll-a, and GPP was correlated with nitrate, suggesting nutrient limitation to GPP in these streams. Multiple regression analysis indicated that nitrate was a significant predictor of variability in NEP over time.

Filoso, **S**., University of Maryland, Chesapeake Biol Lab, Solomons, USA, filoso@umd.edu
Palmer, M. A., University of Maryland, College Park , USA, mpalmer@umd.edu

RESTORATION AS A NETWORK PROCESS OR STREAM BY STREAM?

Large investments have been made in restoring waterways in the U.S. particularly in specific regions such as the mid-Atlantic, central California, and the Pacific NW. The efforts have focused on both streams/rivers and tidal waters and for both domains have involved many locally implemented restoration projects. In coastal waters, this has included for example, living shoreline projects and tidal wetland restoration. For inland waters, this has included stream bank stabilization and riparian replanting along with a variety of other typically small-scale interventions. Based on published restoration frameworks, it is clear that for both domains the focus has increasingly been moving toward a watershed perspective but it is not clear that the projects going into the ground really reflect that. We present data from 8 stream restoration projects some of which were in headwater regions and some in coastal boundary lowlands thus their watershed context was quite different. The eight projects were all completed in Coastal Plain streams in the Chesapeake Bay watershed. They vary greatly in their effectiveness which is likely related to the position within the network. We will discuss what measurements are needed to better understand the role of network position in restoration effectiveness and what it might mean to restore a waterway using a watershed perspective.

Filstrup, **C**. **T**., Baylor University, Waco, USA, Christopher_Filstrup@baylor.edu
White, J. D., Baylor University, Waco, USA, Joseph_D_White@baylor.edu
Byars, B. W., Baylor University, Waco, USA, Bruce_Byars@baylor.edu
Prochnow, S. J., Baylor University, Waco, USA, shane.j.prochnow@exxonmobil.com
Lind, O. T., Baylor University, Waco, USA, Owen_Lind@baylor.edu

IMPACT OF CLIMATE CHANGE ON TERRESTRIAL ORGANIC MATTER LOADING TO A SOUTH-CENTRAL UNITED STATES RESERVOIR

Climate change influences aquatic ecosystem structure and function at various spatiotemporal scales. At mesoscales, climate change modifies both intensity and periodicity of natural climate cycles, such as the El Niño-Southern Oscillation (ENSO), that can directly impact watershed hydrologic functions. Because ENSO affects water availability and potentially land cover, climate change may modify terrestrial organic matter (TOM) loading to streams and reservoirs. We investigated the influences of ENSO climatology and land cover on TOM loading rates to a south-central US reservoir. We assessed water quality impacts based on OM source shifts related to ENSO-influenced stream discharge. Land cover was determined using 1950s aerial photographs which recorded drought conditions similar to predicted regional precipitation changes. Using linked watershed-lake water quality models, we assessed TOM loading rates, turnover times, and nutrient release rates. We evaluated model simulations by comparison with sediment core organic matter (SCOM) composition. SCOM elemental and isotopic ratios oscillated with 3-6 year periods similar to OM source shifts associated with ENSO. Our results demonstrated a potential mechanism for climate change influence on watershed-reservoir ecosystems where ENSO climatology predominates.

Findlay, **S**., Cary Institute of Ecosystem Studies, Millbrook, USA, findlays@caryinstitute.org
Sinsabaugh, R., University of New Mexico, Albuquerque, USA, rlsinsab@unm.edu

MULTI-SCALE INFLUENCES ON STREAM BIOFILM EXTRACELLULAR ENZYME ACTIVITIES

Stream biofilms use extracellular enzymes to meet demands for carbon, nitrogen and phosphorous and allocation may be affected at several scales. Simplest expectations are based on physiological responses such as end-product inhibition suggesting for instance that phosphatase should be repressed if inorganic P is available. At the ecosystem scale, streams with greater overall demand for C, N, or P may exhibit higher enzyme activitites as communities depend more heavily on complex organic forms. Lastly, there may be large-scale spatial patterns in response to a host of covarying soils, geology or land use variables. A common gravel substrate was incubated in 72 streams forming the LINXII study of nitrogen cycling, representing streams from eight regions across North America and three land use classes. Inorganic nutrient concentrations varied widely but were only weakly associated with differences in enzyme activity. An ordination based on enzyme activities showed some structure associated with the region of sample collection. Stream metabolic variables such as GPP and respiration were not simply related to enzyme activities but nitrogen uptake rates were positively associated with expression of peptidase activity.

Finlay, **J. C.**, University of Minnesota, EEB, St. Paul, USA, jfinlay@umn.edu
Mack, M. C., University of Florida, Gainsville, USA, mcmack@ufl.edu
Neff, J. C., University of Colorado, Boulder, USA, Jason.C.Neff@colorado.edu
Chapin, F. S., University of Alaska, Fairbanks, USA, fffsc@aurora.uaf.edu
Davydov, S. A., North-East Scientific Station, Far East Branch of the Russian Acad., Cherskii, Russian Federation,
Davydova, A., North-East Scientific Station, Far East Branch of the Russian Acad., Cherskii, Russian Federation,
Anthony, K. W., University of Alaska, Fairbanks, USA, kmwalteranthony@alaska.edu
Zimov, S., North-East Scientific Station, Far East Branch of the Russian Acad., Cherskii, Russian Federation, sazimov55@mail.ru

AQUATIC RESPONSE TO PHOSPHORUS RELEASE FROM WARMING ARCTIC WATERSHEDS

Nutrient limitation of aquatic primary production is a dominant feature of arctic freshwaters that arises from strong suppression of terrestrial nutrient cycling by cold temperatures. We examined river biogeochemistry in a rapidly warming region of northeast Siberia. Two years of near continuous sampling shows that during summer, small rivers have algal biomass and carbon metabolism levels that can reach those observed in eutrophic rivers and lakes in temperate regions. Elevated river productivity is linked to unusually high concentrations of phosphorus in small streams draining thawing Pleistocene-aged permafrost, particularly during the spring thaw when values up to 250 micrograms of P per L were observed. Average P concentrations in these small streams exceed those observed in 70 other arctic streams by 4 to 90 fold. Phosphorus is widely known to be strongly conserved within cold northern soils. Our study provides evidence that arctic warming may affect aquatic productivity via mobilization of nutrients from the surrounding landscape.

Finn, **D. S.**, Australian Rivers Institute, Griffith University, Nathan, Queensland, Australia, finnd@science.oregonstate.edu
Bonada, N., Department of Ecology, University of Barcelona, Barcelona, Catalonia, Spain, bonada@ub.edu
Múrria, C., Department of Entomology, Natural History Museum, London, United Kingdom, cmurria@gmail.com
Hughes, J. M., Australian Rivers Institute, Griffith University, Nathan, Queensland, Australia, jane.hughes@griffith.edu.au

EVIDENCE THAT THE SMALLEST BRANCHES (HEADWATERS) ARE VITAL TO NETWORK-SCALE DIVERSITY.

The importance of headwaters in stream networks can be quantified as the degree to which headwaters provide network-scale "benefits". One potential benefit is headwater contribution to whole-network biodiversity. Although headwaters are traditionally assumed depauperate compared to mid-order ("navigable") streams, this assumption arises from a linear perspective in which alpha (local) diversity increases downstream from one headwater to one mid-order reach. We hypothesized that beta (among-site) diversity has the opposite pattern in streams; i.e., that the many small tips of stream networks are more beta diverse than the less-abundant mid-order branches. We assembled regional datasets from across the globe to test this hypothesis. Regional datasets comprised N≥4 independent local samples from either headwater or mid-order sites. Beta diversity thereby could be calculated for each region*stream size. Furthermore, we accumlated regional datasets having both intraspecific (genetic diversity) and interspecific (taxonomic diversity) information. Results suggest that headwaters have significantly greater beta diversity than do mid-order streams at both intraspecific (N=9 headwater, N=9 mid-order datasets) and interspecific (N=10 headwater, N=6 mid-order datasets) levels. Headwaters therefore may contribute disproportional biodiversity benefits to many stream networks.

First, **M. R.**, Woods Hole Oceanographic Institution, Woods Hole, USA, mfirst@whoi.edu
Gast, R. J., Woods Hole Oceanographic Institution, Woods Hole, USA, rgast@whoi.edu
Bernhard, J. M., Woods Hole Oceanographic Institution, Woods Hole, USA, jbernhard@whoi.edu

METABOLIC RATES OF MARINE AND FRESHWATER BACTERIVOROUS PROTISTS FEEDING ON THE PATHOGENIC BACTERIA, *CAMPYLOBACTER JEJUNI*

Certain pathogenic bacteria are capable of resisting digestion by bacterivorous protists and, subsequently, intracellular survival and growth. While numerous terrestrial and freshwater protists are known to harbor pathogenic bacteria, it is less clear whether pathogens are capable of intracellular survival in marine protists. To address the hypothesis that salinity impacts the ability of intracellular pathogens to survive within protists, we measured the critical metabolic rates of both marine and freshwater protists (including ciliates, flagellates, and amoebae) feeding on the enteric pathogen, *Campylobacter jejuni*. Marine and freshwater protists were isolated from the environment and offered live *Campylobacter jejuni* labeled with a fluorogenic compound (CellTracker Green CMFDA, hereafter CTG). Protist fluorescence was strongly related to the number of bacteria ingested and was used as a proximal measure for intracellular bacterial concentrations. Protist fluorescence and the concentration on bacteria were measured via flow cytometry and were used to calculate rates of ingestion, digestion, and egestion. These metabolic rates varied between protist groups tested. The longest intracellular survival time was measured in freshwater protists (5 h), indicating *Campylobacter* may be best adapted to intracellular survival in a low salinity environment.

Fischer, **D. G.**, The Evergreen State College, Olympia, WA, USA, fischerd@evergreen.edu
LeRoy, C. J., The Evergreen State College, Olympia, WA, USA, leroyc@evergreen.edu
Janda, S., The Evergreen State College, Olympia, WA, USA,
Stygar, A., The Evergreen State College, Olympia, WA, USA,
Martin, A., The Evergreen State College, Olympia, WA, USA,

DOES INTRA-SPECIFIC VARIATION IN PRODUCTIVITY AND GROWTH-ALLOCATION OF A FOUNDATION RIPARIAN FOREST TREE LEAD TO DIFFERENCES IN BANK STABILIZATION?

In this study we use 75 permanent plots in *Populus* -dominated riparian forest in Utah, USA, to assess differential persistence and growth among parent and hybrid *Populus* trees (*P. fremontii* S. Watson, *P. angustifolia* James, and *P. fremontii x angustifolia* hybrids). Over six-years, we found that while one species (*P. fremontii*) is most productive, the same species was most likely to be lost in bank erosion in moderate-sized flood events (based on 120 years of peak flow data). Previous work has demonstrated *Populus fremontii* produces significantly lower fine root biomass in natural stands, and is less likely to produce clonally-linked stands compared to *P. angustifolia* and hybrids. Thus, vulnerability to bank erosion events may highlight a trade-off between high above-ground carbon gain, clonal expansion, and long term persistence at a site. Additionally, these patterns provide an explanation for the persistence of hybrids and less productive trees in the presence of a more productive species. Genetic-based trade-offs in above-ground competitive ability and below-ground growth patterns may equalize contributions to long-term stand carbon uptake in the face of a dynamic hydrologic disturbance regime.

Fitzsimons, **J. D.**, Fisheries and Oceans Canada, Burlington, Canada, john.fitzsimons@dfo-mpo.gc.ca
Arts, M. T., Environment Canada, Burlington, Canada, Michael.Arts@ec.gc.ca
Brown, L., Environment Canada, Burlington, Canada, Lisa.Brown@ec.gc.ca
Brown, S. B., Environment Canada, Burlington, Canada,
Honeyfield, D. C., US Geological Survey, Wellsboro, USA, honeyfie@usgs.gov
Tillitt, D. E., US Geological Survey, Columbia, USA, dtillitt@usgs.gov

ARE DREISSENIDS AFFECTING THE AVAILABILITY OF ESSENTIAL NUTRIENTS TO AQUATIC COMMUNITIES IN THE GREAT LAKES?

Dreissenids, through their consumption of phytoplankton, affect the zooplankton that channel energy and essential nutrients obtained from phytoplankton to fish, resulting in a bottom-up cascade of effects on fish communities. Recent declines in fish recruitment from lakes colonized by dreissenids are not proportional to dreissenid abundance. This suggests that although dreissenids cause qualitative changes to zooplankton, possibly affecting their ability to support fish growth and reproduction, such changes may not be proportional to dreissenid density alone but reflect changes imposed by the underlying physico-chemical and/or biological environment (e.g. phosphorous, %calanoids) as well. We measured concentrations of several nutrients with known effects on fish: thiamine (B1), carotenoids (total (TC) and astaxanthin (AX)), essential fatty acids (ARA, EPA, DHA), and one anti-nutrient (thiaminase (B1X)), in zooplankton collected from lakes Michigan (LM), Huron (LH) and Superior (LS) where dreissenid abundance was high, moderate, and low, respectively. Concentrations of B1 (LH>LM>LS), TC (LM>LS>LH), AX (LH=LM=LS), ARA (LH, LM>LS), EPA (LH=LM=LS), DHA (LH>LM, LS)

were not proportional to dreissenid abundance whereas B1X was (LM>LH>LS). Therefore, nutrient availability may be influenced by both environment and dreissenids.

Flecker, **A. S.**, Cornell University, Ithaca, NY, USA, asf3@cornell.edu
McIntyre, P. B., University of Michigan, Ann Arbor, MI, USA, pbmcinty@umich.edu
Moore, J. W., University of California, Santa Cruz, Santa Cruz, CA, USA, jwmoore@biology.ucsc.edu

MIGRATORY FISHES AS MATERIAL AND PROCESS SUBSIDIES IN RIVERINE ECOSYSTEMS

Migratory fishes are common in rivers throughout the world, and can fundamentally alter recipient ecosystems. We explore different types of freshwater fish migrations and their importance as key subsidies from two perspectives, material and process subsidies. Most commonly, migratory species are considered in the context of material transfers of energy, nutrients, and other resources resulting in direct changes in resource pools. As a complement to this view of migratory species as "mobile bags of nutrients", migratory species can be important as process subsidies, which arise from feeding or other activities and directly affect process rates within recipient ecosystems. We compare ecological conditions and geographical patterns where we expect to find different types of subsidies from migratory fishes. Unlike material subsidies, which require high migrant biomass as conveyor belts of materials, we posit that migratory fishes can provide crucial process subsidies even when migrant biomass is low, if they are functionally unique and strong interactors. Drawing upon experimental and observational studies, we conclude that accounting for both material- and process-based perspectives is necessary to understand the ecological significance of fish migrations.

Fleet, **V.**, Ryerson University, Toronto, Canada, fleet.vivian@gmail.com

DETERMINING IMPACT OF TRIBUTYLTIN ON DAPHNIA MAGNA USING THE MULTISPECIES FRESHWATER BIOMONITOR

The analysis of organism behaviour represents a sensitive and ecologically-relevant method to monitor aquatic ecosystem quality. Behavioural responses can occur within hours of exposure to toxic substances and therefore can be used as an early-warning notification for spills or contamination of a water system. In this study, the effects of the aquatic pollutant tributyltin (TBT), an antifouling agent used on the hulls of ships, has been tested on Daphnia magna and quantified using the Multispecies Freshwater Biomonitor (MFB). The MFB is a non-optical, fully-automatic, online, real-time biomonitor designed to record behavioural patterns of aquatic vertebrates and invertebrates using quadrupole impedance conversion techniques. By using the MFB, the behavioural reactions of D. magna, such as change in swimming activity generated by a specific toxicant or family of toxicants can be determined. TBT concentrations tested were 1, 10, and 100 µg/L. At exposure to 10µg/L, swimming activity was seen to decrease slightly several hours after exposure. A statistically-significant decrease was observed when organisms were exposed to 100µg/L, with the initial effects becoming observable within 2 hours of exposure and death after 12 hours.

Flinn, **M. B.**, Murray State University, Murray, USA, michael.flinn@murraystate.edu
Larouche, J. R., University of Vermont, Brulington, USA, jlarouch@uvm.edu
Bowden, W. B., University of Vermont, Burlington, USA, breck.bowden@uvm.edu

THE INFLUENCE OF THERMOKARST ON SEDIMENT, ORGANIC MATTER, AND MACROINVERTEBRATE COMMUNITY DYNAMICS IN ARCTIC HEADWATER STREAMS

Recent research has documented changes in arctic climate that influence permafrost degradation and the incidence of thermokarst formation. In 2009, we examined several thermokarst failures on headwater streams near Toolik Lake, AK, USA. We quantified significant differences between reference (upstream) and impacted stream reaches affected by two different thermokarst features. Sediment deposition, measured with sediment traps, showed that there were no differences in the organic fractions; however, the inorganic fraction was ~2x higher ($P<0.05$) in the impacted reaches. The pattern of benthic organic matter and fine sediment (stovepipe core) generally showed a 2x increase in the impacted reaches. Significant increases of ammonium ($P<0.05$) and benthic chlorophyll a ($P<0.01$, rock scrubs) were significantly higher in the impacted reaches and increased sharply downstream of the thermokarst, especially in late summer. Benthic macroinvertebrates showed a decrease in abundance and biomass in the impacted reaches. The response in functional feeding groups was variable between the streams and reaches. Collector-gatherer groups showed little change in abundance and biomass, whereas scraper biomass showed a 3x decrease and shredders showed a 2-5x increase in the impacted reaches.

Flury, **S.**, Aarhus University, Aarhus, Denmark, sabine.flury@biology.au.dk
Gessner, M. O., ETH Zurich / Eawag, Duebendorf, Switzerland, mark.gessner@eawag.ch

EXPERIMENTALLY SIMULATED GLOBAL WARMING AND NITROGEN ENRICHMENT EFFECTS ON MICROBIAL LITTER DECOMPOSERS IN A MARSH

Atmospheric warming and increased nitrogen deposition are changing habitat conditions, which in turn can alter species composition in communities. Since microbes are essential for most biogeochemical transformations, a key question is to what extent microbial communities are affected. To answer this question, we analyzed microbial communities on leaf litter decomposing in mesocosms under conditions of simulated climate warming and nitrogen enrichment in a littoral freshwater marsh. Phragmites leaf litter enclosed in mesh bags was placed into the mesocosms in autumn. Following retrieval in spring and summer, litter samples were analyzed for bacterial community composition, bacterial and fungal biomass, and microbial respiration. Fingerprinting profiles of bacteria obtained by denaturing gradient gel electrophoresis (DGGE) indicate that communities responded to experimental warming, mesh-size of the litter bags, and sampling date. Microbial respiration and bacterial biomass were unaffected by warming or nitrogen addition. However, fungal biomass was reduced by warming. Overall, climate change effects were weak, suggesting that microbial communities on decomposing leaves in freshwater marshes are quite robust to both temperature increases and surplus nitrogen in the ranges forecast by current climate models.

Folino-Rorem, **N.**, Wheaton College, Wheaton, USA, nadine.c.folino-rorem@wheaton.edu

EFFECTS OF SALINITY ON THE INVASIVE, EURYHALINE HYDROID CORDYLOPHORA

Cordylophora is a colonial, euryhaline hydroid occurring in freshwater and brackish habitats. The distribution of Cordylophora may be expanding due to its ability to acclimate in habitats of different salinities. The purpose of this research was to assess colony growth of a freshwater and a brackish population of Cordylophora in various salinities. Colonies from a freshwater and a brackish river were transitioned through varying salinities in a stepwise manner with 0 PSU serving as a control for the freshwater population and 10 PSU serving as a control for the brackish population. Mean numbers of hydranths and polyp size were recorded at salinities ranging from 0-24 PSU. Colony growth was optimal at 4PSU for the freshwater population and 12 PSU for the brackish population. Brackish population results concur with previous work; however, this research is unique because the growth of a freshwater population of Cordylophora in various salinities has not been previously documented. Studying how this invasive hydroid acclimates and grows in habitats of varying salinity will aid in understanding how this invasive hydroid becomes established in new aquatic habitats.

Follstad Shah, **J. J.**, Duke University, Durham, USA, follstad.shah@duke.edu
Harner, M. J., University of Nebraska-Kearney, Kearney, USA, harnermj@unk.edu
Tibbets, T. M., University of Wyoming, Laramie, USA, riosuerte@gmail.com

CONVERSION OF FOUNDATION SPECIES IN SEMIARID TO ARID RIPARIAN ECOSYSTEMS AND EFFECTS ON N CYCLING AND RETENTION

River regulation has resulted in the loss of the seasonal flood pulse in many semiarid to arid riparian ecosystems. Altered flood regime combined with periodic drought and increased fire frequency has led to declines in native *Populus deltoides* ssp. *wislizeni* (Rio Grande cottonwood) forests. Nonnative *Tamarix* spp. (salt cedar) and *Elaeagnus angustifolia* (Russian olive) are now the 3rd and 4th most common woody riparian species in the interior, western U.S. These three species differ with respect to their adaptations for water and nitrogen (N) acquisition and their abilities to withstand fire and flooding, which results in species-specific differences in litter quality and quantity, rates of litter decomposition, and N inputs to riparian soils and adjacent surface waters. Climate change is predicted to alter the timing and magnitude of the spring flood pulse as well as increase the likelihood of more frequent and prolonged

drought. Hence, *Tamarix* spp. and *E. angustifolia* are expected to dominate riparian forests of semiarid to arid regions of the U.S. in less than a century, resulting in potentially significant changes in N cycling and retention.

Fong, **A**. **A**., University of Hawaii, Honolulu, USA, fonga@hawaii.edu
Clemente, T. M., University of Hawaii, Honolulu, USA, tclement@hawaii.edu
Viviani, D. A., University of Hawaii, Honolulu, USA, viviani@hawaii.edu
White, A. E., Oregon State University, Corvallis, USA, awhite@coas.oregonstate.edu
Wheeler, B. R., University of Hawaii, Honolulu, USA, bwheeler@hawaii.edu
Updyke, B. D., University of Hawaii, Honolulu, USA, updyke@hawaii.edu
Weersing, K. A., University of Hawaii, Honolulu, USA, weersing@hawaii.edu
Ernst, J. A., Algalita Marine Research Foundation, Long Beach, USA, jeffery.ernst@gmail.com
Karl, D. M., University of Hawaii, Honolulu, USA, dkarl@hawaii.edu
Kemp, P. F., University of Hawaii, Honolulu, USA, paulkemp@hawaii.edu

PLASTIC PARTICLES CREATE NOVEL MICROBIAL MICROHABITATS IN THE NORTH PACIFIC

Marine particles and aggregates have long been studied using microbiological and chemical analyses to understand their role in biogeochemical cycling, food web dynamics, and microbial processes. By these means and imaging, macroscopic marine aggregates, also known as marine snow, have been identified as microbial micro-environments, heavily colonized by bacteria and enriched in nutrients relative to surrounding waters. In the summer of 2008, aboard the R/V Kilo Moana, we had the opportunity to collect 'novel' marine particles from the North Pacific Gyre; mainly small, synthetic plastic debris. We collected plastic particles via surface net tows and coincident whole sea water samples for nucleic acid extraction and molecular analyses. Unlike naturally-formed organic particles, plastic particles are compositionally new micro-habitats that are not easily degraded and remain afloat indefinitely. To examine the microbial communities of plastic pieces and surrounding waters, we employed PCR-based techniques, including terminal-restriction fragment length polymorphism (T-RFLP), cloning and sequencing. Additionally, we have compared these results to corresponding data on marine snow. To our knowledge, this is the first presentation of such data on plastic particles in the marine environment.

Forshay, **K**. **J**., Office of Research and Development, United States Environmental Protection Agency, Ada, USA, forshay.ken@epa.gov
Mayer, P., Office of Research and Development, United States Environmental Protection Agency, Ada, USA,
McElmurry, A., Office of Research and Development, United States Environmental Protection Agency, Ada, USA,
Kent, A., Department of Natural Resources and Environmental Sciences, University of Illinois , Urbana-Champaign, USA,
Koval, J., Department of Natural Resources and Environmental Sciences, University of Illinois , Urbana-Champaign, USA,
Faulkner, B. M., Office of Research and Development, United States Environmental Protection Agency, Ada, USA,
Zhao, Y., Department of Earth and Environment, Franklin and Marshall College, Lancaster, USA,
Merritts, D., Department of Earth and Environment, Franklin and Marshall College, Lancaster, USA,
Walter, R., Department of Earth and Environment, Franklin and Marshall College, Lancaster, USA,

DENITRIFICATION AND NITROGEN DYNAMICS IN BANK SEDIMENTS OF A MID-ATLANTIC INCISED STREAM DEPOSITED WITH DEEP LEGACY SEDIMENTS.

Excess legacy sediments deposited in former impounded streams frequently bury Holocene pre-settlement wetlands, decrease *in-situ* nitrogen removal, and increase nitrogen transport downstream, particularly where deep incised channels limit sediment-water interactions. This has prompted efforts in the mid-Atlantic region to remove legacy sediments and restore floodplain wetlands. In this study we measured the denitrification rates and limiting nutrients (carbon and/or nitrate) of incised bank sediment strata at Big Spring Run. This stream has highly variable riparian groundwater nitrate-N over 20 mg L^{-1} to near zero and is slated for legacy sediment removal in 2010. Our results show that buried pre-settlement hydric soils support significantly greater denitrification potential than accumulated legacy sediments (18.36 ± 6.41nG $g^{-1}hr^{-1}$ vs. 4.01 ± 1.37, $p<0.05$). We found that organic carbon limits denitrification potential in deposited legacy sediments (post hoc $p<0.05$) while buried hydric sediments are not limited by carbon, even after centuries of burial. These denitrification rates, nutrient concentrations, and nitrate ^{15}N and ^{18}O help identify geomorphic structures where sediment and groundwater interactions will support enhanced denitrification and aid in future restoration activities in the region.

Fortino, **K**., University of North Carolina Chapel Hill, Chapel Hill , USA, kfortino@email.unc.edu
Whalen, S. C., University of North Carolina Chapel Hill, Chapel Hill, USA,

CONNECTIONS BETWEEN THERMOCLINE DEPTH AND ORGANIC MATTER MINERALIZATION IN ARCTIC LAKES: A POTENTIAL FEEDBACK BETWEEN CLIMATE CHANGE AND CARBON STORAGE.

The overall effect of climate change on arctic lakes remains unclear. Lakes are a common landscape feature in the arctic with connections to carbon cycling through sediment organic matter sequestration. We found that variation in sediment organic matter mineralization (measured as sediment oxygen demand) is explained primarily by variation in temperature and oxygen availability. This indicates that factors affecting lake temperature and oxygen indirectly affect sediment metabolism and therefore organic matter sequestration. In stratified lakes, the distribution of temperature and oxygen is primarily controlled by thermocline depth. We found that thermocline depth was related to light attenuation in the water, which was related to the concentration of dissolved organic matter. The interconnection between these factors provides a potential climate change feedback to arctic carbon cycling. Changes in terrestrial organic matter inputs to lakes due to climate change will alter transparency and the depth of the thermocline, changing the distribution of temperature and oxygen in the lake and thus the factors limiting the decomposition of organic matter stored in lake sediments.

Francis, **D**. **R**., Geosciences Dept., University of Massachusetts, Amherst, MA, USA, dfrancis@geo.umass.edu
Engels, S., Dept. of Biology, University of New Brunswick, Fredericton, NB, Canada, sengels@unb.ca
Shuman, B., Geology and Geophysics, University of Wyoming, Laramie, WY, USA, bshuman@uwyo.edu
Cwynar, L. C., Dept. of Biology, University of New Brunswick, Fredericton, NB, Canada, cwynar@unb.ca

COMPARISON OF LOCAL AND REGIONAL TRAINING SETS FOR CHIRONOMID-INFERRED LAKE LEVEL CHANGE

Quantitative reconstructions of lake level changes require calibration data sets based on modern chironomid distributions, but there is some debate over the merits of local versus regional training sets. In a study of eight lakes in the Plymouth aquifer, Massachusetts, surficial sediment samples (5-25 per lake) were analyzed for chironomid remains. These data were used to construct single-lake inference models (site-specific models) and multiple-lake inference models (local models). These models are used to interpret down-core chironomid assemblages from Crooked Pond, MA. We also use inference models based on a large regional training set. Results can be compared to water-depth reconstructions derived from other, independent proxies, mainly sedimentological characteristics and pollen analysis. In the Plymouth aquifer lakes, composition of chironomid assemblages varied within lakes. Shallower lakes show small-scale variability related to depth, but lakes deeper than ~6 m show a clear turnover in assemblages and have distinctly different (sub-) littoral and profundal chironomid communities. We use the regional training set to test whether these compositional changes influence temperature reconstructions in these lakes.

Francis, **T. B.**, Northwest Fisheries Science Center, NOAA, Seattle, WA, USA, tessa.francis@noaa.gov

Brodeur, R. D., Northwest Fisheries Science Center, NOAA, Newport, OR, USA, rick.brodeur@noaa.gov

Levin, P. S., Northwest Fisheries Science Center, NOAA, Seattle, WA, USA, phil.levin@noaa.gov

Peterson , W. T., Northwest Fisheries Science Center, NOAA, Newport, OR, USA, bill.peterson@noaa.gov

Ruzicka, J. J., Northwest Fisheries Science Center, NOAA, Newport, OR, USA, jim.ruzicka@noaa.gov

Scheuerell, M. D., Northwest Fisheries Science Center, NOAA, Seattle, WA, USA, mark.scheuerell@noaa.gov

ANALYSIS OF OREGON COAST ZOOPLANKTON INTERACTIONS AND STABILITY USING MULTIVARIATE AUTOREGRESSIVE (MAR) MODELS WITH A MOVING WINDOW

The Northern California Current marine ecosystem is a highly dynamic system characterized by fluctuations of several key physical drivers at multiple temporal scales, including interannual cycles in regional climate packages, such as the PDO and ENSO. Accompanying these physical fluctuations are shifts in zooplankton community composition, particularly of copepods that are key prey for migrating Pacific salmon. Despite observed correlations between copepod community composition in coastal Oregon waters and Pacific salmon survival, little is known about the influence of physical drivers on the entire zooplankton community, or about the interactions among zooplankton taxa. Furthermore, management strategies aimed at improving the status of Pacific salmon lack solid predictive tools for large-scale oceanic regime shifts that may impact salmonid food webs. Here we use multivariate autoregressive (MAR) models to simultaneously identify the strongest environmental drivers of zooplankton community abundance, and the key interactions among potentially competing zooplankton taxa in coastal Oregon waters using a time series from 1997-2009. Using a novel moving window MAR (mwMAR) approach, we also explore the use of community stability metrics as leading or lagged indicators following large-scale regime shifts.

Frandsen, **P. B.**, Brigham Young University, Provo, USA, paulbfrandsen@gmail.com

Wertz, J. R., Brigham Young University, Provo, USA, fred3233@gmail.com

Nelson, C. R., Brigham Young University, Provo, USA, rileynelson@byu.edu

DIPTERA FAMILY DIVERSITY IN MONGOLIAN RIPARIAN ZONES AS IT RELATES TO HABITAT VARIABLES AND GRAZING PRESSURES

We examined adult Diptera family diversity in the riparian zone of Mongolian streams. Previous studies have examined the usefulness of Diptera family diversity as a bioindicator in other types of habitats elsewhere. Yellow pan traps were placed on the stream bank and collected after one hour at 68 different sites in western Mongolia during extended expeditions in 2008 and 2009. We collected at least 41 different families in our traps. We compared family-level diversity to measures of grazing pressure and water quality gathered by our research team. Initial analyses suggest that fly diversity is lower in more intensely grazed areas. Some aquatic groups, such as Chironomidae, were ubiquitous while others were only distributed in low impacted areas. We sorted adult dance flies (Diptera: Empididae), most of which are aquatic, to genus and initial results indicate the same patterns are followed at lower taxonomic levels.

Franke, **D.**, Memorial University of Newfoundland, St. John's, Canada, dfranke@mun.ca

Ziegler, S. E., Memorial University of Newfoundland, St. John's, Canada,

FACTORS REGULATING THE USE OF DISSOLVED ORGANIC CARBON BY BOREAL STREAM BIOFILM COMMUNITIES IN THE HUMBER RIVER WATERSHED, WESTERN NEWFOUNDLAND

In situ experiments were conducted using stream water and colonized tiles to assess how biofilm heterotrophic activity may be regulated by carbon and nutrient availability at sites within nine headwater boreal streams over three seasons. Community level respiration and dissolved organic carbon (DOC) uptake were measured and indicate highest microbial activity within wetland-dominated sites congruent with both the elevated DOC concentrations and greater proportion of carbohydrate carbon in peatland sources in this watershed. Further, trends of decreasing respiration rates downstream in these forested and wetland catchments followed decreases in carbohydrate and aromatic relative to aliphatic content, suggesting DOC source and composition influences microbial activity in these streams. Results of nutrient manipulations included in these experiments indicate that biofilm activity was limited by labile carbon at heavily nutrient-impacted sites, whereas heterotrophic activity within the forest and wetland catchments appeared co-limited by carbon, nitrogen, and phosphorous. These results suggest that heterotrophic microbial response to watershed nutrient enrichment caused by environmental change may become limited by bioavailable carbon in boreal streams.

Frauendorf, **T. C.**, Southern Illinois University, Carbondale, USA, tfrauend@siu.edu

Colon-Gaud, C., Southern Illinois University, Carbondale, USA, checo@siu.edu

Barnum, T. R., University of Georgia, Athens, USA, barnutr@uga.edu

Whiles, M. R., Southern Illinois University, Carbondale, USA, mwhiles@zoology.siu.edu

Lips, K. R., University of Maryland, College Park, USA, klips@umd.edu

Pringle, C. M., University of Georgia, Athens, USA, cpringle@uga.edu

Kilham, S. S., Drexel University, Philadelphia, USA, kilhams@drexel.edu

TROPHIC BASIS OF PRODUCTION IN A NEOTROPICAL HEADWATER STREAM: IMPLICATIONS FOR THE ECOLOGICAL CONSEQUENCES OF AMPHIBIAN DECLINES

The lack of a conceptual model describing the structure and function of neotropical streams limits our understanding of the potential consequences of ongoing amphibian declines in these systems. We examined gut contents of dominant invertebrates and tadpoles in a Panamanian headwater stream and combined this information with secondary production estimates to assess the trophic basis of production (TBP) and energy flow pathways. Omnivory was prevalent among all taxa examined. Non-algal biofilm material was the major contributor (average = 52%) to production of dominant taxa of all functional feeding groups except predators. Resource consumption rates did not change seasonally, but total annual organic matter consumption rates varied greatly among the dominant invertebrate scraper (*Farrodes*, 0.85 g/m^2/yr), filterer (*Macronema*, 7.6 g/m^2/yr), collector-gatherer (*Chironomidae*, 2.7 g/m^2/yr), and predator (*Tanypodinae*, 1.0 g/m^2/yr). The dominant shredder, *Anchytarsus*, consumed ~0.40 g/m^2/yr of coarse organic matter. Organic matter consumption by dominant tadpole taxa was 0.27 g/m^2/yr. This is the first study to examine the TBP in a neotropical stream, and it will allow for quantitative assessments of how amphibian declines may affect energy flow.

Freimann, **R.**, Eawag / ETH Zurich, Dübendorf, Switzerland, remo.freimann@eawag.ch

Robinson, C., Eawag / ETH Zurich, Dübendorf, Switzerland, Christopher.Robinson@eawag.ch

Buergmann, H., Eawag / ETH Zurich, Kastanienbaum, Switzerland, helmut.buergmann@eawag.ch

Findlay, S., Cary Institute of Ecosystem Studies, Millbrook, USA, findlays@ecostudies.org

MICROBIAL BIODIVERSITY IN SWISS ALPINE FLOODPLAINS: SEASONAL ASPECTS AND THE SHIFTING ROLE OF BACTERIA IN ECOSYSTEM FUNCTIONING

Microbes, such as heterotrophic bacteria, are crucial in the functional ecology of terrestrial and aquatic ecosystems, being the driving force behind metabolic processes, nutrient retention and recycling. Little is known about the bacterial community structure and function in alpine aquatic ecosystems. The proceeding climate-induced landscape change in alpine regions will likely influence microbial biodiversity and hence the ecosystem functioning. This study was conducted to understand the influence of water-resource (e.g. streamwater geochemistry) and seasonal variations in potential driving factors (e.g. organic material input and quality) on the hyporheic microbial biofilm. We studied three floodplains which all incorporate glacial, groundwater-fed and snow-fed streams. Average bacterial abundance was low in the glacial streams, whereas abundance was highest in groundwater-fed tributaries. Whole-cell in situ hybridization revealed a seasonal variability in abundance of Alpha- and Betaproteobacteria within all study sites. Seasonal effects were stronger pronounced in glacial streams. Detection of Eubacteria and abundance of Proteobacteria differed between floodplains. Our results suggest that seasonal factors (e.g. ice- and snowmelt dynamic, hydrologic linkages) contribute to the dynamic of stream biofilm.

Friedenberg, **N**. **A**., Applied Biomathematics, Setauket, NY, USA, nick@ramas.com
Killgore, K. J., US Army Corps of Engineers ERDC, Vicksburg, MS, USA, jack.killgore@erdc.usace.army.mil

AN ECOLOGICAL RISK ANALYSIS FRAMEWORK FOR PALLID STURGEON IN THE LOWER MISSISSIPPI RIVER

Pallid sturgeon represents a particular challenge for ecological assessment due to long lifespan, complex reproduction schedule, and chronically low population densities. Paradoxically, these life history features demand increased precision in management. In light of the absence of necessary data for full and confident model parameterization, the best role any quantitative analysis can play is to identify factors likely to have the most influence over viability. Such information can then guide management decisions and future data collection efforts. We formulate a spatially explicit metapopulation model of the lower Mississippi River and examine sensitivity to gross assumptions about spatial structure and population regulation using a risk analysis framework. The model differs from existing population viability analyses of pallid sturgeon both in its geographic scope and in its consideration of a latitudinal gradient in body size, which greatly reduces the expected size and fecundity of adults in southern populations. Ongoing efforts to elucidate the basic details of pallid life history include an endoscopy study that will identify the sex ratio and age of first reproduction in the lower Mississippi River.

Fritsen, **C**. **H**., Desert Research Institute, Reno, NV, USA, Christian.Fritsen@dri.edu
Memmott, J. C., Desert Research Institute, Reno, NV, USA, Jeramie.Memmott@dri.edu
Ross, R. M., University of California at Santa Barbara, Santa Barbara, CA, USA, ross@msi.ucsb.edu
Quetin, L. B., University of California at Santa Barbara, Santa Barbara, CA, USA, quetin@msi.ucsb.edu
Vernet, M., Scripps Institution of Oceanography, San Diego, CA, , mvernet@ucsd.edu

THE TIMING OF SEA ICE FORMATION AND ITS EFFECTS ON ENERGY TRANSFER INTO THE WINTER SEA ICE ECOSYSTEM ALONG THE WESTERN ANTARCTIC PENINSULA

Algae in sea ice are a required food source for overwintering juvenile Antarctic krill with implications for successful overwintering. The timing of ice formation in the Southern Ocean and subsequent energy input through exposure of the ice to photosynthetically active radiation (PAR) is thought to be a determinant of the abundance of algae that accumulates and/or grows in sea ice before winter onset. We have produced a model estimating total cumulative exposure of seasonal Antarctic sea ice to PAR. The model uses remotely sensed sea ice concentrations and PAR from the NASA/GEWEX SRB Project to estimate total ice exposure to PAR (TIEP). Initial evaluations show that the timing of ice formation has profound effects on the energy available for primary production (e.g. west of the Western Antarctic Peninsula (WAP), a near one month difference in ice formation and PAR input from 2001 to 2002 can lead to a five order of magnitude difference in PAR exposure going into winter) and can readily be evaluated when assessing changes in ecosystems thought to be due to changes in regional ocean's geophysical dynamics.

Fritz, **K**. **M**., USEPA, National Exposure Research Laboratory, Ecological Exposure Research Division, Cincinnati, USA, fritz.ken@epa.gov
Johnson, B. R., USEPA, National Exposure Research Laboratory, Ecological Exposure Research Division, Cincinnati, USA, johnson.brent@epa.gov
Price, R., Federal Energy Regulatory Commission, Washington DC, USA, rachel.price@ferc.gov

EXPORT OF DETRITUS AND INVERTEBRATE FROM HEADWATER STREAMS: LINKING MOUNTAINTOP REMOVAL AND VALLEY FILL COAL MINING TO DOWNSTREAM RECEIVING WATERS

Mountaintop removal and valley fill (MTR/VF) coal mining has resulted in large scale alteration of the topography, reduced forest productivity, and burial of headwater streams in the US Central Appalachians. Although MTR/VF coal mining has occurred for several decades and the direct impacts to headwater have been studied, there is little known about the consequences to downstream ecosystems. We examined the linkage of headwater streams to downstream receiving waters by comparing detritus and invertebrate subsidies from headwater streams draining forested and MTR/VF catchments in a southern West Virginia stream network. Drift nets (250-µm mesh) were deployed over 24-h periods seasonally near the outlets of 5 forested and 5 MTR/VF streams. Mean winter discharge ranged from 1.6 – 29.3 L s^{-1}. Total detritus (4.3-151 .0 mg m^{-3}) and total invertebrate (0.01-1.04 mg m^{-3}) export varied substantially among mined and forested streams during the winter, but did not differ by land use. However, mayfly density and biomass exported from forested catchments were significantly higher than from MTR/VF catchments during the winter, where mayflies were collected from only one of the five MTR/VF streams.

Frossard, **A**., Department of Aquatic Ecology, Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland, aline.frossard@eawag.ch
Gerull, L., Department of Freshwater Conservation, Brandenburg University of Technology, Cottbus, Germany, gerull@tu-cottbus.de
Mutz, M., Department of Freshwater Conservation, Brandenburg University of Technology, Cottbus, Germany, m.mutz@tu-cottbus.de
Gessner, M. O., Department of Aquatic Ecology, Eawag: Swiss Federal Institute of Aquatic Science and Technology , Dübendorf, Switzerland, gessner@eawag.ch

FLUCTUATING PATTERNS OF MICROBIAL ENZYME ACTIVITIES IN AN EARLY SUCCESSIONAL STREAM NETWORK

Metabolic activity in stream networks is regulated by a combination of factors related to landscape structure, with water availability expected to be a main driver. Accordingly, we hypothesized that across the intermittent stream network of an artificial early successional watershed (Chicken Creek in Germany), microbial metabolism is highest in permanent groundwater upwelling zones. We expected lowest rates in soils adjacent to channels and intermediate rates at other in-stream sites. Substrate analogues linked to fluorescent molecules were used to measure potential activities of ten enzymes. In each season, we sampled a total of 24 sites along the courses of three stream channels. Potential enzyme activities varied little among sites, despite contrasts in long-term water availability and other environmental factors. However, seasonal variability was pronounced, with the patterns varying among the tested enzymes. Weak correlations of water chemistry and temperature with enzymatic potentials suggest that the seasonal patterns were produced by shifts in microbial communities. Whether this explanation holds or not, it is clear that enzyme dynamics at a given site were much more prominent than spatial variation across physically contrasting sites.

Fuller, **C**. **B**., Clarkson University, Potsdam, USA, cfuller900@gmail.com
Bonner, J. S., Clarkson University, Potsdam, USA,
Ojo, T., Clarkson University, Potsdam, USA,
Kirkey, W., Clarkson University, Potsdam, USA,
Islam, M. S., Beacon Institute, Beacon, USA,

COLLOIDAL CONCENTRATION ESTIMATION USING ADCP ECHO INTENSITY

Interest has grown for using ADCPs to make suspended solids concentration (SSC) measurements in aqueous environments due to the ability make simultaneous multipoint measurements with high spatial and temporal resolutions. The echo intensity measured by ADCPs is a function of both the particle size and concentration and thus provides the theoretical basis for measuring SSC. This study shows depth specific echo intensity from a 2400 kHz ADCP to be linear on a semi-log scale to colloidal clay suspension mass concentration standards. Both the linear slopes and correlation coefficients increased with depth as a result of signal attenuation from beam spreading and water absorption. The laboratory methods and computations used to derive depth bin specific SSC estimates are shown. The empirical relationship between the measured echo intensity and total volume concentration is evaluated with respect to the theoretical echo intensity derived from the Rayleigh scattering equation and the empirical particle size distribution determined with a Laser In-Situ Scattering Transmissometer. This analysis will provide insight regarding the applicability of this technology to natural systems characterized by non-ideal (i.e. non-spherical) particles.

Fuller, **R**., Colgate University, Hamilton, USA, rfuller@colgate.edu
Doyle, S., Colgate University, Hamilton, USA,
Levy, L., Colgate University, Hamilton, USA,
Owen, J., Colgate University, Hamilton, USA,
Shope, E., Colgate University, Hamilton, USA,
Swarr, G., Colgate University, Hamilton, USA,
Vo, L., Colgate University, Hamilton, ,
Weichert, K., Colgate University, Hamilton, USA,
Wolyniak, E., Colgate University, Hamilton, USA,
Doyle, M., University of North Carolina, Chapel Hill, USA,

INFLUENCE OF FLOOD HISTORY AND HYDROLOGY ON TRANSPORT OF ORGANIC MATTER IN FREQUENTLY FLOODED RIVERS.

We studied 4 rivers with different hydrographs and flood frequencies in the Adirondack Mountains, New York USA (Indian, Upper Hudson, Cedar, and Boreas Rivers) during summer and autumn 2005. Recreational releases from Abanakee Dam 4 days/week from April to October increased discharge 10 fold in the Indian River and to a lesser extent in the Upper Hudson below their confluence. In all rivers, particulate organic matter (POM) transport decreased from June to August, and there was a shift from mostly terrestrial POM in June to filamentous algae in July and August in the Indian and Upper Hudson River because of scouring of periphyton during releases. We did not observe an exhaustion of POM in transport in these 2 rivers despite the frequent floods. However, in 2006, we sampled POM transport in all rivers during and after a natural flood. While POM transport was high in the Indian River during the flood, it was not as high as in rivers with natural hydrographs suggesting POM transport in the Indian was lower due to previous scour from recreational releases.

Füreder, **L**., University of Innsbruck, Innsbruck, Austria, leopold.fuereder@uibk.ac.at
Leichtfried, M., Institute of Limnology, Mondsee, Austria, maria.leichtfreid@oeaw.ac.at
Weliange, W. S., University of Innsbruck, Innsbruck, Austria, wasanthaweliange@yahoo.co.uk
Amasaringhe, U. S., University of Kelaniya, Kelaniya, Sri Lanka, zoousa@kln.ac.lk

THE IRESA PROJECT: CATCHMENT PROPERTIES, HABITAT CONDITIONS AND FUNCTIONAL ORGANIZATION OF KEY SPECIES IN TWO TROPICAL RIVERS

The cooperative project "IRESA - Initiative of River Ecology in Sri Lanka: from Science to Application", between Austria and Sri Lanka investigates two streams each draining different climate zones. The aim of this study was to investigate the spatio-temporal distribution of macroinvertebrates and fish and their trophic relationships in these two contrasting tropical rivers. Catchment conditions, land-use activities and anthropogenic impacts were assessed during three field trips in 2005, 2006 and 2007. Main physico-chemical parameters, seston and Aufwuchs were different when the streams were compared; the number of fish species, benthic macroinvertebrate families and morphospecies differed also significantly. Dual stable isotope analysis (δ15N, δ13C) were used to estimate the functional organisation of key organisms. The feeding ecology of fish and benthic macroinvertebrates and their trophic interactions along a longitudinal gradient were found to be dependent from the environmental conditions in the two tropical streams.

Furey, **P**. **C**., University of California Berkeley, Department of Integrative Biology, Berkeley, USA, pcfurey@hotmail.com
Power, M. E., University of California Berkeley, Department of Integrative Biology, Berkeley, USA, mepower@berkeley.edu
Lowe, R. L., Bowling Green State University, Department of Biological Sciences, Bowling Green, USA, Lowe@bgsu.edu
Cambell-Craven, A. M., University of California Berkeley, Department of Integrative Biology, Berkeley, USA, acampbellcraven@berkeley.edu

FUNCTIONALLY DIFFERENT MIDGE (*PSEUDOCHIRONOMUS RICHARDSONII*) IMPACTS ON *CLADOPHORA* MEDIATED BY DIFFERENT ALGAL EPIPHYTES

In the South Fork Eel River, California, midge larvae (*Pseudochironomus richardsonii*) weave retreats in the filamentous alga, *Cladophora*, and graze on its algal epiphytes. Epiphyte assemblages of *Cladophora* vary spatially and seasonally. New *Cladophora* growth is green, turns yellow with early diatom colonization primarily by *Cocconeis*, and later rusty-colored as it becomes heavily epiphitized by *Epithemia* spp., diatoms that contain N-fixing cyanobacteria. To determine how midge grazing influences epiphyte assemblage structure, we incubated green, yellow, and rusty *Cladophora* in the presence and absence of midges and assessed midge impacts on epiphytes with light and scanning electron microscopy. Midges were less effective at grazing adnate *Cocconeis* cells than loosely attached *Epithemia*. Midge removal of *Epithemia* from rusty *Cladophora* restored its green color. In contrast, at the margins of *Cocconeis*, we observed concentrations of heterotrophic epiphytes and bacteria. *Cocconeis* may have enhanced heterotroph growth, either by providing a micro-refuge from midges, or by injuring *Cladophora* cell walls and causing leakage. These two dominant *Cladophora* epiphytes exert different direct and indirect (grazer-mediated) effects that are likely functionally significant for food-webs and biogeochemical fluxes.

Gabel, **F**., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, gabel@igb-berlin.de
Breyer, P., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, breyer@igb-berlin.de
Burmester, V., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, burmester@igb-berlin.de
Pusch, M., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, pusch@igb-berlin.de
Walz, N., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, walz@igb-berlin.de
Garcia, X. F., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, garcia@igb-berlin.de

SHIP-INDUCED WAVES REDUCE GROWTH AND FITNESS OF NATIVE BUT NOT OF INVASIVE BENTHIC INVERTEBRATES

Ship-induced waves disturb benthic invertebrates colonizing littoral zones. However, few is currently known about the consequences for individuals of long-term wave exposition. In this study, we compared the impacts of ship-induced waves on the growth and fitness of four species of native and invasive macroinvertebrates. Two amphipods (native Gammarus roeseli and invasive Dikerogammarus villosus) and two gastropods (native Bithynia tentaculata and invasive Physella acuta) were separately exposed to simulated waves and in control flume without waves for six weeks. Growth rates (body length and dry mass) from 30 individuals of each treatment were determined biweekly and ingestion and activity were monitored by video records. Fitness was evaluated by glycogen content analyses. For the native invertebrates similar ingestion rates were observed in both treatments, however, lower growth rate and fitness were recorded under wave disturbance. No differences were recorded between treatments for the invasive species. Because ship-induced waves impact the growth and fitness of native species more than of invasive ones, this may ultimately lead to changes in the composition of the littoral macroinvertebrate community.

Gabel, , K. W., New York City Department of Environmental Protection, Valhalla, USA, kgabel@dep.nyc.gov
Wehr , J. D., Louis Calder Center - Biological Field Station, Fordham University, Armonk, USA, wehr@fordham.edu
Truhn, **K**., Louis Calder Center - Biological Field Station, Fordham University, Armonk, USA, find_kam@yahoo.com

ASSESSMENT OF BMP EFFECTIVENESS IN AN AGRICULTURAL LANDSCAPE USING DIATOMS AND MACROINVERTEBRATES

In an effort to minimize impacts of agricultural runoff, the NYC Department of Environmental Protection in conjunction with the Watershed Agricultural Council and local farmers have implemented Best Management Practices (BMPs) such as riparian buffers, manure management, and barnyard improvements on working farms in upstate NY. To assess BMP effectiveness, diatom composition and macroinvertebrate community composition were analyzed along with water quality parameters in first-order streams within the watershed. Three stream classes, reference, BMP, and non-BMP, were selected based on watershed size and land-use intensity. Diatom species richness, % eutraphenic species, diatom model affinity, trophic diatom index and generic diatom index all indicated greater water quality in BMP streams than unimproved agricultural streams, although reference streams had significantly greater water quality than either stream class. Several diatom indexes also

correlated significantly with turbidity, conductance, and dissolved P and N. Macroinvertebrate data and indexes (richness, % EPT, HBI, DMA) showed similar trends, but none were statistically significant among stream classes. Data suggest that diatoms may be more sensitive indicators of BMP effectiveness in first order agricultural streams in NY state.

Lehrer-Brey, G. L., University of Wisconsin - Madison, Madison, USA, lehrerbrey@wisc.edu
Nilsson, E. J., University of Wisconsin - Madison, Madison, USA, enilsson@wisc.edu
Vander Zanden, M. J., University of Wisconsin - Madison, Madison, USA, mjvanderzand@wisc.edu

DOES INDIVIDUALITY INCREASE SUCCESS OF INVADERS? INDIVIDUAL DIET SPECIALIZATION IN THE RUSTY CRAYFISH (ORCONECTES RUSTICUS)

Invasive species are a major threat to the biodiversity, structure and function of ecosystems. The rusty crayfish is an example of an invasive species that has negatively impacted freshwater ecosystems by reducing the densities and diversity of macroinvertebrates and native congeners. In the presence of high intraspecific competition, theory suggests that individuals should specialize in order to minimize competition. Because rusty crayfish are opportunistic omnivores, it is unknown if individual diet specialization occurs and contributes to their ability to establish and maintain high population densities. We hypothesized that individual rusty crayfish will have more specialized diets in lakes with higher population densities. To test this, ten crayfish were collected from 17 lakes in northern Wisconsin and their gut contents were analyzed. The Proportional Similarity Index was used to compare diets of individual crayfish from each population. Results support our hypothesis, indicating that individual diet specialization increases with crayfish density. This suggests that as population density increases and resource availability decreases, individual crayfish become more specialized as a way of decreasing intraspecific competition. This may contribute to their success as invaders.

Gaiser, **E. E.**, Florida International University, Miami, USA, gaisere@fiu.edu

REGULATION OF OLIGOTROPHY BY PERIPHYTON IN KARSTIC WETLANDS

Periphyton is an abundant and ubiquitous feature of karstic, oligotrophic freshwater wetlands, usually forming thick mats that blanket shallow limestone sediments and submersed plants. They are considered to be primary ecosystem engineers by forming marl and stabilizing soils, controlling concentrations of nutrients and gases, and supplying food and structure for other organisms. Calcareous periphyton mats are comprised of a taxonomically distinct and highly symbiotic association of bacteria and algae that regulate water column concentrations of phosphorus to an ambient range of 5-10 ug/L. Upon exposure to above-ambient concentrations of phosphorus, mats dissociate and are replaced by ubiquitous microbial communities indicative of enrichment. The importance of calcareous mats in regulating water column nutrient concentrations in karstic wetlands will be discussed. The paradox of high periphyton productivity in this low-nutrient setting challenges the application of classic concepts of oligotrophy to karstic freshwater ecosystems.

Galatowitsch, **M. L.**, University of Georgia, Athens, GA, USA, galatom@uga.edu
Batzer, D. P., University of Georgia, Athens, GA, USA, dbatzer@uga.edu

BENEFITS AND COSTS OF *LEPTOPHLEBIA* (EPHEMEROPTERA) MOVEMENTS BETWEEN RIVER CHANNELS AND FLOODPLAIN WETLANDS

Linkages between river channels and floodplain wetlands are important for organisms in each habitat, but especially so for species that use both habitats. Nymphs of certain mayfly species (e.g., Leptophlebiidae, Siphlonuridae) undergo seasonal movements into seasonal floodplain habitats. Migrations have primarily been documented in northern temperate climates; there are no comprehensive studies from southern latitudes. High densities of leptophlebid nymphs have been observed in Southeastern US floodplains, but how and why they colonize and develop in these temporary habitats has not been established. We studied benefits and costs of *Leptophlebia* mayfly movements into temporary floodplain wetlands in the Georgia Piedmont through descriptive observations and field experiments. While we found mayflies actively migrated into floodplains, few environmental (i.e. temperature, predation, food quality or abundance) advantages were apparent in wetland compared to river habitats. Despite this, mayflies had higher growth rates in the wetlands and were adapted to tolerate short-term drying typical of floodplain habitats. The reasons why mayflies moved into floodplains remain ambiguous; though may be attributed to avoiding swift river flows or an evolutionary relic behavior from temperate climate conditions.

Galbraith, **L. M.**, Australian Rivers Institute, Griffith University, Brisbane, Australia, l.galbraith@griffith.edu.au
Säwström, C., Australian Rivers Institute, Griffith University, Brisbane, Australia, c_sawstrom@hotmail.com
Pollard, P. C., Australian Rivers Institute, Griffith University, Brisbane, Australia, p.pollard@griffith.edu.au

LYSOGENY AND VIRAL INDUCTION OF FRESHWATER CYANOBACTERIA IN SUBTROPICAL AUSTRALIA

Viral lysis as a result of lysogenic induction has been implicated in the sudden termination of cyanobacteria blooms. However, little is known of the extent of lysogeny in freshwater subtropical cyanobacteria. We induced lysogeny by adding mitomycin C (1 mg/L). In isolates of cyanobacteria, five of eight species lysed, with the decrease in host cells accompanied by a concomitant increase in virus (cyanophage) abundance. In the wild, mitomycin C (1 mg/L) addition induced lysogeny in cyanobacteria in two of six lakes sampled in spring and summer. From our results it appears that lysogeny is a common occurrence in cyanobacteria in subtropical Australia. We have also studied lysogeny in seven strains of the cyanobacteria *Cylindrospermopsis raciborskii* and present our findings. Cyanobacteria in culture and in the wild co-exist with heterotrophic bacteria, which are generally more abundant and may also be lysogenic. We discuss methods to detect increases in cyanophage when investigating lysogeny in cyanobacteria with associated heterotrophic bacteria, and evaluate the implications of high rates of lysogeny for bloom dynamics.

Gallina, **N.**, University of Geneva, Geneva, Switzerland, nicole.gallina@unige.ch
Anneville, O., Natinal Institute for Agricultural Research INRA, Thonon-les-Bains, France, orlane.anneville@thonon.inra.fr
Jacquet , S., Natinal Institute for Agricultural Research INRA, Thonon-les-Bains, France, stephan.jacquet@thonon.inra.fr
Beniston, M., University of Geneva, Geneva, Switzerland, Martin.Beniston@unige.ch

DO EXTREME CLIMATIC EVENTS HAVE AN IMPACT ON THE DEVELOPMENT OF CYANOBACTERIA IN LAKE GENEVA?

Cyanobacteria, a pigmentary group of phytoplankton, are of particular interest. Some genera have the capacity to proliferate excessively and to produce toxic blooms, which may lead to major negative impacts on the environment and on public health. In Lake Geneva, the largest lake in central Europe, cyanobacteria blooms still remain anecdotal. The aim of this study is to analyze whether, as hypothesized, more frequent episodes of harmful cyanobacteria bloom outbreaks could occur in Lake Geneva under warmer climatic conditions projected for the coming decades of the 21st century. Air temperature extremes under current climate were used as a proxy for future "average" climate forced by enhanced greenhouse gases, since many climate models suggest that today's extremes may become the norm by 2100. We investigated the evolution of cyanobacteria in response to extreme air temperature events which occurred in Lake Geneva from 2000 to 2008, and compared their behaviour to a 30-year reference period. The results indicate that under extreme seasonal temperature events, cyanobacteria become more important and are able to alter the common species composition.

Gangloff, **M. M.**, Appalachian State University, Boone, USA, gangloffmm@appstate.edu
Hoch, R. A., Appalachian State University, Boone, USA, hoch.rachael@gmail.com
Hamstead, B. A., Appalachian State University, Boone, USA, byron.hamstead@gmail.com>
Silvano, A. L., Alabama Cooperative Fish & Wildlife Research Unit, Auburn, USA, silvaal@auburn.edu
Grand, J. B., Alabama Cooperative Fish & Wildlife Research Unit, Auburn, USA, grandjb@auburn.edu

FRESHWATER MUSSEL MICROHABITAT USE IN THE SIPSEY RIVER, ALABAMA

The Sipsey River in west-central Alabama is a global hotspot for freshwater mussel biodiversity. Populations of 35 species persist in this pristine Mobile

Basin stream. In 2009 we quantitatively sampled mussels using 0.25 m^2 quadrats (n = 30 per site) at 7 randomly-selected sites. We excavated quadrats and measured physical habitat parameters at equi-distant intervals along cross-channel transects. Quantitative sampling and haphazard shell collections detected 24 taxa (21 alive) with site-scale richness ranging from 7 to 21 (2 to 15 alive) including 4 federally-listed mussels. Pleurobema decisum, a federally endangered species, was the most abundant mussel detected (n = 145, density = 2.8 m^{-2}). Mean mussel density was 8.5 m^{-2} and ranged from 0.3 to 26.7 m^{-2}. We used backward stepwise regression (BSR) to model quadrat-scale density and richness. BSR models revealed that substrate parameters were the best predictor of mussel density ($F = 12.9$, $p < 0.001$). Richness was best predicted by depth and particle diameter ($F = 37.6$, $p < 0.001$). These data suggest that microhabitat parameters are important to mussels even in relatively pristine streams.

Ganguly, **S**. **S**., University of Arkansas, Fayetteville, USA, sganguly@uark.edu
Smock, L. A., Virginia Commonwealth University, Richmond, USA, lasmock@vcu.edu

SPATIAL AND TEMPORAL VARIABILITY OF INVERTEBRATE COMMUNITIES IN VERNAL POOLS ON THE COASTAL PLAIN OF VIRGINIA

Vernal pools are among the least studied 'isolated' wetlands and have been known to exhibit spatial and temporal variations in the invertebrate communities present. The extent of these variations with respect to taxonomic composition and abundance was determined among a suite of 10 close proximity vernal pools in eastern Virginia, USA. Taxa such as the chironomid Endochironomus, a cyclopoid copepod (Cyclops sp.), a species of long-legged fly (Dolichopodidae) and water mites (Hydracarina) composed majority of the invertebrates in the pools. In Principle Component Analysis, more than 70% of the differences observed in the taxa present and their abundances among pools in both seasons were explained by Axes 1 and 2. Correlation and regression analyses indicated a significant relationship between temperature and total species richness of the pools; however temperature explained only about 37 % of these variations. Taxa richness and abundance in the pools decreased as the hydrologic year progressed. β-diversity was low in both seasons; however α-diversity decreased as the hydrologic year progressed, indicating a convergence in community structure in the closely located but hydrologically distinct pools.

Garcia, **E**. **A**., Charles Darwin University, Darwin, Australia, erica.garcia@cdu.edu.au
Townsend, S., Charles Darwin University, Darwin, Australia,
Douglas, M. M., Charles Darwin University, Darwin, Australia,

CONTEXT DEPENDENCY IN PERIPHTON AND INVERTEBRATES: INTERACTIONS BETWEEN VELOCITY AND NUTRIENTS IN THE AUSTRALIAN WET-DRY TROPICS

The interactive effect of river velocity and nutrient addition on paver periphyton and benthic invertebrates was examined in a 2-factorial experiment conducted in a 7th order river in the Australian wet-dry tropics during base flow conditions. The velocity factor was represented by 5 categories (0, 0.27, 0.48, 0.78 and 0.97 m/s) and nutrient addition by control and treatment. Nutrients were added by slow release capsules contained in mesh bags. Overall periphyton biomass was lowest at the highest velocity site and responded positively to nutrient addition only at the 0 m/s and 0.78 m/s sites. AFDM varied significantly between the different velocity sites but did not vary relative to nutrient treatments. Invertebrate communities in the high velocity sites differ greatly from all other sites regardless of nutrient treatment but at 0 m/s sites the community was more diverse with nutrient addition. These results highlight the importance of considering context dependency when examining periphyton biomass and invertebrate community structure.

García Lago, **L**., University of Vigo, Vigo, Spain, lilizar@uvigo.es
Pardo Gamundi, I., University of Vigo, Vigo, Spain, ipardo@uvigo.es

TEMPERATURE AND FOOD QUALITY INFLUENCE ON THE LIFE HISTORY TRAITS OF A DOMINANT DETRITIVORE SPECIES

Many studies have focused on different aspects of life histories, but few is known on the effects that water temperature and food quality have on all aquatic instars and aerial adults. Changes in tree species composition are a common practice in Galician (NW Spain) forests and over world. This activity can influence detritus quality and quantity, and water temperature through higher isolation due to deforestation. Brillia bifida (Chironomidae) is a dominant detritivore colonizing leaf packs in temperate streams. We manipulated experimentally food quality (alder vs. eucalyptus) and water temperature (14ºC vs. 9ºC) during larval development. At warm temperature, the development time was shorter, there were fewer maturates and growth rates were higher that at cold temperature. The survival and emergence were higher when larvae were reared in alder leaves at cold temperature. Sex ratio was unbalanced, and surprisingly, no males emerged in eucalyptus at warm temperature. In addition, larvae consumed more eucalyptus at warm temperature, which did not result in a higher biomass. Our results indicate important consequences for detritivores development when food quality from riparian areas is changed.

García-Roger, **E**. **M**., University of Barcelona, Barcelona, Spain, egroger@pcb.ub.es
Sánchez-Montoya, M. M., University of Murcia, Murcia, Spain, marsanch@um.es
Gómez, R., University of Murcia, Murcia, Spain, rgomez@um.es
Suárez, M. L., University of Murcia, Murcia, Spain, mlsuarez@um.es
Vidal-Abarca, M. R., University of Murcia, Murcia, Spain, charyvag@um.es
Rieradevall, M., University of Barcelona, Barcelona, Spain, mrieradevall@ub.edu
Prat, N., University of Barcelona, Barcelona, Spain, nprat@ub.edu

INFLUENCE OF HABITAT FEATURES AND AQUATIC MACROINVERTEBRATE ASSEMBLAGES OF MEDITERRANEAN TEMPORARY AND PERMANENT STREAMS: IMPORTANCE OF SEASONAL CHANGES

Here we examine the importance of seasonal changes in the characteristics of habitat features and aquatic macroinvertebrate assemblages of temporary and permanent streams from two very different catchments in the Western Mediterranean (Spain). We performed an innovative sampling design based in taking up to 20 small (15x15 cm) Surber samples according to the relative frequency of mesohabitats (i.e. riffles and pools) and microhabitats (i.e., a row of different mineral and organic-based substrates) in a reach, at two different moments during the hydrological cycle: 1) during the flowing period, where pool-riffle sequences are well-established, and 2) the dry phase, when only pools are expected to occur in the temporary streams. At the dry season, both a reduction in the available total habitat and in microhabitat diversity in all sites studied was observed. As a result, taxa richness decreased in all streams during the dry season, but more importantly in the temporary streams and in their remaining riffles. Macroinvertebrate assemblages differed among catchments (geographical identity) and sites (permanent vs temporary) within, as well as between mesohabitats and among microhabitats, particularly those mineral and organic, with some taxa related to particular habitats. The ratio EPT/OCH was proved to be a good indicator of the river intermittency.

Garey, **A**. **L**., Virginia Commonwealth University, Richmond, USA, gareyal@vcu.edu
Smock, L. A., Virginia Commonwealth University, Richmond, USA, lsmock@vcu.edu

EFFECTS OF FLOW PEAKING FOR HYDROELECTRIC POWER GENERATION ON THE BENTHIC MACROINVERTEBRATES OF THE ROANOKE RIVER, NC

We conducted a 3-year (2007-2009) investigation on the effects of flow peaking for hydroelectric power generation on the benthic macroinvertebrates of the Roanoke River, NC. We sampled each year in May to June, before the onset of summer hydropeaking, and again in late June to early July, after hydropeaking began. Hydropeaking events were characterized by rapid discharge increases of approximately 10-fold with sustained high flows for 3 to 5 hours. Analysis of taxonomic composition and of several common macroinvertebrate metrics indicated no significant differences between pre- and post-peaking samples. Punctuated increases in macroinvertebrate drift occurred during hydropeaking. Drift increased rapidly at the onset of peaking, but was not sustained throughout the peaking cycle. No increases in drift were observed during sampling on non-peaking days. Seventy-three taxa occurred exclusively in the drift during hydropeaking compared to base-flow periods. No taxa occurred exclusively in the drift during base-flow. Our results indicate that hydropeaking increases macroinvertebrate drift in a predictable manner. Drift sampling was much more effective for detecting hydropeaking effects in the system than standard benthic sampling.

Garris, **N**. **E**., UNC Charlotte/ Department of Biology, Charlotte , USA, ngarris3@uncc.edu

Long , E. D., UNC Charlotte/ Department of Civil and Environmental Engineering , Charlotte , USA, edlong@uncc.edu

Clinton, S. M., UNC Charlotte/ Department of Biology , Charlotte , USA, sclinto1@uncc.edu

McMillan , S. K., UNC Charlotte/ Department of Engineering Technology, Charlotte , USA, SMcMillan@uncc.edu

PATTERNS OF N AND P UPTAKE ACROSS URBAN HEADWATER STREAMS WITH VARYING LEVELS OF URBANIZATION

The overall aim of our study was to evaluate nutrient retention efficiency of streams with varying levels of urbanization in the metropolitan region of Charlotte, North Carolina, USA. During summer 2009, we conducted nutrient (NO_3^- and PO_4^{3-}) injections concurrently with a NaCl tracer in 3 streams: Gar Creek, Toby Creek, and Little Sugar Creek. Reach integrated transient storage parameters were estimated using OTIS coupled with calculation of reach scale nutrient spiraling metrics. Mean instream nutrient concentrations were similar across all sites (0.31 ± 0.03 mg L^{-1} NO_3^- and 0.07 ± 0.01 mg L^{-1} PO_4^{3-}). Despite differences in channel form, streambed heterogeneity, instream geomorphic structures, and riparian canopy, nitrate uptake velocities across all three streams were similar (V_f =0.8 - 1.2 mm min^{-1}). Phosphorus uptake (as V_f) across the three streams was correlated with transient storage suggesting the importance of channel diversity and heterogeneity. Interestingly, the restored stream had the lowest transient storage and nutrient uptake rates. We are continuing to investigate the importance of channel diversity and heterogeneity in urban streams and their potential role as "hot spots" for N-retention.

Gašparovic, **B**., Ruder Boškovic Institute, Zagreb, Croatia, gaspar@irb.hr

Frka, S., Ruder Boškovic Institute, Zagreb, Croatia, frka@irb.hr

Koch, B. P., Alfred Wegener Institute for Polar and Marine Research; University of Applied Sciences, Bremerhaven, Germany, Boris.Koch@awi.de

Zhu, Z. Y., East China Normal University, Shanghai, China, zyzhu@sklec.ecnu.edu.cn

Lechtenfeld, O., Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, Oliver.Lechtenfeld@awi.de

Kattner, G., Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, Gerhard.Kattner@awi.de

SPATIAL AND SEASONAL VARIATION OF LIPIDS IN THE KRKA RIVER ESTUARY (MIDDLE ADRIATIC)

Lipid classes and fatty acids of the particulate and the dissolved organic matter were investigated in the Krka River estuary (Adriatic Sea) in autumn (September 2008) and spring (May 2009) to get insight on different freshwater/marine processes taking place during different seasons. Krka River is one of the most pristine European rivers. The sampling strategy included sampling of freshwater, halocline and seawater at stations of different trophic status. Total particulate lipids showed large variations, from 12.6 to 55.4 µg/l, while total dissolved lipids varied only from 20.7 to 40.0 µg/l. Autumn was characterized by processes of organic matter degradation, while new organic matter production takes place during spring. Fatty acid distribution patterns are used to distinguish between various sources. Bacterial branched fatty acids were very low in May. The halocline appeared to be the layer suitable for phytoplankton accumulation as revealed from higher contribution of phytoplankton polyunsaturated fatty acids (PUFA), compared to freshwater and marine layer. The comparison between estuarine and marine stations revealed that PUFA were more important at marine station although organic matter pool (DOC+POC) was lower there.

Gates, **K**. **K**., Montana State University, Bozeman, USA, kgates@montana.edu

Kerans, B. L., Montana State University, Bozeman, USA, bkerans@montana.edu

MOLLUSC COMMUNITY RESPONSE TO ANNUAL DEWATERING: DISPERSAL INTO SEASONALLY AVAILABLE HABITAT VERSUS CONFINEMENT IN DEPTH REFUGE

The Middle Snake River is a highly altered system containing a number of endemic mollusc species. Impoundments along the river are managed primarily for agriculture and discharge is often reduced by over 90% during winter months. Our objective was to examine the affects of winter dewatering on mollusc communities during the end of the subsequent high water period. Surveys were conducted in August of 2006, 2007, and 2008. Quarter meter plots were surveyed along transects with a Venturi suction dredge. Chi-square analysis was used to compare species richness in watered and dewatered habitats. Five months after re-watering the littoral zone, most mollusc species, including an endangered gastropod, were still confined to deeper continuously watered habitat. The invasive *Potamopyrgus antipodarum* was only found at high densities in continuously watered habitats suggesting that population growth may be limited by dewatering. Several species were found evenly distributed in both habitat types suggesting better dispersal capabilities. Our findings indicate that long-term anthropogenic management of a large river may push some mollusc species, including an endangered native and an invasive, into a depth refuge.

Gee, **E**. **M**., The University Of Melbourne, Melbourne, Australia, e.gee@pgrad.unimelb.edu.au

Western, A. W., The University Of Melbourne, Melbourne, Australia, a.western@unimelb.edu.au

Swearer, S., The University Of Melbourne, Melbourne, Australia, sswearer@unimelb.edu.au

Williams, J., The University Of Melbourne, Melbourne, Australia, j.williams@pgrad.unimelb.edu.au

CAN PASSIVE TRANSPORT EXPLAIN THE DISTRIBUTION OF EGGS AND LARVAE IN A STRONGLY STRATIFIED ESTUARY?

The estuarine dependent species black bream (Acanthopagrus butcheri) is an important commercial and recreational fish in temperate Australia. A significant drought in the past decade has coincided with decreasing catches of black bream in the Gippsland Lakes. This study links the hydrodynamics of a major Lakes tributary, The Mitchell River, to the dispersal of the early-life stages of black bream. A 3-dimensional, salinity stratified, hydrodynamic model of the estuarine reach of the Mitchell River was developed. Continuous salinity data were collected at 5 sites during a field program. Water level variation was continuously monitored at 3 sites. The model was calibrated and confirmed using water level and salinity data collected during two independent time periods. An individual based model of black bream eggs and larvae was then coupled to the hydrodynamic model. A passive drift scenario was compared to field observations of the distribution of eggs and larvae to investigate the extent to which passive drift explains the dispersal of eggs and larvae in this strongly stratified estuary. Ongoing work will incorporate larval abilities and preferences into the model.

Gelhaus, **J**. **K**., The Academy of Natural Sciences, Philadelphia, USA, gelhaus@ansp.org

Hayford, B. L., Wayne State College, Wayne, USA, bhayford@gmail.com

RELATIONSHIP BETWEEN THE VARIATION OF ADULT AQUATIC INSECTS TO STREAM CONDITION IN STREAMS FROM MONGOLIA

The Mongolian Aquatic Insect Survey sampled streams during July, 2003-2006, and 2008. On-site, family-level identifications of adult aquatic insects were made at each site. Study sites were restricted to those sites in which only stream habitat was present to reduce the possibility of including non-riverine insects in the analysis. Culling the data resulted in the 53 sites used in multiple regression analysis to test whether family level taxonomic metrics varied in relation to variation in dissolved oxygen, gravel substrate, total dissolved solids, nitrate, pH, and percent forbs. The analyses produced three statistically significant models; one for percent Ephemeroptera richness, one for percent Plecoptera richness, and one for percent Diptera richness. Dissolved oxygen, TDS, and pH were the strongest contributors to variation of percent Ephemeroptera richness. Percent forbs was the only significant contributor to variation in Plecoptera richness. Dissolved oxygen and pH were significant contributors to variation in percent Diptera richness. We concluded that estimates of family-level diversity of aquatic insects varied in response to stream condition.

Gentzel, **T**., University of North Carolina - Greensboro, Greensboro, USA, tracy.gentzel@gmail.com

Hershey, A. E., University of North Carolina - Greensboro, Greensboro, USA,

Rublee, P., University of North Carolina - Greensboro, Greensboro, USA,

EFFECTS OF METHANE PRODUCERS AND CONSUMERS ON THE DIET OF CHIRONOMUS LARVAE IN AN ARCTIC LAKE

Up to 40% of methane produced in aquatic systems is oxidized before it is released into the atmosphere. Microbial oxidation of methane is an important sink and potentially an important pathway for the incorporation of detrital carbon into aquatic food webs. In this study, we tested the hypothesis that methane-derived carbon (MDC) was an important carbon source for Chironomus larvae in a small arctic lake, but that utilization of MDC by larvae

differed with depth. We found that an order of magnitude more methane was produced at 5 m depth than at 2.5 m. PCR analysis of sediments, larval tubes, and gut contents, found methanogens in all samples, while the distribution of methanotrophs was restricted to surface sediments, larval tubes and gut contents. These results are consistent with our hypothesis that MDC is an important basal food resource in this small lake. Furthermore, the combination of biogeochemical and microbial approaches provides insight into functional differences among habitats for a ubiquitous benthic consumer.

Geraci, **C**. **J**., National Museum of Natural History, Smithsonian Institution, Washington, DC, USA, geracic@si.edu

Al-Saffar, M. A., Twin Rivers Institute for Scientific Research, The American University of Iraq-Sulaimani, Sulaimani, Iraq, moalsaffar@gmail.com

Zhou, X., Biodiversity Institute of Ontario, Univeristy of Guelph, Guelph, Canada, xinzhou@uoguelph.ca

BARCODING MESOPOTAMIA: DNA FACILITATES BIODIVERSITY AND BIOASSESSMENT RESEARCH IN THE TIGRIS-EUPHRATES RIVER BASIN, IRAQ

Monitoring water quality using aquatic insects as sentinels is based on sound taxonomic knowledge that is not available in many parts of the world. Iraq's Tigris-Euphrates River Basin is a major drinking water source, and its Southern Marshes ecosystem suffered extensive desiccation from 1991 - 2003. Since the marshes were re-flooded in 2003, several biodiversity surveys have been conducted to measure their recovery. These surveys have produced thousands of benthic macroinvertebrate specimens needing identifications, yet little taxonomic work has been done for most major aquatic invertebrate groups in Iraq. We employed DNA barcoding to expedite identification and association of life history stages for aquatic insects in the Southern Marshes and in the headwater streams of the Tigris River in northern Iraq. We will summarize the results and compare the success of DNA barcoding for Trichoptera, Ephemeroptera, Odonata, Diptera, and Coleoptera.

Gessner, **M**. **O**., Eawag/ETH, Dubendorf, Switzerland, gessner@eawag.ch

MacKenzie, R. A., USDA Forest Service, Hilo, USA, rmackenzie@fs.fed.us

Wiegner, T. N., University of Hawaii , Hilo, USA, wiegner@hawaii.edu

Farrington, H., Stanford University, Stanford , USA, heraldof@stanford. edu

Vitousek, P. M., Stanford University, Stanford , USA, vitousek@stanford.edu

LITTER QUALITY EFFECTS ON DECOMPOSITION ACROSS A NUTRIENT GRADIENT IN HAWAI'IAN STREAMS

Understanding how litter quality and environmental conditions control litter decomposition rate is essential to assess effects of environmental change on ecosystem functioning. We took advantage of a gradient in dissolved nutrient concentration to assess the influence of species identity (Metrosideros polymorpha vs Trema orientalis) and nutrient supply on decomposition rates of leaves across nine streams on the Island of Hawai'i. Exponential decay coefficients varied more than threefold, ranging from 0.0036-0.0121 per day for Metrosideros and from 0.0212-0.0902 per day for Trema. Nonetheless, litter mass loss of the two species was strongly correlated (R=0.95). This indicates that variation in environmental conditions affected their decomposition in similar ways. However, a stronger positive relationship between dissolved nutrient concentration and decay rate of Metrosideros litter (R=0.77 vs 0.61 for Trema) also hints at the possibility that dissolved nutrient availability affects decomposition of the recalcitrant Metrosideros leaves more than that of much faster decomposing Trema leaves. Overall, our results suggest that predicting responses of leaf decomposition to enhanced nutrient supply requires quantitative information on the influence of nutrient pools in both litter and the environment.

Ghadouani, **A**., The University of Western Australia, Perth, Australia, Anas. Ghadouani@uwa.edu.au

Smith, M. D., The University of Western Australia, Perth, Australia,

Goater, S. E., The University of Western Australia, Perth, Australia,

Reichwaldt, E. S., The University of Western Australia, Perth, Australia, elke. reichwaldt@uwa.edu.au

Knott, B., The University of Western Australia, Perth, Australia, Brenton.Knott@ uwa.edu.au

EFFECTS OF MULTIPLE STRESSORS ON THE FUNCTIONING OF THE THROMBOLITE INHABITED LAKE CLIFTON: EVIDENCE FOR AN ECOLOGICAL TRANSITION

The Yalgorup lakes, a Ramsar listed groundwater-fed system in south-western Australia with significant scientific and conservation value due to the presence of a unique range of lake systems, resident waterfowl and the presence of the only thrombolite reef in the southern hemisphere. Comparisons with historical data revealed a significant increase in salinity since 1985 and a possible increase in phosphorus concentrations in the lake in the recent decade, although historical nutrient data are rather sparse. There is a clear indication that climate change has contributed significantly to the major changes in the lake's biogeochemical characteristics. The increased salinity may be due to concentration of lake water through a combination of high evaporation, little rainfall and higher groundwater abstraction which leads to a decrease of fresh groundwater input. Comparison of the composition of the thrombolite community with historical data indicates a large reduction in relative abundance of Scytonema sp. and other filamentous cyanobacterial species, which are believed to be fundamental for the thrombolite structure. It is unclear how the combined effects of these multiple stressors will affect the future of this unique system of international significance.

Giling, **D**. **P**., Monash University, Melbourne, Australia, Darren.Giling@sci. monash.edu.au

Reich , P., Monash University, Melbourne, Australia, paul.reich@dse.vic.gov.au

Thompson, R. M., Monash University, Melbourne, Australia, ross.thompson@ sci.monash.edu.au

RIPARIAN VEGETATION ALTERS BASAL CARBON SOURCES AND ECOLOGICAL STOICHIOMETRY IN AN AUSTRALIAN INTERMITTENT STREAM

Effects of changes in riparian vegetation on patterns of aquatic biodiversity and ecosystem function have now been well established. Changes in the relative availability of allochthonous and autochthonous basal resources due to changes in riparian trees have been shown to alter invertebrate productivity and species composition. These effects can be expected to be particularly major in Australian streams where many systems dry to chains of pools in summer, and there is little or no longitudinal supply of organic matter from upstream sources. Using a lowland stream in inland Victoria we described the effects of changes in riparian vegetation on basal carbon sources and ecological stoichiometry of a freshwater crayfish (*Cherax destructor*). Removal of riparian forest increased in-stream macrophyte growth, increasing quality of basal resources and thus crayfish productivity. The flow on effects of this increased population on other stream invertebrates is unknown but would be expected to be significant. These results are discussed within the context of current proposals to revegetate large lengths of streams both for ecological values and to accrue carbon credits.

Gillis, **C**. **A**., INRS Centre - Eau Terre Environnement, Quebec, Canada, gilliscaroleann@hotmail.com

Bergeron, N. E., INRS Centre - Eau Terre Environnement, Quebec, , normand. bergeron@ete.inrs.ca

Couture, P., INRS Centre - Eau Terre Environnement, Quebec, , patrice. couture@ete.inrs.ca

THE EFFECT OF *DIDYMOSPHENIA GEMINATA* ON JUVENILE ATLANTIC SALMON IN THE MATAPEDIA RIVER (QUEBEC, CANADA)

In 2006, blooms of *Didymosphenia geminata* Schmidt (didymo) were, for the first time, officially identified in the Matapedia River, an Atlantic salmon (*Salmo salar*) river of the Gaspe peninsula (Quebec, Canada). In a previous study, Gillis and Chalifour (2009) showed that the presence of didymo caused significant changes in macroinvertebrate abundance and in benthic community structure between pre- (2006) and post-incursion (2007) sites for this river. Although its presence is suspected to alter diet and feeding behavior of juvenile Atlantic salmons through food web interactions, this question has never been addressed. This study aims at evaluating the effects on the early stages of this salmonid by assessing prey availability, fish densities, feeding behaviour, growth and condition in didymo-affected and didymo-free reaches. In 2009, in order to assess didymo's impact on drifting invertebrate dynamics, benthos, invertebrate drift and juvenile salmon gut content were sampled. Study sites were electric fished to compare fish densities in a wide range of didymo biomasses. The preliminary results, currently under analysis, will be presented and implications of didymo invasions for Atlantic salmon populations will be discussed.

Gislason, **G**. **M**., University of Iceland, Reykjavik, Iceland, gmg@hi.is
Palsson, S., Univeristy of Iceland, Reykjavik, Iceland, snaebj@hi.is

ORIGIN OF THE CADDISFLES *POTAMOPHYLAX CINGULATUS* AND *APATANIA ZONELLA* (TRICHOPTERA: LIMNEPHILIDAE) IN ICELAND

Phylogeography, applying genetic markers to study dispersal and origin of species, has been a successful approach and revealed differences among populations which were not visible morphologically. Here we report the results from a study on two caddisflies in Iceland; *Potamophylax cingulatus*, a common species in Northern Europe which colonized Iceland during the last 40 years, and *Apatania zonella*, a circumpolar parthenogenic Arctic species, which has been in Iceland for a long time. Icelandic biota is known to originate mainly from Europe. Variation in 1100 base pairs of the mitochondria COI gene in specimens from different areas of Iceland, Faroe Islands, Britain, Norway, Greenland, and N-America was studied. No variation was found within *P. cingulatus* in Iceland and the Faroes where the same haplotype was found. The Icelandic and Fareos populations are more related to British, than to Norwegian populations. *A. zonella* showed two distinct evolutionary lines in Iceland that were separated 1-2 My ago. The age of the differentiation and the geographic variation suggests that Iceland was colonized by two populations, one from N-America and the other from Europe.

Glass, **J**. **B**., Arizona State University, Tempe, USA, jennifer.b.glass@asu.edu
Chandra, S., University of Nevada Reno, Reno, USA, sudeep@cabnr.unr.edu
Elser, J. J., Arizona State University, Tempe, USA, j.elser@asu.edu
Anbar, A. D., Arizona State University, Tempe, USA, anbar@asu.edu

MOLYBDENUM LIMITATION OF NITRATE ASSIMILATION AT CASTLE LAKE, CALIFORNIA

Molybdenum (Mo) is an essential micronutrient for microbial assimilation of NO_3^-. In 1960, Goldman demonstrated that low (< 5 nM) Mo limited primary productivity at Castle Lake. In the 1980s, Axler and Goldman showed that addition of Mo increased $^{15}NO_3^-$ uptake, but only when > 1 µM NO_3^- was present, suggesting that Mo and NO_3^- may co-limit primary productivity at Castle Lake. We performed in situ bottle incubations (with MoO_4^{2-} and NO_3^- added singularly or in combination to 100 nM and 100 µM, respectively) in Castle Lake. In July 2008, Mo and NO_3^- co-limited protein expression and glutamine synthetase activity in the hypolimnion. Nitrate reductase activity was limited by NO_3^- in the epilimnion (background NO_3^- 0.02 µM) and by Mo in the hypolimnion (NO_3^- 0.4 µM). In June 2009, $^{15}NO_3^-$ uptake increased in the epilimnion with added Mo. This response was not observed in the hypolimnion where elevated NH_4^+ may have been inhibiting $^{15}NO_3^-$ uptake. Furthermore, no change in chlorophyll was observed, suggesting that heterotrophs – not primary producers – may be responsible for the increased $^{15}NO_3^-$ uptake.

Glenn, **C**. **R**., University of Hawaii, Honolulu, USA, glenn@soest.hawaii.edu
Burnett, W. C., Florida State University, Tallahassee, USA, wburnett@fsu.edu
Lucey, P. G., University of Hawaii, Honolulu, USA, lucey@higp.hawaii.edu
Johnson, A. G., U.S. Geological Survey, Honolulu, USA, ajohnson@usgs.gov
Peterson, R. N., Coastal Carolina University, Conway, USA, rpeters2@coastal.edu
Kelly, J. L., University of Hawaii, Honolulu, USA, Jacque Kelly

UPSCALING AND DOWNSCALING SUBMARINE GROUNDWATER DISCHARGE AND NUTRIENT FLUXES BY COMBINING IN SITU MEASUREMENTS WITH AERIAL INFRARED IMAGING

High-resolution (0.1 C, 0.5 m) aerial thermal infrared (TIR) imagery from the dry western coasts of the large volcanic island of Hawaii provides exact locations and fine-scale mixing structures of both diffusive flows and more than 50 buoyant submarine groundwater discharge (SGD) point-sourced "plumes" dispersing into the ocean. The plumes are cool, brackish, nutrient-rich groundwaters injected into and floating on top of warm tropical seawater. SGD fluxes were estimated using continuously-measured 222Rn and salinity for six of the largest discharge locations. We then used a proportionality between plume surface area discharge rate of the larger plumes to approximate individual flux estimates for all and each of the individual groundwater plumes mapped, and, for 65 km of coastline, we estimate a cumulative total groundwater (mixed fresh and marine) flux from 42 point-source groundwater inputs to be about 260,000 cubic meters/day. Estimated SGD nutrient fluxes for this dry, relatively pristine setting rival Hawaiian river outputs, are of comparable magnitude to that reported for rather heavily populated coastlines elsewhere, and are the only source of new nutrients available to this region's coastal ocean.

Glozier, **N**. **E**., Environment Canada, Saskatoon, Canada, nancy.glozier@ec.gc.ca
Donald, D. B., Environment Canada, Regina, Canada, david.donald@ec.gc.ca
McIvor, E., Environment Canada, Saskatoon, Canada,
Waiser, M., Environment Canada, Saskatoon, Canada,
Cessna, A. j., Agriculture and Agri-Food Canada, Saskatoon, Canada,

PESICIDE CONCENTRATIONS IN CANADIAN PRAIRIE WETLANDS: PREVALENT MIXTURES AND ECOLOGICAL EFFECTS

Prairie waters are susceptible to herbicide overspray and atmospheric transport. Monitoring and evaluation of ecological effects of pesticide in the Canadian prairies was conducted over 7 years. Two insecticides and 30 herbicides were detected; the most frequently detected (>80%) were Glyphosate, MCPA, 2,4-D, clopyralid, dicamba, diclorprop, mecoprop, and bromoxynil. Although these herbicides are present in most wetlands, guidelines have yet to be established for many or for mixtures. We assessed effects of these mixtures with two approches; field surveys of tadpole populations and a novel wetland mesocosm system. We established an environmentally relevant mixture (1X) and treatments applied ranged from 0X -1000X. Results, in the field surveys, indicated that wood frog and chorus frog tadpole abundance was reduced by up to 74% where elevated glyphosate concentrations exist. Similarly, glyphosate alone reduced periphyton, phytoplankton and dipteran production by 30%. More glyphosate is used throughout the globe than any other pesticide, and our findings suggest that this toxic effect of glyphosate may result in a trophic cascade response in wetlands producing a reduced tadpole abundance and changes in overall wetland community structure.

Goforth, **C**. **L**., Department of Entomology, University of Arizona, Tucson, AZ, USA, chrisgof@cals.arizona.edu
Smith, R. L., Department of Entomology, University of Arizona, Tucson, AZ, USA, bobsmith@cals.arizona.edu

RESPIRATORY BEHAVIORS OF THE GIANT WATER BUG ABEDUS HEBERTI (HEMIPTERA: BELOSTOMATIDAE)

Aquatic insects exhibit many respiratory adaptations that allow them to survive the low oxygen conditions of their environment. Our goals were to document and describe two potential respiratory behaviors expressed by the giant water bug Abedus herberti, to determine under what conditions these behaviors are expressed, and to determine whether these behaviors increase respiratory efficiency. We observed 24 Abedus herberti individuals at 3 depths and described their respiratory behaviors. We also compared the submersion times of bugs we allowed to express the behaviors versus those we disallowed. We observed two respiratory behaviors and the expression of both increased with increasing water depth. Submersion times were significantly higher in bugs allowed to express the behaviors than those disallowed. These behaviors apparently increase submersion time by promoting gas exchange with the water and providing ventilation. A. herberti are buoyant insects, so increased submersion time should substantially decrease the number of trips to the surface necessary to support respiration, increasing the amount of time they can devote to capturing food and decreases the likelihood of predation at the surface.

Golladay, **S**. **W**., J.W. Jones Ecological Research Center, Newton, USA, sgollada@jonesctr.org
Vedas, E. M., Valdosta State University, Valdosta, USA, emvedas@valdosta.edu
Knothe, G., J.W. Jones Ecological Research Center, Newton, USA, gknothe@jonesctr.org
Blackmore, M., Valdosta State University, Valdosta, USA, mblackmo@valdosta.edu
Smith, N., J.W. Jones Ecological Research Center, Newton, USA, nsmith@jonesctr.org
Atkinson, C. L., Oklahoma Biological Survey, Norman , USA, carlalatkinson@gmail.com

WATER QUALITY AND LARVAL MOSQUITO POPULATIONS IN ISOLATED AGRICULTURAL AND REFERENCE WETLANDS IN THE GULF COASTAL PLAIN, GEORGIA USA.

We sampled water quality and larval mosquito abundance in 10 reference and 10 agricultural wetlands from spring through fall 2009. Generally, agricultural wetlands had higher pH, suspended solids, NO_3-N, and PO_4-P concentrations compared to reference sites. During weekly surveys we collected 23 species of larval mosquitoes from reference sites. Of these, 12 species were not observed in agricultural wetlands including *Aedes albopictus, Culex peccator, Cx. pilosus, Cx. quinquefasciatus, Cx. salinarius, Cx. tarsalis, Ochlerotatus atlanticus, Oc.*

canadensis, Oc. infirmatus, Oc. mitchellae Oc. thibaulti, and *Oc. triceriatus*. We collected 13 species of larvae from agricultural wetlands including 4 unique species (*Cx. coronator, Psorophora columbiae, Ps. Discolor* and *Ps. Horrida*). Species found in both types included *Ae. vexans, Anopheles crucians, An. punctipennis, An. quadrimaculatus, Culiseta melanura, Cx. erraticus, Cx. restuans, Cx. territans, Oc. sticticus, Ps. howardii,* and *Uranotaenia sapphirina*. *Ae. Vexans* and *Culex spp*. were the most abundant larvae collected. Agricultural and reference wetlands support diverse larval mosquito populations, however there has been little systematic sampling in rural areas of the Gulf Coastal Plain.

Gomes, F. A., COPPE/UFRJ, Rio de Janeiro, Brazil, francian@ird.gov.br
Godoy, **J**. **M**., PUC-Rio, Rio de Janeiro, Brazil, jmgodoy@puc-rio.br
Carvalho, Z. L., IRD/CNEN, Rio de Janeiro, Brazil, zenildo@ird.gov.br
Godoy, M. L., IR/CNEN, Rio de Janeiro, Brazil, malu@ird.gov.br
Lopes, R. T., COPPE/UFRJ, Rio de Janeiro, Brazil,

SHORT AND LONG-LIVED RADIUM ISOTOPES IN SURFACE WATERS FROM ILHA GRANDE BAY, ANGRA DOS REIS, BRAZIL

The Angra dos Reis nuclear power plant site is located 130 km south from Rio de Janeiro city. Seawater is used as cooling water for both units; the cooling water is pumped from Itaorna Bay and discharged into Piraquara de Fora Bay, together with the liquid effluents from the two NPPs. Piraquara de Fora Bay belongs to a large bay system, Ilha Grande Bay and, therefore, conservative radionuclides in seawater will reach this bay with the tidal movement and, at the end, exported to open sea. Radium isotopes behave conservatively in seawater and can be applied as natural tracers to carry out dispersion studies. Two transets involving eight sampling points each were performed in Ilha Grande bay and 228Ra, 226Ra, 224Ra and 223Ra determination realized. The results have shown that the conservative radionuclide dispersion is controlled by eddy diffusion with negligible net offshore advection. The calculated eddy diffusion coefficient was 26 km2 d−1 and 25 km2 d−1, based on 223Ra and 224Ra respectively.

Gomez, **J**. **D**., Earth and Environmental Sciences, New Mexico Institute of Mining and Technology, Socorro, USA, jdgomez@nmt.edu
Wilson, J. L., Earth and Environmental Sciences, New Mexico Institute of Mining and Technology, Socorro, USA, jwilson@nmt.edu
Cardenas, M. B., Department of Geological Sciences, The University of Texas at Austin, Austin, USA, cardenas@jsg.utexas.edu

EXPLORING THE DYNAMICS OF SINUOSITY-DRIVEN HYPORHEIC ZONES

Hyporheic exchange is modulated by diurnal and seasonal dynamic forcing that modifies hyporheic system geometry, flow field (FF), and age distribution (AD), and influences timing-sensitive biochemical reactions. This work explores the role of dynamic forcing on FFs and ADs for the case of channel sinuousity-driven lateral hyporheic exchange. A two-dimensional, transient, numerical flow and transport model is used to illustrate the effect that dynamics, caused by stochastically generated flood events, has on FFs and ADs, and therefore on the quality of the hyporheic zone as a natural biochemical reactor. FFs and ADs change with hydrological regime and system properties. In particular, the sediment's storage capacity plays a key role, determining the memory that the hyporheic zone has of previous flood events. For example, the rising limb of the flood events cause accumulation of young water into the system and diminish the flux of aged hyporheic water into the stream. Older water is then released during the falling limb at time scales dictated by the hydraulic characteristic time of the system; however, if this characteristic time is of the order of the time between flood events, old water is accumulated, increasing the water ages inside the system.

Gonçalves, **A**. **L**., IMAR-CMA, Department of Life Sciences, University of Coimbra, Coimbra, Portugal, aga@ci.uc.pt
Lírio, A. V., IMAR-CMA, Department of Life Sciences, University of Coimbra, Coimbra, Portugal,
Pratas, J., Department of Earth Sciences, University of Coimbra, Coimbra, Portugal,
Canhoto, C., IMAR-CMA, Department of Life Sciences, University of Coimbra, Coimbra, Portugal,

WATER CONTAMINATED WITH URANIUM MINE RUNOFF DID NOT AFFECT LITTER DECOMPOSITION BUT DECREASED FEEDING BY THE SHREDDER SERICOSTOMA VITTATUM

Polluted streams by uranium drainages are abundant in Central Portugal where over 50 mines are abandoned. Here we looked at a stream receiving runoff waters from an abandoned mine after rehabilitation. We investigated leaf (Quercus robur) decomposition and associated decomposer communities and its impacts, through dietary exposure, on the ecology of the shredder Sericostoma vitattum. Leaf mass loss, toughness and fungal biomass in oak substrates did not differ between reference and a stream polluted receiving mine runoff (U= 27.8 µg/L; pH = 5.6). However, microbial respiration was significantly higher in leaves exposed to contaminated waters. Shredders consumed preferentially leaves exposed to reference than contaminated stream water. Although 100% survivorship was observed in both treatments, consumption and relative growth rate decreased to half in larvae provided contaminated leaves. This may be related with less palatable leaf-microbial assemblages and/or with higher contents of metals accumulated by the leaves and, further on, by the larvae. We hypothesize that treated U mine drainages may impair stream ecosystem function through its effects on shredders performances rather than microbial processing.

Goodwin, **K**. **E**., Washington State University Vancouver, Vancouver, USA, kara.goodwin@email.wsu.edu
Harrison, J. A., Washington State University Vancouver, Vancouver, USA, john_harrison@vancouver.wsu.edu
Sobota, D. J., Washington State University Vancouver, Vancouver, USA, daniel_sobota@vancouver.wsu.edu

INCREASING THE SPATIAL RESOLUTION OF A GLOBAL NUTRIENT MODEL: AN APPLICATION OF NEWS2-DIN IN CENTRAL CALIFORNIA

Nitrogen (N) enrichment of surface waters has been linked to ecosystem impacts such as hypoxia and harmful algal blooms. Modeling of land-based sources and landscape sinks of N provides insight into mechanisms controlling N transport downstream through watersheds. Here we increase the spatial resolution of a global dissolved inorganic nitrogen (DIN) transport model, NEWS2-DIN. Modifications to the global model include a lower transfer efficiency of terrestrial inputs to surface waters for natural versus anthropogenic N sources. We use this downscaled model to investigate patterns and controls of DIN sources and river export in central California river basins. Results show reasonable agreement between measured DIN export (kg N basin-1 yr-1) and modeled river export from the California basins (R2=0.76). Model results also show DIN export from all basins is dominated by anthropogenic N sources (52-99% of yield), particularly fertilizer and manure. These results suggest that even in systems where the major fraction of watershed N inputs consists of natural N-fixation or atmospheric deposition, DIN export is highly sensitive to agricultural N inputs.

Gooseff, **M**. **N**., Penn State University, University Park, PA, USA, mgooseff@engr.psu.edu
Payn, R. A., Montana State University, Bozeman, MT, USA, rpayn@montana.edu
Briggs, M. A., Syracuse University, Syracuse, NY, USA, martybriggs1@gmail.com
McGlynn, B. L., Montana State University, Bozeman, MT, , bmcglynn@montana.edu
Bencala, K. E., U.S. Geological Survey, Menlo Park, CA, , kbencala@usgs.gov
Wondzell, S. M., U.S. Forest Service, Olympia, WA, , swondzell@usfs.fed.us
Haggerty, R., Oregon State University, Corvallis, OR, , haggertr@oregonstate.edu

METHODS, APPLICATIONS, AND LIMITS OF ASSESSING RESIDENCE TIME DISTRIBUTIONS OF SOLUTES IN STREAMS

Streams are viewed as both integrators of upslope watershed processes and as open systems that are intimately connected to alluvial and deeper aquifers. Hence, measurements of spatial and temporal patterns of stream solutes and hydrology can provide characteristics (i.e., mean residence times, median transport times, etc.) of residence time distributions (RTDs) of water and solutes in both stream channels and the broader watershed. Several new methods for estimating RTDs and their properties have been developed and applied in streams in the past decade. We will compare and contrast such methods for conducting, analyzing and modeling stream tracer experiments. Although all of these methods have common practical limitations related to tracer properties or measurement techniques, the ability to more accurately characterize RTDs continues to refine our understanding of associated biogeochemical cycling in streams and watersheds.

Gorbach, **K**. **R**., University of Dayton, Dayton, USA, krj315@hotmail.com
Shoda, M. E., University of Dayton, Dayton, USA, megan.shoda@gmail.com
Vonderhaar, D. A., University of Dayton, Dayton, USA, doug.vonderhaar@gmail.com
Benbow, M. E., University of Dayton, Dayton, USA, benbowme@notes.udayton.edu
Burky, A. J., University of Dayton, Dayton, USA, Albert.Burky@notes.udayton.edu

VARIABILITY OF WATERSHED EFFECTS ON MACROINVERTEBRATE COMMUNITY RESPONSE TO WATER DIVERSIONS IN TROPICAL ISLAND STREAMS.

Freshwater removal from stream ecosystems modifies the natural flow regime, altering habitat and species composition through small-scale changes in microhabitat flow dynamics and large-scale effects on ecosystem processes. Benthic community response to water withdrawal was studied in four watersheds of the West Maui Mountains, Hawaii. In 2007 and 2008, physical stream condition, stream discharge, and habitat scale flow were evaluated upstream and downstream the highest elevation diversion in each watershed. This assessment was used to define the physical habitat template for comparing macroinvertebrate community response differences between riffle and cascade habitats. There was a positive and significant relationship between discharge and total benthic macroinvertebrate densities with 12 – 73% reductions downstream. Two-way ANOVA revealed significant effects of watershed and location relative to diversion, including an interaction, suggesting diversion effects on macroinvertebrate density depended on the watershed. Significant changes in diversity and percent native taxa downstream of diversions also varied by watershed, but also by habitat: cascade habitats were home to significantly more endemic taxa compared to riffles. Results suggest the importance of understanding watershed variation on the impact of diversions.

Gorbunov, **M**. **Y**., Rutgers University, New Brunswick, USA, gorbunov@marine.rutgers.edu
Falkowski, P. G., Rutgers University, New Brunswick, USA, falko@marine.rutgers.edu

DEVELOPMENT AND APPLICATIONS OF PICOSECOND KINETIC FLUOROMETRY TO STUDY FLUORESCENCE LIFETIMES AND PHOTOSYNTHETIC PROCESSES IN OCEANIC ECOSYSTEMS

Chlorophyll fluorescence became a workhorse of biological oceanography but the interpretation of fluorescence signals is inevitably complicated by remarkable variability in fluorescence quantum yields which are strongly affected by the physiological state and taxonomic composition of phytoplankton. Here we report the development of an instrumental package to directly measure fluorescence lifetimes and yields in the ocean with an overarching goal to develop improved models and algorithms for retrieving phytoplankton biomass, physiological status, and the rates of primary production. The quantum yields and lifetimes of chlorophyll fluorescence are directly derived from picosecond laser induced kinetics. Multiple component deconvolution analysis of fluorescence kinetics provides insight into the rates and efficiency of energy transfer in primary photosynthetic reactions in relation to environmental forcing. We present the instrumental design and methodology and discuss the first applications of this new technology to study the physiological mechanisms of variability in fluorescence yields in the ocean.

Gore, **J**. **A**., University of Tampa, Tampa, USA, jgore@ut.edu
Kelly, M. H., Southwest Florida Water Management District, Brooksville, USA, Marty.Kelly@swfwmd.state.fl.us
Casper, A. F., Environmental Lab USACE-ERDC, Vicksburg, USA, andrew.f.casper@usace.army.mil

THE ATLANTIC MULTIDECADAL OSCILLATION (AMO) AS A SURROGATE FOR EARLYCLIMATE CHANGE: SHIFTS IN COMMUNITY COMPOSITION IN FLORIDA, USA, RIVERS

The Atlantic Multidecadal Oscillation (AMO) operates on an approximate 60-year cycle, creating 20- to 40-year wet and dry precipitation cycle with an order of magnitude difference in mean monthly and daily flows. By modeling habitat availability, using time-series analysis, we predict that the intensity and duration of low-flow events, whether wet- or dry-hydrographic periods, affects the composition and structure of fish and benthic macroinvertebrate communities. In the Myakka River, largemouth bass are most sensitive to habitat change during dry periods while sensitivity shifts to spotted sunfish during wet periods. We have also predicted shifts in the composition of chironomid assemblages of the northern Withlacoochee River. The AMO cycles act in a similar pattern to predictions of global climate change from wet-to-dry or dry-to-wet geographic patterns. In essence, with changes in sensitivity and dominance, it can be inferred that the lotic community is undergoing a restructuring every shift from wet to dry hydrographic increment, as habitat availability favors one species over another. Understanding these shifts in composition establish a baseline of AMO effects for comparison to those of continuing climate change.

Gothe, **E**. **K**., SLU, Uppsala, Sweden, emma.gothe@vatten.slu.se
Sandin, L., SLU, Uppsala, Sweden, leonard.sandin@vatten.slu.se

LINKING HEADWATER STREAM BIOTA TO WATER CHEMISTRY AND ENVIRONMENTAL VARIABLES IN A NORTHERN SWEDISH WATERSHED, A STREAM NETWORK PERSPECTIVE

The European Community (EC) Water Framework Directive stipulates that all surface waters with a watershed area > 10 km2 must reach "good ecological status" by 2015. The directive thus excludes many headwater streams; one of the most prevalent lotic habitats in the world. At present, very little is known about these small streams especially in terms of biodiversity patterns and how species are distributed at larger spatial scales (stream-network and landscape scale). In this study we sampled macroinvertebrates across a stream network situated in northern Sweden (Krycklan catchment). We assessed species composition in a total of 14 headwater streams, upstream and downstream of every confluence (12 nodes), all the way down to the main channel. A total of 50 sampling sites were included in the study. With this large scale approach we assessed i) the degree of biotic dissimilarity between headwater sites ii) whether species composition differ upstream and downstream of confluences iii) what variables (water-chemistry, temperature, local environmental variables. e.g. hydrology) are mainly responsible for structuring species composition in this particular stream network.

Goulden, **C**. **E**., Academy of Natural Sciences, Philadelphia, USA, cgoulden@ansp.org
Hayford, B., Wayne State College, Wayne, USA, bhayford@gmail.com

STREAM RESPONSE TO CLIMATE CHANGES AND GRAZING BY DOMESTICATED HERBIVORES ALONG THE EASTERN SHORE OF LAKE HOVSGOL, MONGOLIA

Increased temperature and weather intensity, already documented for northern Mongolia, may be exacerbated by an increase in overgrazing by domesticated herbivores. The International Long Term Ecological research station at Lake Hovsgol, located in northern Mongolia includes a north/south grazing gradient along the east shore of the lake which we used to study the impact of grazing on stream condition. Forty-eight samples from eighteen sites and six watersheds collected during summer months over three years were analyzed using non-metric multidimensional scaling (NMMDS) to detect pattern in the sites based on macroinvertebrate and water quality data. The NMMDS ordination showed a clear gradient in sites along the north/south grazing gradient. Variation in conductivity and salinity, water quality variables which typically increase in the presence of overgrazing, contributed most to the pattern in the sites. Macroinvertebrates did not contribute to pattern in the sites, indicating that water quality has been impacted by the grazing but that the impact has not yet impaired the macroinvertebrate community.

Govindarajan, **A**. **F**., Woods Hole Oceanographic Institution, Woods Hole, USA, afrese@whoi.edu
Sutherland, K. R., California Institute of Technology, Pasadena, USA, krsuth@caltech.edu
Bucklin, A., University of Connecticut, Groton, USA, ann.bucklin@uconn.edu
Madin, L. P., Woods Hole Oceanographic Institution, Woods Hole, USA, lmadin@whoi.edu

AN EVOLUTIONARY PERSPECTIVE ON THE THALIACEA

The Thaliacea includes approximately 70 species of holoplanktonic, gelatinous tunicates, consisting of 3 major lineages: the Salpida (salps), Pyrosomatida (pyrosomes), and Doliolida (doliolids). Thaliaceans are filter feeders, and salps in particular have the highest known filtration rates among zooplankton. Despite their interesting biology and important role in ocean ecosystems, relatively little is known about their evolutionary relationships with other tunicates and with each other, or the evolution of their swimming and feeding strategies. Here we present a thaliacean phylogeny based on 18S rDNA. Our results support a basal position for the pyrosomes, and identify some conflicts with morphologically-based relationships of the Salpida. We find the subfamily Salpinae is paraphyletic, with the Cyclosalpinae deeply nested within it. We also resolve the

position of *Weelia* (*Salpa*) *cylindrica*, finding it to be relatively distantly related to other Salpa species. We explore the evolution of swimming and feeding characteristics of salps by mapping these characters onto our phylogeny. Lastly, we investigate the utility of 28S rDNA and ITS-1 sequences in resolving species-level relationships and as a species barcode.

Govoni, **D**. **P**., Hólar University College, Saudarkrokur, Iceland, dan.govoni@gmail.com

Kristjánsson, B. K., Hólar University College, Saudarkrokur, Iceland, bjakk@mail.holar.is

Ólafsson, J. S., Institute of Freshwater Fisheries, Reykjavik, Iceland, jsol@veidimal.is

ASSESSING THE ROLE OF ECOLOGICAL FACTORS IN MACROINVERTEBRATE COMMUNITIES IN ICELANDIC COLD SPRINGS

Springs are common in Iceland due to geologically young porous bedrock and high precipitation rates on the North Atlantic island. Prior to our work, almost no studies have focused on general ecological knowledge of spring sources in Iceland, although studies have been conducted on associated springbrooks and pools. Therefore, the objective of this study was to estimate macroinvertebrate abundance and assess community structure at the source in cold (2.88-6.75°C) springs, where the habitat is discrete. In order to explore the relationships between physicochemical spring conditions and macroinvertebrate community structure and function, macroinvertebrate samples and environmental variables were collected, in the summers of 2003-2006, from 26 cold rheocrene and limnocrene springs within Iceland's volcanically active zone. Because Chironomidae is the most abundant and diverse taxon in Icelandic freshwaters, individuals from this family were identified to species and are central to our analysis. Our initial results show that variation in the subfamilies Orthocladiinae and Diamisinae can be explained by differences in spring system type and substrate composition. Ongoing analysis will give further information regarding species composition and ecosystem function.

Graça, **M**., IMAR-CMA, Dep. of Life Sciences, Univerity of Coimbra, Coimbra, Portugal, ccanhoto@ci.uc.pt

Canhoto, C., IMAR-CMA, Dep. of Life Sciences, Univerity of Coimbra, Coimbra, Portugal, abelho@esac.pt

Abelho, M., IMAR-CMA, Dep. of Life Sciences, Univerity of Coimbra, Coimbra, Portugal, Veronica@ci.uc.pt

Ferreira, V., IMAR-CMA, Dep. of Life Sciences, Univerity of Coimbra, Coimbra, Portugal,

Encalada, A., IMAR-CMA, Dep. of Life Sciences, Univerity of Coimbra, Coimbra, , ,

CAN WE PREDICT LITTER DECOMPOSITION RATES AND THE ROLE OF SHREDDERS ACROSS SYSTEMS?

Understanding the processes that control the breakdown of organic matter is essential to predict pathways of energy transference from the detrital pool across food webs, nutrient cycling and carbon storage. We carried out several independent studies on litter breakdown in tropical streams and found that, in some of those streams breakdown rates were extreme fast, whereas in others we recorded extreme slow breakdown rates. We also observed that the contribution of shredder invertebrates to litter breakdown ranged from very important to negligible. We argue that litter decomposition rates and the role of shredder invertebrates can be predicted across all systems based upon local climate and geology. Accordingly, water stress (climate) and low nutrient availability (geology) will favor plant traits with low decomposability; in this case microbial decomposition will be slow and shredders will be numerically unimportant. Conversely, high nutrient content in soils and water would allow fast biological decomposition and the presence of shredders. We propose that further studies on litter decomposition should be analyzed taken into account climate-geology factors.

Grace, **M**. **R**., Water Studies Centre, Monash University, Clayton, Australia, mike.grace@sci.monash.edu.au

DETERMINING THE MAJOR CONTRIBUTIONS TO METABOLISM IN A FOURTH-ORDER, LOWLAND STREAM

The open water (whole stream) method measures overall gross primary production and community respiration, but provides no information about which component(s) of the ecosystem are contributing to these integrating measures. Consequently, several other techniques were employed in conjunction with the open water measurements to determine the relative importance of several ecosystem components in the Yarra River, a 4th-order stream in Victoria, Australia. Water column primary productivity was determined using $H^{14}CO_3^-$ incubations; tritiated thymidine incorporation measured water column bacterial productivity (thus enabling an estimate of bacterial respiration); and light and dark benthic chambers were used to determine the rates of littoral zone benthic respiration and primary productivity. Even though there was no change in stream order along the 130 km study region, ranging from the foothills to the small weir wall separating the freshwater section and the estuary, metabolism in the Yarra River followed the predictions of the River Continuum Concept due to the presence of distinct biogeographical zones.

Graham, **J**. **L**., U.S. Geological Survey, Lawrence, KS, USA, jlgraham@usgs.gov

Ziegler, A. C., U.S. Geological Survey, Lawrence, KS, USA, aziegler@usgs.gov

CYANOBACTERIAL COMMUNITY DYNAMICS, TASTES AND ODORS, AND TOXINS IN CHENEY RESERVOIR, KANSAS, 2001-2009

Since 2001, continuously monitored and discrete water-quality data has been collected in Cheney Reservoir, Kansas to evaluate the environmental factors influencing occurrence of cyanobacterial nuisance compounds. Patterns in cyanobacterial abundance, geosmin, and microcystin were consistent during 2001-2009. Cyanobacteria peaked in late winter and late summer. Late winter populations were dominated by Aphanocapsa and Oscillatoria; during late summer dominant taxa varied, but were commonly Anabaena, Aphanizomenon, and/or Oscillatoria. Geosmin always occurred during late winter, with occasional microcystin detections. Conversely, microcystin always occurred during late summer, with occasional geosmin detections. Late winter events followed seasonal minima in turbidity and nitrate, whereas late summer events followed seasonal maxima in orthophosphorus. Preliminary predictive models for geosmin were based on the continuously monitored variables turbidity and specific conductance; geosmin is predicted more effectively in late winter, likely because these variables best characterize the environmental conditions that occur prior to late winter events. The biogeochemical constraints associated with occurrence of cyanobacteria, geosmin, and microcystin varied seasonally. Thus, multiple seasonal models may be more effective than a single model in predicting the occurrence of cyanobacterial nuisance compounds.

Grantz, **E**. **M**., University of Arkansas, Fayetteville, USA, egrantz@uark.edu

Scott, J. T., University of Arkansas, Fayetteville, USA, jts004@uark.edu

NITROGEN RETENTION AND DENITRIFICATION EFFICIENCY IN RESERVOIRS

The role of reservoirs as landscape-level nitrogen (N) sinks is not well studied, particularly the contribution of denitrification to N removal in these ecosystems. This study estimates annual N loads in the major inflow and outflow streams of three Arkansas reservoirs through mass balance modeling in a gauged stream network. Stream stage was monitored continuously, and discharge and dissolved N concentration were measured 12 times annually during base flow and 12 times annually during storm flow. Loading estimates were derived for lake inflow and outflow sites. Differences in the inflow and outflow N loads represent N retained or exported by the reservoirs. We also estimate internal N recycling from reservoir sediments and sediment denitrification rates seasonally using intact sediment core incubations at in-situ temperatures. Measured gas and nutrient flux rates were scaled to ecosystem level rates and compared with N retention/removal efficiency to determine the importance of permanent N removal in these systems.

Grapentine, **L**. **C**., Environment Canada, Burlington, Canada, Lee.Grapentine@ec.gc.ca

Milani, D., Environment Canada, Burlington, Canada, Danielle.Milani@ec.gc.ca

MERCURY TRANSFER FROM SEDIMENTS TO BENTHIC INVERTEBRATES: INFLUENCES OF SEDIMENT PHYSICOCHEMISTRY, OVERLYING WATER QUALITY, AND TAXONOMIC GROUP

The transfer of mercury from sediment through benthic invertebrates to fishes and their consumers is an important biomagnification pathway in areas contaminated by industrial discharges of mercury. To better understand and predict mercury bioaccumulation in benthic invertebrates, effects of selected habitat factors on improving sediment-invertebrate methlymercury (MeHg) concentration relationships were assessed in 3 industrially contaminated areas in the Great Lakes-St. Lawrence River system. Using multiple linear regression methods to select subsets of predictor variables, concentrations of MeHg,

Mn, Fe, and N in sediment and particle size class fractions best accounted for whole-body invertebrate MeHg concentration. Sediment MeHg concentration in single predictor models was generally weakly or not related to invertebrate MeHg concentration, but was always significant with additional predictors. Multiple predictor models increased R^2 to 0.34-0.80. Epibenthic gastropods and amphipods accumulated MeHg to higher levels than those in infaunal chironomids and oligochaetes. These results indicate conditions under which mercury uptake from sediment by invertebrates may be favored, representing an increased hazard for biomagnification in higher trophic level taxa.

Graves, **P. H.**, Maryland Department of Natural Resources, Annapolis, MD, USA, pgraves@dnr.state.md.us

Ciccotto, P. J., Maryland Department of Natural Resources, Annapolis, MD, USA, pciccotto@dnr.state.md.us

RARE, THREATENED, AND ENDANGERED ODONATE FAUNA OF TWO WATERSHEDS IN THE LOWER POTOMAC RIVER DRAINAGE, MARYLAND

Sixty percent of Maryland's odonate species are considered Rare, Threatened, or Endangered (RTE). To prioritize areas for the protection of biodiversity, the Maryland Department of Natural Resources (MD DNR) has identified 10 watersheds with the highest rates of occurrences of imperiled and rare stream species, including odonates. We examined the odonate fauna of two of these conservation priority watersheds to determine the distribution and status of several imperiled odonate species in Maryland. Odonate nymphs collected from 2000-2009 from two Lower Potomac River drainage watersheds, Zekiah Swamp Run and Breton Bay, by volunteers and MD DNR's Maryland Biological Stream Survey were identified to species, when possible. Eight RTE species were collected in the Zekiah Swamp Run watershed and seven were collected from the Breton Bay watershed. One State Endangered and one State Threatened species were found in each watershed. These data detail the distribution and habitats of rare odonates in two priority watersheds in Maryland and will be critical to the conservation and management of these species and their habitats.

Grebliunas, **B. D.**, Illinois State University, Normal, USA, bdgrebl@ilstu.edu

Perry, W. L., Illinois State University, Normal, USA, wlperryilstu.edu

SEASONAL DYNAMICS AND POTENTIAL LIMITATION OF DENITRIFICATION RATES IN WETLANDS RECEIVING AGRICULTURAL TILE DRAINAGE

Excessive application of anhydrous ammonia often leads to degraded water quality both locally and downstream of agricultural regions. In central Illinois, drainage tiles bypass traditional approaches to intercept agriculture runoff. Wetlands represent an underutilized approach to intercept, retain, and remove excess nitrate. I investigated rates of denitrification from March-June 2009 in three replicate wetland complexes receiving agricultural tile drainage. Water entering the complexes can exceed 20 mg NO3-N/L, but we observed reductions of 35-91% from inflow to outflow. Denitrification rates differed between complexes ($p < 0.0001$) with average rates of: 0.300, 1.134, and 6.891 (mg N/kg/hr). Additionally, average denitrification rates differed ($p = 0.0013$) between the three wetlands within each complex (example: 0.508, 0.198, and 0.192 [mg N/kg/hr]). Denitrification rates decreased from spring to summer ($p < 0.0003$) as inflowing water nitrate concentrations decreased. Understanding the role and limitations of denitrification rates in wetlands receiving tile drainage will allow us to focus future projects on improving the efficiency of these wetlands as tools for nitrate pollution mitigation.

Green, **M. B.**, Plymouth State University, Plymouth, USA, mbgreen@plymouth.edu

Wollheim, W. M., University of New Hampshire, Durham, USA, wil.wollheim@unh.edu

Basu, N. B., University of Iowa, Iowa City, USA, nandita-basu@uiowa.edu

Gettel, G. M., University of New Hampshire, Durham, USA, gretchen.gettel@unh.edu

Rao, P. S., Purdue University, West Lafayette, USA, pscr@purdue.edu

Morse, N., University of New Hampshire, Durham, USA, nat.morse@unh.edu

Stewart, R., University of New Hampshire, Durham, USA, rob.stewart@unh.edu

EFFECTIVE DENITRIFICATION SCALES PREDICTABLY WITH WATER RESIDENCE TIME ACROSS DIVERSE SYSTEMS

Denitrification is a central process in the nitrogen cycle. The factors controlling denitrification are known, yet general quantitative comparison of controls on denitrification remains a rich area of study. We demonstrate that the 'effective' denitrification rate constant (first-order rate constant in the units of inverse time) and advective water transport (mean residence time) scale inversely across diverse systems, ranging from hillslopes and groundwater to large lakes and estuaries. As a result, we observe a relatively constant nitrogen removal across nine orders of magnitude in transport time scales. A central question remains as to why reaction time scale varies approximately linearly with transport time scale. We suggest that the variability of reaction time scale arises from hydrologic masking of an intrinsic denitrification rate constant. A two-compartment model shows how reaction time scale varies with the amount of advective water, and thus water residence time, explaining how denitrification losses in the reactive zone of a system are controlled by mass transfer to that reactive zone. Our finding highlights mean residence time in the advective zone as a primary control on effective rate constants of denitrification, while other factors (e.g., nitrate and organic carbon concentrations) provide secondary controls. Furthermore, the relationship between reaction time scale and water residence time demonstrates the strong coupling of the water and nitrogen cycles.

Green, **W. R.**, U.S. Geological Survey, Arkansas Water Science Center, Little Rock, USA, wrgreen@usgs.gov

REAL-TIME LAKE AND RESERVOIR METEOROLOGICAL AND VERTICAL WATER-QUALITY MONITORING

Recent advances in sensor technology and data telemetry allow data for a number of surface meteorological and vertical water-column data to be collected simultaneously, in real time, for lakes and reservoirs. With recent advancements in computer technology, three-dimensional lake and reservoir models can be run in much shorter time frames, allowing for real-time simulations of hydrodynamics and water quality. Together, these advances allow for the development of quasi-real-time decision-support systems for water-quality management of individual lakes and reservoir systems. One such water-quality monitoring system has been operating in Beaver Lake in northwestern Arkansas since February, 2008. Meteorological characteristics include air temperature, relative humidity, wind speed and direction, net radiation, shortwave radiation, and photosynthetic active radiation. Water quality characteristics include water temperature and dissolved oxygen. Thermistors (16) and optical dissolved oxygen sensors (8) are distributed at various depths from the surface to about 27 meters deep. All data are recorded every 30 seconds and transmitted hourly to the USGS Arkansas Water Science Center. Data are then loaded into the USGS NWIS database for storage and retrieval.

Greenwood, **M. J.**, University of Canterbury, Christchurch, New Zealand, michelle.j.greenwood@gmail.com

McIntosh, A. R., University of Canterbury, Christchurch, New Zealand, angus.mcintosh@canterbury.ac.nz

Harding, J. S., University of Canterbury, Christchurch, New Zealand, jon.harding@canterbury.ac.nz

McHugh, K. E., University of Canterbury, Christchurch, New Zealand, katie.mchugh@canterbury.ac.nz

Niyogi, D., Missouri University of Science and Technology, Rolla, USA, niyogid@mst.edu

DIRECT AND INDIRECT EFFECTS OF RIPARIAN MANAGEMENT ON AQUATIC INVERTEBRATE COMMUNITIES IN A DEGRADED AGRICULTURAL LANDSCAPE

The management of riparian zones by planting vegetation and excluding stock reduces nutrient and sediment run-off into streams. However, reported effects on aquatic invertebrate communities have been variable, particularly in highly degraded systems. In substantially altered landscapes, riparian management may be less effective if legacies of historic land-use remain or management is not targeted at vulnerable parts of the network, such as headwaters. We assessed the direct and indirect effects of riparian management and stream size on the invertebrate communities of 64 agricultural waterways on the Canterbury Plains, New Zealand. Small, headwater streams were most degraded and riparian management positively affected stream communities. However, structural equation models revealed the strongest effect of riparian management was on food resources, while the strongest determinants of aquatic invertebrate communities were in-stream habitat and temperature, which were influenced by stream size. As a result, a larger positive effect of riparian management may result from techniques which are targeted to improve in-stream habitat, especially in small streams.

Gresens, **S**. **E**., Towson University, Towson, MD, USA, sgresens@towson.edu

SILT-CLAY SEDIMENTS REDUCE PHOSPHORUS LIMITATION AND INCREASE PERIPHYTON ACCRUAL IN LABORATORY MICROCOSMS

Runoff and erosion from stream banks creates pulses of suspended sediment which may have either positive or negative effects on attached algae. Phosphorous adsorption isotherms were constructed for three clays collected from local stream banks, to determine whether chemical properties of the clays could predict the growth response of periphyton in recirculating microcosms. Langmuir models were used to estimate P-binding affinities and sorption capacities of clays. Periodic additions of sediment to microcosms, to yield 30 mg/L in suspension, lead to increased biomass accrual (AFDM and chlorophyll) compared to controls without sediment. Stimulation of algal biomass was correlated with decreased alkaline phosphatase activity of periphyton. The two clay types with the lowest P-binding affinities stimulated algal growth significantly more than the remaining clay and the control, over forty days. The amount of phosphorus initially bound to these clays did not predict effects on algae. Results indicate that algae were able to obtain phosphorus from sediment incorporated into the periphyton mat.

Gretz, **M**. **R**., Michigan Technological University, Houghton, USA, mrgretz@mtu.edu
Kiemle, S. N., Michigan Technological University, Houghton, USA, snkiemle@mtu.edu

WHAT A TANGLED WEB WE WEAVE - STALK DEGRADATION AS A POTENTIAL *DIDYMOSPHENIA GEMINATA* MITIGATION METHOD

If *Didymosphenia geminata* (didymo) was just another benthic diatom producing a uniform 1–5 mm thick brown scum/slime on rocks, it would not be the subject of intense worldwide interest. Production of prodigious amounts of tightly woven stalk material differentiates didymo from other benthic diatoms and is a very important aspect of its biology which contributes to nuisance blooms. Attempts at control or mitigation of didymo should include limiting stalk proliferation or eliminating stalk mass. Didymo stalks are composed primarily of a sulfated xylogalactan, which has been reported for stalks of related freshwater diatoms *Gomphonema* and *Cymbella*. These stalks are intrinsically hydrophilic and cross-linked by ionic cross-bridging. Partial degradation of stalks with several chemical and enzymatic agents revealed that stalks were organized with concentric layers of hydrated xylogalactan surrounded by a tough outer striated layer which was resistant to degradation. Mechanical methods did not effectively degrade hydrated mats. Enzymatic degradation of stalk masses has application in future mitigation and biocontrol initiatives. We are in the process of identifying specific inhibitors of stalk polysaccharide synthesis.

Griffith, **M**. **B**., U.S. Environmental Protection Agency, ORD, National Center for Environmental Assessment, Cincinnati, USA, griffith.michael@epa.gov
Norton, S. B., U.S. Environmental Protection Agency, ORD, National Center for Environmental Assessment, Washington, USA, norton.susan@epa.gov
Alexander, L. C., U.S. Environmental Protection Agency, ORD, National Center for Environmental Assessment, Washington, USA, alexander.laurie@epa.gov
Pollard, A. I., U.S. Environmental Protection Agency, ORD, National Center for Environmental Assessment, Washington, USA, pollard.amina@epa.gov
Suter, G. W., U.S. Environmental Protection Agency, ORD, National Center for Environmental Assessment, Cincinnati, USA, suter.glenn@epa.gov

MOUNTAINTOP MINES AND VALLEY FILLS: REPLACING ONE DOWNSTREAM IMPACT ON WATER QUALITY WITH ANOTHER

Historically, water quality impacts from coal mining were low pH and elevated metal concentrations. These problems resulted from the oxidation of pyrite (FeS_2) to form H_2SO_4 and $Fe^{(3+)}$ along with dissolution of metals, such as Al, by the acidic water. Such acidic mine drainage remains a legacy of coal mining. A difference with MTM/VF compared to older surface mining methods is that the acidic waters are neutralized within the valley fills. However, while waters downstream from valley fills are generally not acidic and may be alkaline, pyrite oxidation still occurs resulting in elevated levels of $SO_4^{(2-)}$. Moreover, the geochemical reactions with carbonate minerals that neutralize the acidity produce elevated levels of other ions, such as $Ca^{(2+)}$, $Mg^{(2+)}$ and $HCO_3^{(1-)}$. Other minerals in the overburden are also solubilized by the above reactions or just by the increased exposure to water releasing ions, such as $K^{(1+)}$, $Na^{(1+)}$ and $Cl^{(1-)}$. All these ions are components of the elevated specific conductivity and total dissolved solids observed downstream of valley fills that are the primary impact on downstream water quality of MTM/VF.

Griffiths, **N**. **A**., University of Notre Dame, Notre Dame, USA, ngriffi1@nd.edu
Tank, J. L., University of Notre Dame, Notre Dame, USA, tank.1@nd.edu
Roley, S. S., University of Notre Dame, Notre Dame, USA, sroley@nd.edu
Stephen, M. L., University of Notre Dame, Notre Dame, USA, miastephen@gmail.com

COMPARISON OF DETRITAL DECOMPOSITION IN FLOODPLAIN AND MAIN CHANNEL HABITATS OF RESTORED AGRICULTURAL STREAMS

Decomposition of organic matter has been understudied in agricultural streams and associated riparian habitats (channel banks and floodplains) despite the dominance of agricultural land use. We measured decomposition rates of three common litter types (maize leaves [*Zea mays*], native rice cut grass [*Leersia oryzoides*], and invasive reed canary grass [*Phalaris arundinacea*]) in four Midwestern streams that have been restored by recreating and reconnecting floodplains to the main channel. In each stream, we compared decomposition in four habitats: main channel of the upstream control (unmanipulated) reach, steep banks in the control reach, main channel of treatment (restored) reach, and on the treatment floodplains. Preliminary results suggest that decomposition was faster in the stream channel compared to banks/floodplains (ANCOVA, $P<0.0001$). Also, decomposition rates in both the stream channel and banks/floodplains were similar between control and treatment reaches (ANCOVA, $P=0.523$). Maize decomposed most quickly and supported higher microbial respiration than either native or invasive grasses (RM ANOVA, $P<0.0001$). Ongoing research will examine the abiotic and biotic controls on decomposition rates, as well as how inundation via flooding influences decomposition in riparian habitats.

Griffiths, **R**. **W**., Oregon State University, Corvallis, USA, bugman@execulink.com
Northcote, T. G., University of British Columbia, Vancouver, USA,

DOES SEASONAL CHANGES IN MORTALITY AND GROWTH EXPLAIN DIFFERENCES IN PRODUCTION OF SHREDDERS, COLLECTORS, SCRAPERS AND A PREDATOR IN A COASTAL MOUNTAIN STREAM?

Understanding the factors that influence the structure and production of populations is a central focus of ecology. This study measured the seasonal mortality and growth of various functional-feeding group populations to determine if they helped explain differences in production among populations. Coastal streams are characterized by stable, low flows with low detrital inputs during summer and flashy, high flows with high detrital inputs during fall. Annual production for populations varied from 50 to 420 mg m^{-2}. Cohorts of the collector, *Paraleptophlebia temporalis* , had the highest annual production. Growth rates showed no differences between summer and fall and were intermediate in value (1.5%/day). In contrast, mortality rates were intermediate in value during summer (1.9%/day) but high during fall (2.8%/day). Cohorts of the predator, *Plumiperla diversa* , had the lowest annual production. Growth rates were high during summer (4.4%/day for 0+ cohort) then dropped to intermediate values in fall (1.5%/day). Mortality rates showed no differences between seasons and were low (<1%/day). Unfortunately, species with intermediate production showed all possible combinations of growth and mortality and thus no relationship could be deduced.

Groeger, **A**. **W**., Texas State University, San Marcos, USA, ag11@txstate.edu
Becker, J., Texas State University, San Marcos, USA,
Fulcher, V., Texas State University, San Marcos, USA,
Kamps, R. H., Texas State University, San Marcos, USA,

SEASOANLY-GENERATED HORIZONTAL CURRENTS AS A MAJOR MIXING MECHANISM IN A SUBTROPICAL, SEMI-ARID RESERVOIR

International Lake Amistad is a large reservoir draining the upstream arid and semi-arid Rio Grande catchment. The reservoir basin is complex, with two distinct arms, and three entering rivers of very different character (R. Grande/Bravo, high sediment load; Pecos R., much more saline; and the Devils R., a hardwater river much more dilute than the other two). Sampling the reservoir for a 38 months period, we observed over three consecutive winters in which an underflowing Pecos would upwardly displace water at the dam resulting in an isopycnal "salty" current flowing 35 km up into the Devils R. arm. This "saltier" water would mix with surface waters in the spring, and explains the mechanism in which high conductance water is moved way upstream into the "dilute" river basin. An inundated dam in this arm would trap the cold salty water from flowing back down to main dam over the summer, so a perched slab of dense water would create a particularly harsh, anaerobic environment relative the other areas in the reservoir.

Groner, **M**. **L**., University of Pittsburgh, Pittsburgh, USA, mlg59@pitt.edu
Buck, J. C., Oregon State University, Corvallis, USA, julia.buck@gmail.com
Blaustein, A. R., Oregon State University, Corvallis, USA, blaustea@science.oregonstate.edu
Rollins-Smith, L. A., Vanderbilt University Medical Center, Nashville, USA, louise.rollins-smith@vanderbilt.edu
Reinert, L. K., Vanderbilt University Medical Center, Nashville, USA, laura.reinert@vanderbilt.edu
Relyea, R. A., University of Pittsburgh, Pittsburgh, USA, relyea@pitt.edu

SCARED SICK? EFFECTS OF SUBLETHAL EXPOSURE TO PREDATORS AND PESTICIDES ON LIFE HISTORY TRAITS, IMMUNE FUNCTION AND DISEASE SUSCEPTIBILITY IN WOOD FROGS

Recent reviews hypothesize that pathogen-associated amphibian declines may be exacerbated by immunosuppression triggered by exposure to contaminants and/or stress hormones released in response to environmental changes. Currently, there are few empirical data in support of these hypotheses. We exposed wood frog tadpoles (Rana sylvatica) to sublethal concentrations of malathion (0, 10, 100 ppb), and cues from caged dragonfly predators (Anax junius). We measured effects of these treatments on life history traits (growth, development and survival) and the susceptibility of wood frog metamorphs to the fungal pathogen Batrachochytrium dendrobatidis (B.d.). Both treatments had mild negative effects on wood frog development, but not growth. Survival was also slightly lower in the highest pesticide treatment when predators were present, but not when predators were absent, supporting past evidence that these stressors can have synergistic negative effects on survival. Surprisingly, mortality rates in frogs exposed to B.d. were lower in individuals stressed by predator cues, while malathion did not effect survival. Overall these data fail to show that contaminants and predator stress cause higher rates of mortality associated with B.d., although they do show that environmental context can alter life history traits and disease susceptibility. Further tests are needed to show whether such stressors alter immune system function and if these results are robust for other pathogens.

Grossman, G. D., University Georgia, Athens, USA, grossman@uga.edu
Ratajczak, Jr., R. University Georgia, Athens, USA, bobrat@uga.edu

MACROINVERTEBRATE DIVERSITY IN A SOUTHERN APPALACHIAN STREAM, A TEST OF THE INTERMEDIATE DISTURBANCE HYPOTHESIS (IDH).

We tested the applicability of the IDH to macroinvertebrate diversity in 2nd, 4th and 5th order streams in the relatively undisturbed Coweeta Creek drainage, (Otto NC, USA). Between autumn 1991 and autumn 1995 we visually quantified the dominant (>50%) substratum in permanent quadrats (2X yearly) in three 100m sites. We classified quadrats as: stable (0-1 changes in dominant substratum), intermediate (2-3 changes), or unstable (=4 changes). In spring 1996 we sampled and identified (genus or family) benthic macroinvertebrates in randomly selected quadrats dominated by erosional substrata. Small sample sizes obscured patterns in the data when analyzed on a site by site basis so we pooled quadrat habitat data, and used PCA to quantify disturbance. We regressed Shannon-Weiner diversity, species richness and evenness (y) against SD of PC1 (x) to test the IDH. Instead of the parabolic relationship predicted, we found significant negative correlations between disturbance and diversity ($p<0.0004$, $r2 = -0.26$), richness ($p<0.006$, $r2 = -0.13$), and evenness ($p<0.09$, $r2 = -0.08$). Generally similar results were obtained using the SD of sand/silt per quadrat as a measure of disturbance.

Grubbs, **S**. **A**., Western Kentucky University, Bowling Green, USA, scott.grubbs@wku.edu
Bernal, R. R., Western Kentucky University, Bowling Green, Canada,

INFLUENCE OF HYDROLOGIC GRADIENTS ON WOODY DEBRIS BREAKDOWN AND MACROINVERTEBRATE COLONIZATION PATTERNS IN A CUMBERLAND PLATEAU WATERSHED, U.S.A.

This research assessed the influence of stream channel type (temporary vs. perennial) on woody debris dynamics in a Cumberland Plateau watershed, comparing processing rates and macroinvertebrate colonization patterns in relation to the hydrologic gradient. Although mean processing rates (-k, per year) in the perennial (pr) reaches (0.160; range: 0.133–0.194) were higher compared to the temporary (tm) reaches (0.133; range: 0.103–0.170), this difference was not significant ($p = 0.09$). Collector-gatherers overall comprised the greatest proportion (tm = 68%, pr = 63%) of macroinvertebrates colonizing wood. Individually, non-Tanypodinae Chironomidae (tm = 48%, pr = 40%), Amphinemura sp. (tm = 6%, pr = 7%), Ameletus sp. (tm = 6%, pr = 8%), Ephemerella (tm = 5%, pr = 7%) and tanypod Chironomidae (tm = 4%, pr = 4%) were the most abundant taxa. There were no significant between-channel differences for total richness, abundance and biomass plus collector-gatherer, shredder, scraper and filtering-collector abundance and biomass. Overall, the hydrologic gradient was sufficiently shallow to support similar ecosystem-level processes and likewise suggests that temporary streams should be afforded equal protection compared to perennial streams.

Grunseich, **K**., Dartmouth College and Rocky Mountain Biological Laboratory, Hanover, USA, kgrunseich@gmail.com
Taylor, B. W., Dartmouth College and Rocky Mountain Biological Laboratory, Hanover, USA, brad.taylor@dartmouth.edu

EFFECTS OF STREAM MACROINVERTEBRATE COMMUNITY COMPOSITION CHANGES ON NUTRIENT RECYCLING

Nutrient supply into an ecosystem is an important factor that can influence its productivity and varies based on species diversity. Here we examined the role of stream macroinvertebrates in recycling nutrients. We measured excretion rates of NH4-N and PO4-P for all readily identifiable taxa in the upper East River in Gothic, CO and examined how these rates varied by body size and across taxa. We also measured whole-stream nutrient uptake rates to estimate the percentage of ecosystem demand met by the macroinvertebrate community. Mean N excretion rate per individual and per unit of biomass varied by nearly three orders of magnitude across invertebrate taxa sampled. The invertebrate community supplied about 13% of nutrient demand, dominated by 3 taxa. We also asked how variation in taxonomic composition affected nutrient supply rates by using simulation models. I found that taxa with high mass-specific excretion rates tend to be most tolerant to organic pollution, which can result in a positive feedback where a disturbance leads to continued change via higher excretion by the new invertebrate community.

Gsell, **A**., Netherlands Institute of Ecology (NIOO-KNAW), Department of Aquatic Ecology, Nieuwersluis, Netherlands, a.gsell@nioo.knaw.nl
Van Donk, E., Netherlands Institute of Ecology (NIOO-KNAW), Department of Aquatic Ecology, Nieuwersluis, Netherlands, e.vandonk@nioo.knaw.nl
Ibelings, B. W., Netherlands Institute of Ecology (NIOO-KNAW), Department of Aquatic Ecology, Nieuwersluis, Netherlands, b.ibelings@nioo.knaw.nl

MAINTENANCE OF HOST INTRASPECIFIC GENETIC DIVERSITY BY PARASITE DRIVEN SELECTION AND ENVIRONMENTAL VARIATION

An increasing number of studies report high intraspecific genetic diversity in diatom populations even in cases with predominantly clonal reproduction and no reported gene flow. Maintenance of genetic diversity for infection related traits is commonly ascribed to host genotype by parasite genotype interactions ($G_H x G_P$). But environmental heterogeneity may also play a role in maintenance of such genetic diversity if the relative fitness of host and parasite genotypes varies with different environments (also called $G_H x G_P x E$ interactions). Thus the real impact of parasitism on the genetic structure of natural host populations remains unresolved. In Lake Maarsseveen (NL), blooms of the diatom *Asterionella formosa* are host to epidemics of the chytrid *Zygorhizidium planktonicum* that can attain over 95% prevalence and thus are predicted to act as strong selective agents on the host. However, the effect of the parasite on host genotype frequencies may be confounded by concurrent seasonal temperature changes. To disentangle genetic from environmental factors and to see how infection related traits are sensitive to thermal variation a $G_H x G_P x E$ interaction experiment in laboratory batch cultures was set up. First results of this experiment will be presented.

Gudasz, **C**., Uppsala University, Uppsala, Sweden, cristian.gudasz@ebc.uu.se
Bastviken, D., Linköping University, Linköping, Sweden, david.bastviken@liu.se
Steger, K., Uppsala University, Uppsala, Sweden, kristin.steger@ebc.uu.se
Premke, K., Uppsala University, Uppsala, Sweden, katrin.premke@ebc.uu.se
Sobek, S., Uppsala University, Uppsala, Sweden, sebastian.sobek@ebc.uu.se
Tranvik, L. J., Uppsala University, Uppsala, Sweden, lars.tranvik@ebc.uu.se

TEMPERATURE CONTROL OF THE ORGANIC CARBON SINK IN LAKE SEDIMENTS

Peatlands, soils, and the ocean floor are well-recognized sites of accumulation of organic carbon (OC), representing important global carbon sinks. Although the annual burial of OC in lakes and reservoirs exceeds that of ocean sediments, inland waters receive very limited attention as a component of the global carbon

cycle. Of the OC being deposited onto the sediments, a certain proportion will be mineralized, and the remainder will be buried over geological timescales. We investigated to what extent a warmer climate will affect OC mineralization and burial in lake sediments. Here we show that the mineralization of OC in lake sediment is strongly positively related to temperature, implying that increased water temperature leads to more mineralization and less burial of OC. For lakes in the boreal zone, we estimate that temperature increases according to the IPCC warming scenarios, result in a 4-27 % (0.9-6.4 Tg C yr-1) decrease in annual OC burial, constituting a feedback of aquatic carbon cycling on climate.

Gudmundsson, **J.**, Agricultural University of Iceland, Reykjavík, Iceland, jong@lbhi.is

Óskarsson, H., Agricultural University of Iceland, Reykjavík, Iceland, hlynur@lbhi.is

METHANE EMISSION FROM THE GILSÁRLÓN HYDROPOWER RESERVOIR IN NORTHERN ICELAND: THE IMPORTANCE OF EBULLITATIVE EMISSION.

We measured methane emission from a 15 year old boreal hydropower reservoir Gilsárlón in Northern Iceland. The measurements extended over three years period from 2003-2005 covering three ice free periods and one ice cover period. Both diffusive emission and ebullition were measured. Diffusive fluxes were measured by floating chambers 14 times over three years. Measured diffusion of methane over the surface of the reservoir was 2,1-2,8 mg CH4 m-2 d-1 on average over ice free period, varying from 0.48 – 8.45 mg CH4 m-2 d-1 with the lowest value recorded in October 2003 and the highest in July 2004. The range in total diffusive emission over ice free period was 0,405-0,568 g CH4 m-2 over the three years. The accumulated emission through ebullition was 8.69- 10.27g CH4 m-2 for the ice free periods based on all active collectors in each collecting period. For the one ice period measured the accumulated ebullition was estimated as 0.380 g CH4 m-2. The results show that 15 years after impoundment of boreal peat methane emission is still considerable and that the bulk of the emission is through ebullition.

Gurtz, **M. E.**, U.S. Geological Survey, Reston, Virginia, USA, megurtz@usgs.gov

Carlisle, D. M., U.S. Geological Survey, Reston, Virginia, USA, dcarlisle@usgs.gov

Paulsen, S. G., U.S. Environmental Protection Agency, Corvallis, Oregon, USA, Paulsen.Steve@epamail.epa.gov

Van Sickle, J., U.S. Environmental Protection Agency, Corvallis, Oregon, USA, Vansickle.John@epamail.epa.gov

ASSESSMENT OF TEMPORAL VARIANCE COMPONENTS AND IMPLICATIONS FOR TREND ASSESSMENT IN BIOLOGICAL MONITORING PROGRAMS

Assessment of temporal trends in biological monitoring programs is often undertaken without an understanding of temporal variability of biological communities. Typically, the within-site variance is unknown and included as part of sampling error. This investigation – designed jointly by the U.S. Geological Survey (National Water-Quality Assessment Program) and the U.S. Environmental Protection Agency (Office of Research and Development) – compared the relative magnitude of short-term (within-year) variability to long-term (between-year) variability in biological indicators of water quality. A total of 33 sites (9 urban, 6 agricultural, and 18 relatively undisturbed streams distributed throughout the U.S.) were sampled in two consecutive years, and twice in a 10-week index period during one of those years; as many as 10 additional annual samples collected in previous years also were used to characterize interannual variability. Four sources of variance were calculated for invertebrate indicators – within-site in a single year, among years, among sites, and interaction between years and sites. Results of this study will provide information on the importance of understanding temporal variability for interpreting long-term (multi-year) trends, and designing future trends sampling.

Gutierrez, **M. H.**, University of Concepcion, Concepcion, Chile, magutier@udec.cl

Pantoja, S., University of Concepcion, Concepcion, Chile, spantoja@udec.cl

Tejos, E., University of Concepcion, Concepcion, Chile, etejos@udec.cl

González, R. R., University of Concepcion, Concepcion, Chile, rogonzal@udec.cl

Quiñones, R. A., University of Concepcion, Concepcion, Chile, rquinone@udec.cl

FUNGI IN THE COASTAL UPWELLING ECOSYSTEM OFF CENTRAL CHILE

We show for the first time water column vertical profiles of fungal biomass and evidenced their role in processing marine organic matter in the Humboldt Current System off Chile, during a 3-year study using molecular tools, epifluorescence microscopy, and incubations with fluorogenic substrates. A higher number of fungal genotypes (PCR-DGGE) were found in nearshore than offshore sites in seawater and sediments, and in summer than winter in surface sediments. Fungal biomass reached up to 40 μg C L^{-1} in surface waters during spring and their vertical patterns agreed with those of chlorophyll-a. The highest fungal biomass rivaled with prokaryote biomass and coincided with the increment in photoautotrophic biomass and extracellular enzymatic hydrolysis during the upwelling season. Most of the hydrolysis of proteinaceous substrate was verified in sizes dominated by fungi during periods of higher phytoplankton and fungal biomasses. This research was funded by the Programa de Investigación Marina de Excelencia, PIMEX-Nueva Aldea (University of Concepcion and Celulosa Arauco y Constitución S.A.) and the COPAS Center (Grant 150100007, CONICYT, Chile).

Guyette, **M. Q.**, Department of Wildlife Ecology, University of Maine, Orono, USA, margaret.guyette@umit.maine.edu

Loftin, C. S., US Geological Survey Maine Cooperative Fish and Wildlife Research Unit, Orono, USA, cynthia.loftin@maine.edu

Zydlewski, J., US Geological Survey Maine Cooperative Fish and Wildlife Research Unit, Orono, USA, jzydlewski@usgs.gov

EVIDENCE OF MARINE-DERIVED NUTRIENT UPTAKE IN ATLANTIC SALMON NURSERY STREAM COMMUNITIES

Prior to construction of dams beginning in the early 1800s, Atlantic salmon and other anadromous species migrated from the ocean to spawn in Maine's extensive rivers and streams. Spawning fish transported marine-derived nutrients to these systems in the form of metabolic expenditure and through decomposition of mortalities. These contributions may have strongly influenced productivity in otherwise nutrient limited systems, bolstering the growth and survival of young Atlantic salmon and other anadromous species. To test this, we stocked four first-order streams with young-of-the-year Atlantic salmon in May 2009 and manipulated nutrient input with a salmon carcass analog placed in treatment reaches in mid-July and late October, timed to match sea lamprey and Atlantic salmon spawning. Atlantic salmon, macroinvertebrate, and water samples were collected during June – December. Water chemistry results show that treatment doubled soluble reactive phosphorus concentrations in the first week following treatment, but effects varied over time. Treatment had no effect on nitrate and nitrite concentrations. We are monitoring Atlantic salmon growth and body condition and macroinvertebrate biomass and community structure to identify change following the treatment.

Haag, **K. H.**, US Geological Survey, Tampa, USA, khhaag@usgs.gov

Lee, T. M., US Geological Survey, Tampa, USA, tmlee@usgs.gov

Walls, S. C., US Geological Survey, Gainesville, USA, swalls@usgs.gov

DESCRIBING FRESHWATER WETLAND HYDROLOGY - APPROACHES AND APPLICATIONS IN FLORIDA

Flooded area and flooding duration are the principal hydrologic parameters that affect wetland ecology. Changes in these parameters driven by climate, groundwater pumping, or land-use affect critical ecosystem functions in freshwater wetlands. Isolated freshwater wetlands are numerous and widespread in low-gradient landscapes of Florida. Describing their hydrologic condition at the landscape scale is critical to regional water management decisions and wildlife conservation initiatives. In case studies, hydrologic conditions were described using continuous wetland water-level measurements, local rainfall data, and bathymetric data collected using standard survey techniques. Flooded area and flooding duration were described for up to 15 years and were correlated with vegetation distribution and invertebrate community composition. In areas where groundwater can flow between shallow and deep aquifers, hydrologic conditions of numerous wetlands within a watershed were inferred by mapping the potentiometric surface of groundwater in the deeper aquifer. A rainfall-runoff model coupled with high-resolution LiDAR and NEXRAD rainfall data was used to simulate hydrologic responses in large groups of wetlands to changes in rainfall. Simulation results can be used to predict occupancy patterns of aquatic biota in wetlands.

Haase, **P**., Senckenberg, Gelnhausen, Germany, peter.haase@senckenberg.de
Lorenz, A. W., University of Duisburg-Essen, Essen, Germany, armin.lorenz@uni-due.de
Hering, D., University of Duisburg-Essen, Essen, Germany, daniel.hering@uni-due.de
Sundermann, A., Senckenberg, Gelnhausen, Germany, andrea.sundermann@senckenberg.de
Jähnig, S. C., Senckenberg, Gelnhausen, Germany, sonja.jaehnig@senckenberg.de

RIVER RESTORATION SUCCESS – A QUESTION OF PERCEPTION

Success and failure of river restoration measures is a strongly debated topic in restoration science. The debate usually focuses on measurable parameters, while more subjective aspects such as landscape aesthetics, or recreational value are left out, even though they play an important role in the perception and communication of restoration success especially by water managers. Based on 26 large river restoration measures, we evaluated and compared objective (hydromorphology, fish, benthic invertebrates) and subjective parameters (perception of success by water managers from an online survey). Our results from the objective parameters showed improved hydromorphology, but mixed results concerning changes of benthic invertebrate and fish assemblages. These results did not correspond to the subjective parameters, which showed a mostly positive self-evaluation of restoration projects by water managers reflecting a different idea about restoration success based on landscape aesthetic values or benefit for the public, and a general "condemned to success"-attitude. Our results indicated that (1) a societal debate about restoration-success-indicators is needed and (2) the out-comings should result in thoughtfully formulated goals prior to restoration and the obligation to monitor success.

Hadwen, **W**. **L**., Australian Rivers Institute, Griffith University, Brisbane, Australia, w.hadwen@griffith.edu.au
Jardine, T. D., Australian Rivers Institute, Griffith University, Brisbane, Australia, t.jardine@griffith.edu.au

WHAT YOU KNEW YOU DIDN'T WANT TO KNOW: EXPLORING TEMPORAL VARIABILITY IN STABLE ISOTOPE SIGNATURES OF STREAM BIOTA IN CANADA AND AUSTRALIA.

The stable isotope signatures of stream biota vary temporally in response to factors like water velocity, water chemistry, temperature and light. Whilst our understanding of local temporal variability is growing, we are yet to synthesise these data across broader scales. We collated temporal stable isotope data for producers and consumers across a diverse range of lotic ecosystems in Australia and Canada and examined the degree to which geography and hydrologic variability might underpin the measured isotopic variability. Producers and consumers exhibited substantial temporal variability in stable isotope signatures, although variability differed greatly from site to site. Interestingly, the range of isotopic signatures was consistently greater in the Australian systems than in their Canadian counterparts and overall, temporal isotopic variability tended to be highest in systems with the greatest hydrologic variability and lowest hydrologic predictability. We suggest that hydrologic variability and predictability may be useful predictors of temporal isotopic variability of stream biota. This has implications for both what to expect and how to accommodate temporal variability in stable isotope and food web studies, particularly in highly variable and unpredictable streams.

Hagenbuch, **E**. **J**., Miami University, Oxford, USA, hagenbej@muohio.edu
González, M. J., Miami University, Oxford, USA, gonzalmj@muohio.edu
Stevens, M. H., Miami University, Oxford, USA, stevenmh@muohio.edu
Vanni, M. J., Miami University, Oxford, USA, vannimj@muohio.edu
Knoll, L. B., Miami University, Oxford, USA, knolllb@muohio.edu
Renwick, W. H., Miami University, Oxford, USA, renwicwh@muohio.edu
Denlinger, J. S., Inland Fisheries Research Unit, ODNR Division of Wildlife, Columbus, USA, jonathan.denlinger@dnr.state.oh.us
Hale, R. S., Inland Fisheries Research Unit, ODNR Division of Wildlife, Columbus, USA, scott.hale@dnr.state.oh.us

COMPLEX RELATIONSHIPS AMONG LAND COVER TYPE, RESERVOIR MORPHOMETRY, PRODUCTIVITY AND ZOOPLANKTON ASSEMBLAGES

Although many studies have examined the effects of eutrophication within aquatic systems, proper management of affected systems will require knowledge of the links between terrestrial subsidies and landscape-level anthropogenic disturbance. Due to their small surface water areas and large watershed area:surface water area ratios, reservoirs often receive substantial subsidies of nutrients and sediments. We used a combination of simple and multivariate techniques to examine relationships among a suite of variables representing landscape-level disturbance, basin morphometry, limnological parameters and zooplankton community biomass (rotifers and crustaceans) for a set of 109 reservoir systems covering a mesotrophic to hypereutrophic gradient. A majority of the environmental variance between reservoirs was explained by limnological parameters indicative of productivity level. A regression tree analysis was used to develop a preliminary classification scheme which predicted reservoir productivity levels according to landscape-level and morphometric parameters. Regressions between zooplankton biomass and individual environmental parameters revealed significant correlations, primarily between pairs of environmental parameters and small-bodied zooplankton biomass (rotifers and copepod nauplii), indicating not only direct links between zooplankton and productivity levels, but also indirect relationships with landscape-level and morphometric parameters.

Haggerty, **R**., Oregon State University, Corvallis, USA, haggertr@geo.oregonstate.edu
Argerich , Oregon State University, Corvallis, USA, argerica@geo.oregonstate.edu
Martí, E., Centre d'Estudis Avançats de Blanes-CSIC, Blanes, Spain, eugenia@ceab.csic.es
Sabater, F., Universitat de Barcelona, Barcelona, Spain, fsabater@ub.edu
Zarnetske, J. P., Oregon State University, Corvallis, USA, zarnetsj@geo.oregonstate.edu

THE USE OF RESAZURIN AS A TRACER TO DIFFERENTIATE STREAM REACHES WITH CONTRASTING METABOLICALLY ACTIVE TRANSIENT STORAGE

Quantification of water transient storage zones has become a critical issue in biogeochemical studies of stream ecosystems addressed to examine factors controlling variation in nutrient retention. The method commonly used to quantify transient storage (based on conservative solutes as hydrologic tracers), does not allow distinguishing among the different compartments that contribute to transient storage. In this study we used resazurin (Raz) as "smart" tracer which, in combination with a conservative tracer (e.g., Cl), is expected to provide information on the relation between metabolically active transient storage and whole transient storage. We conducted a combined addition of Raz and Cl along a 563-m stream section with two differentiated reaches. The upstream reach (357 m) was scoured to bedrock (and thus transient storage was associated only with surface compartments) and the downstream reach (206 m) had a deep hyporheic zone (and thus transient storage was associated with both surface and hyporheic compartments). We measured whole-reach respiration at each reach and we examined the evolution of Cl, and Raz concentrations at the bottom of each reach and at 10 wells.

Haire, **S**. **A**., Department of Water Resource Science, University of Minnesota, 1985 Buford Ave, Saint Paul, MN 55108, Saint Paul, USA, hair0005@umn.edu
Johnson, D. K., Metropolitan Council Environmental Services, 2400 Childs Road, Saint Paul, MN 55106, Saint Paul, USA,
Ferrington, Jr., L. C., Department of Entomology, University of Minnesota, 1980 Folwell Avenue, Saint Paul, MN 55108, Saint Paul, USA,

THREE DECADES OF BIOMONITORING (1979-2007) IN THE MISSISSIPPI NATIONAL RIVER AND RECREATION AREA, MINNEAPOLIS-SAINT PAUL, MINNESOTA

The Metropolitan Council Environmental Services started biomonitoring the three large rivers in the Minneapolis-Saint Paul Metropolitan Area in 1979, as a key component of a long-term water quality monitoring program. Macro-invertebrates have been sampled annually at 9 long-term biomonitoring stations on the Upper Mississippi River, 2 stations on the Minnesota River, and 2 stations on the St. Croix River, using Hester-Dendy artificial substrate samplers and Ponar sediment samplers. Macroinvertebrate community assemblages at Upper Mississippi River stations within the Mississippi National River and Recreation Area (MNRRA) were analyzed using multiple metrics, including Taxa Richness, Shannon Diversity Index, Hilsenhoff Biotic Index, percent EPT, percent Ephemeroptera, and percent Chironomidae. Long-term trends in macroinvertebrate community metrics within MNRAA indicate improved conditions both upstream and downstream of Minneapolis-Saint Paul in years with average and high river flows, but short-term declines downstream in years

with reduced flows. We hypothesize that improving trends in macroinvertebrate metrics are related to improving water quality trends within MNRRA, and may be attributed to improved wastewater treatment plant performance and a marked reduction in combined sewer overflow (CSO) discharges.

Hairston, **N. G.**, Cornell University, Ithaca, NY, USA, ngh1@cornell.edu
Kearns, C. M., Cornell University, Ithaca, NY, USA, cmk4@cornell.edu
Jones, L. E., Cornell University, Ithaca, NY, USA, lej4@cornell.edu
Ellner, S. P., Cornell University, Ithaca, NY, USA, spe2@cornell.edu

PHYTOPLANKON-QUALITY CYCLES AS AN ESSENTIAL COMPONENT OF LAKE CLEAR-WATER PHASE CONSUMER- RESOURCE DYNAMICS

It is well established that the annual clear-water phase (CWP) in many temperate-zone lakes is caused by the grazing down of phytoplankton by cladocerans, especially *Daphnia*. Some investigators have proposed that the CWP is a single oscillation of a consumer-resource cycle between *Daphnia* and phytoplankton, but peak *Daphnia* abundance is typically almost exactly out of phase with phytoplankton biomass, rather than the quarter cycle offset typical of consumer-resource dynamics. We show that, when seasonal changes in the phytoplankton species assemblage – driven in part by grazer consumption – are included in mathematical models, observed CWP patterns result. Consistent with theory, we show for Oneida Lake, NY, that phytoplankton food quality for grazers, measured by *Daphnia* juvenile growth rate, is intermediate during the CWP between high quality in the spring bloom and low quality in late summer.

Hale, R. L., Arizona State University, Tempe, USA, rlhale@asu.edu
Grimm, **N. B.**, Arizona State University, Tempe, USA, nbgrimm@asu.edu

STOICHIOMETRY OF URBAN RUNOFF FROM PAVEMENT TO THE RIVER

Ecological stoichiometry is a tool that integrates concepts within ecology from nutrient limitation to species composition to nutrient cycling. Human actions have dramatically altered absolute and proportional availability of resources globally and locally, and previous work has shown that human-dominated ecosystems have N:P ratios close to the Redfield ratio (16:1). Land cover in urban areas is heterogeneous, thus sources and sinks of N and P may vary both spatially and temporally. The stoichiometry of urban runoff from the scale of parcels to river basins has implications for nutrient cycling, productivity, and community composition of urban streams. Using existing data from water managers, we examined how export of N and P scale from impervious surfaces to small catchments to rivers. Runoff from impervious surfaces scales to catchment export well for P but poorly for N, suggesting significant sinks for N within the urban landscape. Runoff stoichiometry was highly variable, but lower than N:P of desert streams. At the river scale, N:P was negatively correlated with discharge, suggesting that N and P cycling are subject to different controls within urban ecosystems.

Hall, **E. K.**, University of Vienna, Vienna, Austria, ed.hall@unvie.ac.at
Preiler, C., WasserCluster Lunz GmbH?Schneider, T., University of Zurich, Zurich, Switzerland, thomas.schneider@botinst.uzh.ch
Riedel, K., University of Zurich, Zurich, , kriedel@botinst.uzh.ch
Battin, T. J., University of Vienna, Vienna, Austria, tom.battin@univie.ac.at

TEATIME IN THE STREAM: THE EFFECT OF RESOURCE QUALITY ON MICROBIAL FORM AND FUNCTION IN INTERSTITIAL STREAM BIOFILMS

Stream ecosystems process large quantities of dissolved organic matter as it moves from the headwaters to the sea. Interstitial biofilms in the hyporheic zone of stream ecosystems contain high levels of microbial biomass and activity. However, the microbial dynamics and biogeochemistry of the hyporheic zone remain poorly understood. We evaluated how variance in resource stoichiometry affected the microbial community and associated biogeochemical activity in interstitial stream biofilms. Specifically, we fed beech leaf leachates that differed in phosphorus content to a series of bioreactors filled with sediment from a sub-alpine stream. Differences in resource stoichiometry resulted in differences in microbial biomass, enzyme activity, diversity of microbial proteins, nitrate flux, respiration, and dissolved organic carbon consumption. We use this model system to link microbial form (community composition and proteome) with function (enzyme activity and biogeochemistry) in order to better understand the mechanisms that link resource heterogeneity to ecosystem function in stream ecosystems.

Hall, **E. M.**, Virginia Commonwealth University, Richmond, USA, halle2@vcu.edu
McCallister, S. L., Virginia Commonwealth University, Richmond, , slmccalliste@vcu.edu
Sobczak, W., Holy Cross University, Worcester, USA, wsobczak@holycross.edu

CARBON SOURCES AND MICROBIAL PROCESSING ALONG A FLUVIAL NETWORK FROM A HEADWATER STREAM IN HARVARD FOREST TO THE QUABBIN RESERVOIR.

Understanding the delivery and processing of terrestrial derived organic carbon within fluvial networks is crucial in accurately defining aquatic-terrestrial-atmospheric connections. Microbial respiration and transformation of OC is a vital consideration when trying to decipher the sources of OC delivered to and processed within the aquatic system vs. those distributed to downstream ecosystems. Dissolved OC (DOC), DO13C and DOC lability were measured at multiple locations along a continuum from headwater streams in Harvard Forest to its final destination at the Quabbin Reservoir during both high and low flow periods. Overlaps in DO13C allochthonous and autochthonous sources impair its ability to discern in situ sources independent from additional measurements. DOC showed roughly a 2 fold difference in concentration from the headwater stream site (Bigelow Brook) to the entrance of the Quabbin reservoir. This 2 fold increase in DOC concentration was accompanied by a 10 fold increase in its bioavailability. The coupling of additional chemical and optical measurements will better help to elucidate the sources of OC along this continuum and its concurrent processing by the microbial community.

Hall, **R. O.**, University of Wyoming, Laramie, USA, bhall@uwyo.edu
Koch, B. J., University of Wyoming, Laramie, USA, bkoch@uwyo.edu

LINKING ANIMALS TO STREAM NITROGEN CYCLING USING ISOTOPE TRACER EXPERIMENTS

Animals can constitute a large component of nitrogen (N) cycling in aquatic ecosystems by their feeding and excretion. An informative means to estimate flows of N or food sources for animals is using isotope tracer additions which allow testing and parameterizing food web models. Additionally, isotope tracer studies allow measuring other ecosystem fluxes of N to which one can compare animal-derived fluxes. One caveat is that one must either know N flows through the animal pool or isotope ratio of food sources to constrain parameter estimates. We modeled N flow through dominant invertebrate taxa in an isotope tracer experiment in a stream in Idaho. Using measured rates of production and excretion, models predicted lower isotope label than data, suggesting that invertebrates assimilated an unmeasured food source, likely live microbial cells. Total assimilation flux by invertebrates was 60% of total DIN removal from the water column. Despite being 0.2% of stream N stock, invertebrates retained 7% of the isotope removed by the stream. Even in an oligotrophic stream with low invertebrate biomass, they constituted a large component of N cycling.

Hallstan, **S.**, Swedish University of Agricultural Sciences, Uppsala, Sweden, simon.hallstan@vatten.slu.se
Johnson, R. K., Swedish University of Agricultural Sciences, Uppsala, , richard.johnson@vatten.slu.se

EFFECTS OF SPECIES DISPERSAL ABILITY AND LANDSCAPE CONNECTIVITY ON SPECIES DISTRIBUTION MODEL ACCURACY

Species distribution models (SDMs) have become important tools in ecology and environmental management, with special importance for conservation biology, invasive species management and environmental assessment. Recent research has shown model accuracy to be affected by species traits such as niche width, geographical range and prevalence. Species dispersal ability is another trait that could greatly influence model accuracy and applications. For example, if SDMs are used to classify ecological status, the status of an isolated ecosystem might be classified as low due to the absence of several species, even though absences may be caused by dispersal barriers and not human-induced stress. Data from some 100 Swedish lakes was used to compare SDM accuracy using species and species assemblages with varying dispersal traits. Our study design included species assemblages with relatively high (i.e. phytoplankton), intermediate (e.g. littoral invertebrates) and poor (profundal invertebrates) dispersal abilities. Analysis of model accuracy also included the importance of connectivity between ecosystems (proximity to refugia, altitude etc) and colonization susceptibility (ecosystem size), to assess the influence of connectivity and dispersal mechanisms on model accuracy.

Halvorson, **H**. **M**., St. Olaf College, Northfield, USA, halvorso@stolaf.edu
Jacobson, M., University of Minnesota, St. Paul, USA, funk0062@umn.edu
Cotner, J., University of Minnesota, St. Paul, USA, cotne002@umn.edu

WATERSHED IMPLICATIONS OF EARTHWORM INVASION AT THE HEADWATERS OF THE MISSISSIPPI

The spread of terrestrial earthworms into previously earthworm-free ecosystems is causing a cascade of ecological changes. Invading earthworms alter forest litter decomposition and nutrient cycling; however, the implications of these changes for watersheds are little understood. This study investigates the possible impacts of invasive earthworms on dissolved organic matter (DOM) and nutrient characteristics in six lakes at the headwaters of the Mississippi River. We hypothesize that earthworms mobilize terrestrial nutrients to increase Nitrogen (N) and Phosphorus (P) availability in lakes, thereby stimulating lake microbial respiration. Lake water was collected four times during the summer of 2009 and analyzed for dissolved organic carbon (DOC) and dissolved organic phosphorus (DOP). Microbial respiration was measured by incubating filtered water and measuring changes in dissolved oxygen by membrane inlet mass spectrometry (MIMS) under four different nutrient treatments (control, +N, +P, and +N,P). DOC and DOP concentrations were variable between lakes, but did not co-vary with earthworm presence. The most invaded lake displayed reduced nutrient limitation and increased microbial respiration when compared with the most pristine lake, which was consistent with our hypothesis.

Hambright, **K**. **D**., University of Oklahoma, Norman, USA, dhambright@ou.edu
Remmel, E. J., University of OKlahoma, Norman, USA, Emily.J.Remmel-1@ou.edu
Kohmescher, N., University of Oklahoma, Norman, USA, nkohmescher@gmail.com
Larson, J. L., University of Oklahoma, Kingston, USA,

EFFECTS OF THE INVASIVE, TOXIGENIC PROTIST, PRYMNESIUM PARVUM, ON GRAZING RATES, FEEDING BEHAVIORS, AND LIFE HISTORY CHARACTERISTICS OF DAPHNIID ZOOPLANKTON

We examined the effects of P. parvum on grazing rates, feeding behaviors, and life history characteristics of daphniid zooplankton. In 24-hr feeding experiments, D. pulicaria exhibited no signs of acute toxicity and had similar clearance rates when feeding on P. parvum compared to Scenedesmus acutus. In 30-min exposures to P. parvum, we observed no significant changes in feeding behaviors (e.g., appendage beat rate) of D. pulicaria, D. pulex, and D. magna, but did observe slight decreases in daphniid heart rates. By contrast, 6-hr exposures to P. parvum resulted in drastic declines in appendage beat rate in D. pulicaria and D. pulex. In 10-day life table experiments, D. pulicaria and D. pulex neonates experienced severe reductions in juvenile growth rate, age at first maturity, fecundity, and survivorship that scaled with relative P. parvum abundance in the diet. Our results indicate strong negative effects of P. parvum on feeding behaviors and life-history characteristics of daphniid zooplankton, and suggest indirect, yet potentially severe, negative consequences for planktivorous fish and other higher trophic levels, in lakes subject to invasion by P. parvum.

Hamilton, **A**. **T**., Tetra Tech, Inc. Center for Ecological Sciences, Santa Fe, NM, USA, Anna.Hamilton@tetratech.com
Stamp, J. D., Tetra Tech, Inc. Center for Ecological Sciences, Montpelier, VT, USA, Jen.Stamp@tetratech.com
Bierwagen, B., U.S. Environmental Protection Agency, Washington DC, USA, Bierwagen.Britta@epamail.epa.gov

VULNERABILITY OF BIOMONITORING PROGRAMS AND ASSOCIATED BIOLOGICAL METRICS AND INDICES

To assess the vulnerability to climate change of biological metrics and indices used to define ecological status, several regionally-distributed state bioassessment data sets were examined. Many widely used, taxonomically based metrics are comprised of both cold water- and warm water-preference taxa, and their differing responses to climate-induced changes in stream temperatures undermines their interpretation with regard to condition status. While the climate responsiveness of these traits groups varies between states and ecoregions, they are generally found to be sensitive to changing temperature conditions. Another widespread and related finding is the moderate but significant relationship between temperature sensitivity and sensitivity to organic pollution. Metrics selected for condition assessments because the composite taxa are either generally sensitive to disturbance, or are in particular responsive to conventional pollutants also have demonstrable sensitivities to climate-related changes in temperature and flow conditions. The feasibility of modifying metrics by partitioning components based on temperature sensitivity was examined, as a means of reducing the potential for changing climate conditions to confound efforts to detect impairment, and to facilitate tracking climate change-related taxa losses and replacements.

Hamilton, **L**. **A**., Universiy of Ottawa, Ottawa, Canada, l.a.hamilton3@gmail.com
Morin, A., University of Ottawa, Ottawa, Canada, amorin@uottawa.ca
Findlay, S. C., University of Ottawa, Ottawa, Canada, findlay@uottawa.ca

VARIATION IN THE SIZE DISTRIBUTION OF BENTHIC ORGANISMS BETWEEN GATINEAU PARK (QUÉBEC, CANADA) AND URBAN STREAMS

Size distributions of benthic macroinvertebrate assemblages are generally stable across sampling sites and regions. However, rarely are these spectra extended to include organisms in larger size classes such as fish. In addition, it is unclear as to whether the stability of the size distribution remains when larger organisms are included. Sixty-seven sites in 45 streams across the National Capital Region (Ottawa, Ontario, Canada) and Gatineau Park were sampled between the summers of 2001 and 2008 for fish and benthic macroinvertebrates to assess whether there is a difference in the shape of the size distribution between park and urban streams. Fish were sampled by electrofishing intensively from a 10 meter riffle segment at each site and macroinvertebrates were collected from the same sample site by collecting cobbles. Results suggest that urban and park sites have similarly shaped spectra, but with urban sites having more organisms.

Hamilton, **S**. **K**., Michigan State University, Hickory Corners, USA, hamilton@kbs.msu.edu
Celi, J. E., Michigan State University, East Lansing, USA, celijorg@msu.edu
Jardine, T. D., Australian Rivers Institute, Nathan, Queensland, Australia, t.jardine@griffith.edu.au
Ward, D. P., Australian Rivers Institute, Nathan, Queensland, Australia, doug.ward@griffith.edu.au
Bunn, S. E., Australian Rivers Institute, Nathan, Queensland, Australia, s.bunn@griffith.edu.au

MAJOR SOLUTE CHEMISTRY AS AN INDICATOR OF HYDROLOGY IN TROPICAL FLOODPLAINS

Understanding inundation hydrology is fundamental to the ecology and management of large tropical floodplains. Sources of flood waters in tropical floodplains include both local precipitation and riverine overflow, and river waters often arise from upland catchments of variable geology. Tropical floodplains usually lie on highly weathered soils that contribute little to the major solutes carried by flood waters, and they tend to have dilute concentrations of major solutes in flood waters, precluding secondary precipitation of minerals such as calcite. Under these conditions, major solute chemistry can be interpreted to indicate sources of flood waters, flow paths and mixtures, and evaporative losses. Care must be taken to select solutes with the most conservative behavior in terms of both mineral precipitation and biotic transformation and release, and this must be evaluated for each setting. In this talk we present examples from major floodplains in South America (Pantanal and Amazon) and northern Australia to demonstrate the utility of major solute chemistry to study inundation hydrology.

Hammann, **S**., IFM_GEOMAR, Christian-Albrechts-Universität zu Kiel, Kiel, Germany, shammann@zoologie.uni-kiel.de
Zimmer, M., IFM_GEOMAR, Christian-Albrechts-Universität zu Kiel, Kiel, Germany, mzimmer@ifm-geomar.de

IS A STERILE SURFACE A KEY TO INVASION SUCCESS?

Seawater is a dense microbial suspension with >106 prokaryotic and >104 eukaryotic propagules per milliliter. Thus, essentially every submerged surface gets immediately covered by biofilm-forming colonizers upon contact with seawater. Animal defense mechanisms against microbial colonization co-evolved with potentially colonizing microbes, but neozoa are confronted with novel microbial colonizers upon invading a new habitat, and are expected to be less well protected against surface-colonization. Surprisingly, neither light- and electron-microscopic inspection nor PCR-screening for bacterial and archaeal DNA of the comb jelly *Mnemiopsis leidyi*, invasive to European coastal marine habitats, revealed any hint on the presence of prokaryotes on the umbrella epithelium of comb jellies from the Baltic Sea. While the mechanisms underlying the effective defense of *Mnemiopsis leidyi* against microbial colonization remain

unknown, we discuss these findings in the context of invading a novel habitat: is the lack of epithelial symbionts a consequence of changing environmental conditions, or is it rather the key for invasion success?

Hammer, **M.**, Södertörn University, Huddinge, Sweden, monica.hammer@sh.se
Mortberg, U., Royal Institute of Technology, Stockholm, Sweden, mortberg@kth.se
Petersson, M., Södertörn University, Huddinge, Sweden, mona.peterson@sh.se

AN ECOSYSTEM PERSPECTIVE ON INTEGRATED WATER MANAGEMENT – LINKING WETLANDS AND WATER BODIES

In this case study, we focus on the ongoing implementation of the EU Water Framework Directive (WFD) in Sweden, applying an ecosystem management approach. The WFD encompasses surface waters, groundwater, estuaries and adjacent coastal waters and introduces a new drainage based management regime. The Northern Baltic Sea Water District in Sweden covers the Lake Mälaren drainage basin and Stockholm archipelago region forming an ecological and geographic gradient from inland to archipelago. Intensive land use transformation has caused biodiversity loss as well as increased nutrient leakage and eutrophication problems in ecosystems downstream. One important measure within the WFD is the creation and restoration of wetlands, with the explicit aim of nutrient retention for the benefit of downstream ecosystems. We combine an expert model for targeting areas susceptible to nutrient leakage, and a topographic model for water flow and wetness for localizing suitable areas for wetland creation and relate these areas to benefits for wetland biodiversity. The models will be used interactively with stakeholders in a participative approach allowing for a learning process and to provide decision support for localizing created wetlands.

Hansen, **D**. **C**., [none], Stillwater, MN, USA, hanse112@tc.umn.edu

UNDERWATER MACRO PHOTOGRAPHY OF STEAM INVERTEBRATES IN SITU--AND WITHOUT GETTING WET

The majority of invertebrates in small streams can be photographed fairly simply, that is, without scuba gear and without an expensive camera housing. The same basic equipment used to do macro photography on land with a good film camera, i.e., a lens designed to do macro, extension rings or a bellows, flashes, and some sort of steady rest, can be readily incorporated in a housing easily made from sheet acrylic plastic. Macro equipment made by Olympus for their 35 mm film SLR cameras is particularly suitable and is available used at moderate prices. The OM 38/2.8 macro lens allows one to photograph as high as 6 times life size, or an area less than 4 X 6 mm. The OM 20/2.0 macro lens goes to 13 times life size, or an area less than 2 X 3 mm; this translates to portions of a Baetis nymph or Deuterophlebia larva. The talk will cover the photographic equipment needed, the construction of the housing, and how the housing is used, with examples of the photographs obtainable at various magnifications.

Hansen, **G**. **A**., University of Wisconsin-Madison, Madison, USA, ghansen2@wisc.edu
Rubinstein, A. M., University of Wisconsin-Madison, Madison, USA, arubinstein@wisc.edu
Hein, C. L., University of Wisconsin-Madison, Madison, USA, clhein@gmail.com
Roth, B. M., University of Wisconsin-Madison, Madison, USA, rothbri@msu.edu
Vander Zanden, M. J., University of Wisconsin-Madison, Madison, USA, mjvanderzand@wisc.edu
Vander Zanden, M. J., University of Wisconsin-Madison, Madison, USA, mjvanderzand@wisc.edu

DISENTANGLING DIRECT AND INDIRECT EFFECTS OF THE INVASIVE RUSTY CRAYFISH ON BENTHIC MACROINVERTEBRATES THROUGH A WHOLE-LAKE MANIPULATION

The rusty crayfish (Orconectes rusticus) is an invasive species that impacts all trophic levels of aquatic ecosystems. Rusty crayfish were removed from Sparkling Lake, Wisconsin from 2001-2008, and their density declined by two orders of magnitude. Macroinvertebrates were sampled for two years when rusty crayfish densities were high (2002-2003) and two years when crayfish densities were low (2008-2009). Fish populations were estimated and diets were analyzed in 2002, 2003, and 2009. Total invertebrate density was 25% lower in years following the crayfish removal. Samples were numerically dominated by diptera; when diptera were removed, total insect density declined by 80%. The response of individual invertebrate groups varied: predatory diptera, gastropoda, and trichoptera densities increased, while non-predatory diptera, ephemeroptera, amphipoda, and coleoptera densities decreased significantly following the rusty crayfish removal. Macrophyte cover increased but did not affect the response of most invertebrate taxa. Invertivorous fish populations and consumption of invertebrates by fishes increased following the crayfish removal. Most invertebrates appear to be more strongly affected by fish consumption than by direct effects of rusty crayfish.

Hanson, **P**. **C**., University of Wisconsin/Center for Limnology, Madison, USA, pchanson@wisc.edu
Kara, E. L., University of Wisconsin/Civil and Environmental Engineering, Madison, USA, kara@wisc.edu
Hamilton, D. P., Waikato University, Hamilton, New Zealand, davidh@waikato.ac.nz
McMahon, T., University of Wisconsin/Civil and Environmental Engineering, Madison, USA, tmcmahon@cae.wisc.edu
Hipsey, M., University of Western Australia, Perth, Australia, matt.hipsey@uwa.edu.au
Hseih, Y., University of Wisconsin/Civil and Environmental Engineering, Madison, USA, yhsieh2@wisc.edu
Carey, C. C., Cornell University, Ithaca, USA, ccc99@cornell.edu
Rose, K., Miami University, Oxford, USA, rosekc@muohio.edu
Winslow, L. A., University of Wisconsin/Center for Limnology, Madison, USA, lawinslow@wisc.edu
Bertilsson, S., Uppsala University, Uppsala, Sweden, stebe@ebc.uu.se

PREDICTION OF PHYTOPLANKTON BLOOMS: USING SENSOR DATA TO WORK AT THE EDGE OF KNOWLEDGE

The wax and wane of a harmful algal bloom exemplifies natural phenomena that are transient in space and time, are driven by complex physical, chemical, and biological interactions, and are critically important to water quality and human health. In lakes, understanding the triggers of a bloom event and predicting where and when it will occur are extremely difficult due to lack of extensive observational data and the demands of developing models that both use the information content of the data and exploit existing knowledge about underlying process. The deluge of sensor data from lake observatories, such as the Global Lake Ecological Observatory Network (GLEON), has driven development of both 'knowledge-centric' and 'data-centric' models. In a study of phytoplankton blooms on Lake Mendota (Madison, Wisconsin), we compare predictive capabilities of a coupled hydrodynamic water quality model and black-box models. The water quality model simulated most lake variables well at scales ranging from days to months. Black-box models captured remaining variance at shorter time scales, suggesting that an approach combining the two model types may be effective at predicting phytoplankton blooms.

Hansson, **S.**, Dept. Systems Ecology, Stockholm University, Stockholm, Sweden, Sture.Hansson@ecology.su.se
Holmborn, T., Dept. Systems Ecology, Stockholm University, Stockholm, Sweden, towe@ecology.su.se
Gorokhova, E., Dept. Systems Ecology, Stockholm University, Stockholm, Sweden, elenag@system.ecology.su.se
Larsson, U., Dept. Systems Ecology, Stockholm University, Stockholm, Sweden, ulf.larsson@ecology.su.se

TRANSBOUNDARY TROPHIC INTERACTIONS – HAVE CHANGES IN THE MARINE OFF-SHORE BALTIC SEA FOOD WEB CAUSED REPRODUCTION PROBLEMS FOR COASTAL FRESHWATER FISH?

Fishing has reduced the cod stock and allowed their prey, sprat, to increase. This resulted in intensified zooplanktivory and decreased abundances of zooplankton in the open Baltic. Simultaneously, recruitment problems were reported for spring spawning coastal fish. Low zooplankton densities were recorded in the habitat of young fish of these species, suggesting that they starved to death. As a possible cause for this, it has been proposed that the large population of sprat have reduced zooplankton also in coastal waters. However, there have been no long-term series on coastal zooplankton available to support the explanation. At least not until now, when shelved zooplankton samples from the period 1976-2008 have been analysed. The data do not support the idea that coastal zooplankton have been negatively impacted by sprat, and that this is the explanation to the reproduction failure of coastal fish. Low zooplankton densities in the shallow water habitat inhabited by young coastal fish can thus not easily be explained by basin wide changes driven by the cod-sprat interaction, but must thus be sought in the local environments.

Hargrave, **C**. **W**., Sam Houston State University, Huntsville, USA, cwhargrave@shsu.edu
Gary, K. P., Sam Houston State University, Huntsville, USA, stdlpg@shsu.edu

INTERACTIONS BETWEEN RIPARIAN PROTECTION AND STREAM CONSUMERS AFFECT STREAM ECOSYSTEM STRUCTURE AND FUNCTION

We conducted two studies to investigate the potential role of riparian protection in promoting efficient ecosystem functioning in low-gradient, Gulf coastal streams. The first was a large-scale observational study, which examined the potential influence of riparian zone on several abiotic and biotic stream properties. The second was an experimental stream study aimed at directly testing the effects of in-stream structure on stream function. In the field study, we found that riparian protection was correlated with lower bank erosion, greater in-stream habitat complexity (namely woody debris), courser substrates, lower turbidity, less suspended material in the water column, and greater species and functional richness of fish assemblages. In the experimental stream study, we found that increased in-stream structure reduced turbidity and downstream transport of suspended materials. This enhanced benthic primary production, aquatic invertebrate biomass and species richness, and caused greater secondary production in a generalist fish species. This research supports the general hypothesis that land management aimed at riparian protection may promote healthy structure and function of stream ecosystems through a variety direct and indirect pathways.

Harms, **T**. **K**., University of Alaska, Fairbanks, USA, tamara.harms@alaska.edu
Jones, J. B., University of Alaska, Fairbanks, USA, jay.jones@alaska.edu

SOURCES OF NITRATE TO ALASKAN STREAMS

Net export of nitrogen (N) occurs from some sub-arctic catchments despite N limitation of vegetation and minimal anthropogenic inputs. We investigated loss of permafrost as a potential mechanism explaining this observation. Increased active layer depth due to thawing permafrost results in deeper flowpaths. Such hydrologic changes may result in decreased opportunity for denitrification to remove NO_3- as water bypasses organic soil horizons, or increased influence of mineralization and nitrification in deeper mineral soils characterized by low C:N. To test these potential mechanisms, we analyzed water chemistry of Alaskan streams across a latitudinal gradient that encompasses sub-arctic and arctic catchments with discontinuous to continuous permafrost cover. Highest NO_3- concentration (10-23 μM) occurred in streams underlain by discontinuous permafrost. Streams with low NO_3- concentration (<5 μM) had the highest concentration of dissolved organic matter. These organic-rich streams drain low-lying catchments that may contain extensive wetlands or intact permafrost, both of which would promote NO_3- retention and removal. During snowmelt, $\delta^{15}NO_3$- was negatively correlated with NO_3- concentration, suggesting significant denitrification activity in catchments with low stream NO_3- concentration, and indicating that low-lying catchments facilitate high rates of N removal.

Harris, **A**. **T**., Central Michigan University, Mount Pleasant, USA, harri1at@cmich.edu
Woolnough, D. A., Central Michigan University, Mount Pleasant, USA, wooln1d@cmich.edu
Zanatta, D. T., Central Michigan University, Mount Pleasant, USA, zanat1d@cmich.edu

INSULAR LAKE ISLAND BIOGEOGRAPHY OF FRESHWATER MOLLUSKS ON THE LAKE MICHIGAN ISLAND ARCHIPELAGO: USING LAKE METRICS TO PREDICT SPECIES DIVERSITY

The traditional use of island biogeography theory (MacArthur and Wilson 1967) has been expanded to explain species richness patterns on various types of habitat islands. The insular lakes of the Beaver and Manitou island chains in Lake Michigan present an excellent opportunity to study these processes on recently formed and isolated habitats. Freshwater mollusk diversity was compared with several geographical, chemical, and biological variables. Non-metric multi-dimensional scaling ordination was used to analyze and highlight the most relevant environmental conditions for mollusk species diversity and presence/absence. Shoreline length and shoreline development values represented the most effective predictors of mollusk diversity, showing the only significant correlations (p=0.0583 and p=0.0081, respectively). The data suggest that shoreline length and development more accurately represent available habitat area in the case of primarily littoral-dwelling mollusks. The relatively weak correlations observed with area and isolation from Lake Michigan suggests that the application of island biogeography theory is limited for mollusks when using these traditional methods.

Harris, **L**. **A**., UMCES-CBL, Solomons, USA, harris@cbl.umces.edu
Brush, M. J., VIMS, Gloucester Point, USA, brush@vims.edu
Giordano, J., VIMS, Gloucester Point, USA,

IMPROVING MODELS OF NITROGEN LOADING AND WATER QUALITY IMPACTS TO COASTAL LAGOONS

Coastal lagoons like those along the Delmarva peninsula from Delaware to Virginia play a critical role in the processing of land-derived nutrients on their transit from watershed to coastal ocean. However, these systems are vulnerable to rapid changes in population, land use, and associated nitrogen (N) loads. As a response to these impacts, lagoons frequently exhibit a shift in the dominant autotroph and nature of nutrient processing that may ultimately affect water quality. In light of the myriad stressors to lagoonal communities, we developed an innovative, management-focused watershed and lagoon modeling tool to understand how changing landuse affects nutrient loads, and how receiving waterbodies respond to these changing loads. Amendments to predictions of nitrogen loading budgets to include restoration and mitigation technologies will be emphasized in this presentation. Interactive stressors of increasing temperatures and sea level rise will also be explored.

Harrison, **E**., Institute for Applied Ecology, University of Canberra, Canberra, Australia, Evan.Harrison@canberra.edu.au
Norris, R., Institute for Applied Ecology and eWater CRC, University of Canberra, Canberra, Australia,
Wilkinson, S., CSIRO Land and Water and eWater CRC, Aitkenvale, Australia,

HOW MUCH IS TOO MUCH? - FINE SEDIMENT THRESHOLDS FOR MACROINVERTEBRATE COMMUNITIES

It is well known that fine sediment <2mm accumulation can change macroinvertebrate community structure. This study in South-east Australia investigated the existence of thresholds in fine sediment accumulation in riffles. In six 5-10 km reaches with varying levels of accumulation defined from the Sediment River Network (SedNet) sediment budget model, macroinvertebrate and fine sediment samples were collected from riffles using 3375cm3 wire basket samplers which were buried in the stream bed and retrieved after one month. On log10 plots of macroinvertebrate community indicators vs fine sediment weight collected within baskets what, thresholds were defined from fitted curves as the point where the slope of the curve equalled Y axis max / X axis max and differential calculus was used to calculate the threshold sedimentation and macroinvertebrate community structure values. A threshold of only ~10% of fine sediment filling interstitial space between cobbles had a negative effect on community structure indicators such as Taxa SIGNAL score 7-10 density and EPT taxa richness. The responses identified here will be useful for assessing how increased fine sediment loads alter aquatic ecosystems.

Harrison, **J**. **W**., University of Waterloo, Waterloo, Canada, joel.harrison.uw@gmail.com
Smith, R. E., University of Waterloo, Waterloo, Canada, rsmith@sciborg.uwaterloo.ca

SPECTRAL ACCLIMATION OF PHYTOPLANKTON TO UV RADIATION: NEW EVIDENCE FROM DEEP BIOMASS MAXIMA

We compared the sensitivity of metalimnetic phytoplankton to ultraviolet radiation (UVR) with that of epilimnetic communities in two highly UVR-transparent Canadian Shield lakes. Quantum efficiency of photosystem II photochemistry (Fv/Fm) from a PAM fluorometer was used as the UVR response metric during 120-minute incubations under irradiance treatments of varying spectral quality. Our results show the phytoplankton of the metalimnion to exhibit considerably higher sensitivity to UVR-induced photoinhibition than epilimnetic algae of the same lakes, and that the difference in response was most pronounced in the UVA (320-400 nm) spectral region. When exposed to dim white light, metalimnetic algae were slower to recover from photodamage than those from the epilimnion. We speculate that by positioning themselves below the depth of UVR penetration, but within the photic zone, metalimnetic algal communities can avoid the energetic costs of adapting to chronic UVR exposure while still obtaining adequate irradiance for meeting metabolic demands. The differences in spectral sensitivity between strata furthermore suggest that UVA

radiation, rather than UVB, exerts the major photoinhibitory stress in the mixed layer of these lakes.

Harrison, **J**. **A**., Washington State University, Vancouver, WA, USA, john_harrison@wsu.edu

Bouwman, A. F., Netherlands Environmental Assessment Agency, Bilthoven, Netherlands, lex.bouwman@pbl.nl

Mayorga, E., University of Washington, Seattle, USA, mayorga@apl.washington.edu

Seitzinger, S. P., IGBP-Royal Swedish Academy of Sciences, Stockholm, Sweden, sybil.seitzinger@igbp.kva.se

DELIVERY OF DISSOLVED INORGANIC PHOSPHORUS AND OTHER NUTRIENTS TO SURFACE FRESH WATERS AND THE COASTAL ZONE

Anticipating and managing nutrient over-enrichment of surface waters and its attendant negative consequences (e.g. hypoxia and harmful algae blooms) will require models that quantitatively link land-based processes to surface water eutrophication. Recently, an international, interdisciplinary scientific work group called *G*lobal *N*utrient *E*xport from *W*ater*S*heds (Global NEWS) has developed and implemented a spatially explicit, global model capable of predicting river transport of multiple nutrients (C, N, P, Si) and multiple nutrient forms (dissolved vs. particulate, organic vs. inorganic forms). Recent Global NEWS results will be presented, with emphasis on an enhancement of the Global NEWS-DIP sub-model called NEWS-DIP-Half Degree (NEWS-DIP-HD). NEWS-DIP-HD explains 78% of the variability in per-basin DIP export for USGS stations, similar to the original NEWS-DIP model and somewhat more than other global DIP transport models. NEWS-DIP-HD output suggests: 1) that hot spots for DIP loading tend to occur in urban centers; 2) that humans supply more DIP to surface waters than natural weathering over the majority (53%) of the Earth's land surface; and 3) that humans have both mobilized and stored a substantial amount of DIP.

Hartfield, **E**. **E**., Auburn University, Auburn, USA, hartfee@auburn.edu

Gangloff, M. M., Appalachian State University, Boone, USA, gangloffmm@appstate.edu

Santos, S. R., Auburn University, Auburn, USA, santosr@auburn.edu

Feminella, J. W., Auburn University, Auburn, USA, feminjw@auburn.edu

CONSEQUENCES OF LOW-HEAD DAMS TO CRAYFISH ASSEMBLAGES AND GENE FLOW IN ALABAMA STREAMS

Dams are numerous in many southeastern US streams, with >10,000 in Alabama alone. Instream physicochemical and biotic impacts of dams can be dramatic. Such barriers can fragment populations, thus decreasing genetic diversity and increasing extinction risk. In 2006–2007, we quantified crayfishes and their habitats at reaches upstream, immediately downstream (mill sites), and >500m downstream of 22 low-head milldams within 9 Alabama drainages. Crayfish abundance was lower at mill sites with intact dams than sites upstream or further downstream, whereas abundance was significantly higher upstream of breached dams than at mill or downstream sites. In contrast, longitudinal abundance was similar among sites on streams with relic dams. Fish censuses indicated that predatory fishes were more abundant at intact dam sites, potentially accounting for lower crayfish abundance at these sites. Tissue from crayfish specimens from two focal, sites were used to amplify and sequence a fragment of the mitochondrial COI gene. Molecular data shows population structuring around low-head dams in some systems, although additional sampling is needed to determine the generality of the pattern.

Harvey, **C**. **J**., NOAA NW Fisheries Science Center, Seattle, USA, chris.harvey@noaa.gov

Beaudreau, A. H., NOAA NW Fisheries Science Center, Seattle, USA, anne.beaudreau@noaa.gov

Francis, T. B., NOAA NW Fisheries Science Center, Seattle, USA, tessa.francis@noaa.gov

Guerry, A. D., NOAA NW Fisheries Science Center, Seattle, USA, anne.guerry@noaa.gov

Levin, P. S., NOAA NW Fisheries Science Center, Seattle, USA, phil.levin@noaa.gov

Plummer, M. L., NOAA NW Fisheries Science Center, Seattle, USA, mark.plummer@noaa.gov

Ruckelshaus, M. H., NOAA NW Fisheries Science Center, Seattle, USA, mary.ruckelshaus@noaa.gov

Samhouri, J. F., NOAA NW Fisheries Science Center, Seattle, USA, jameal.samhouri@noaa.gov

APPLYING MARINE ECOSYSTEM MODELS TO MULTI-SECTOR ECOSYSTEM MANAGEMENT

Ecosystem models have become popular tools for exploring hypotheses about large-scale marine food webs and fisheries. In years to come, these models will be increasingly called upon to serve as central operating models for integrated, multi-sector ecosystem assessment, management strategy evaluation and spatial planning. We are developing ecosystem models for the Puget Sound region for this purpose. Here, we focus on an Ecopath with Ecosim model of central Puget Sound and present a series of simulations that relate food web dynamics to habitat management, ecosystem services, and goals of the Puget Sound Partnership (PSP), an agency charged with protecting and restoring the Puget Sound ecosystem. Preliminary findings indicate that bottom-up forcing dominates energy flow, although trophic cascades may originate from bald eagles (*Haliaeetus leucocephalus*). Harvest and non-consumptive values supported by eelgrass (*Zostera marina*) habitat are strongly influenced by food web interactions and spatial patterns of eelgrass use by salmon and forage fish. Finally, simulated changes in food web structure illuminate tradeoffs between PSP goals related to species, habitats, water quality, water quantity, and human well-being.

Harvey, **J**. **W**., U.S. Geological Survey, Reston, USA, jwharvey@usgs.gov

Noe, G. B., U.S. Geological Survey, Reston, USA, gnoe@usgs.gov

Larsen, L. G., U.S. Geological Survey, Reston, USA, lglarsen@usgs.gov

Nowacki, D. J., U.S. Geological Survey, Reston, USA, dan.nowacki@gmail.com

McPhillips, L. E., U.S. Geological Survey, Reston, USA, lmcphillips@usgs.gov

FIELD FLUME INVESTIGATION OF THE ROLE OF VEGETATION IN FINE SEDIMENT AND PARTICULATE PHOSPHORUS TRANSPORT IN A SHALLOW AQUATIC ECOSYSTEM

Flow interactions with aquatic vegetation and their effects on sediment transport and ecological processes in aquatic ecosystems are uncertain. Here we quantified sediment transport in the Everglades by progressively increasing flow velocity in a field flume constructed around undisturbed bed sediment and emergent macrophytes. Suspended sediment < 100 &microm was dominant in the lower range of laminar flow and was supplied by detachment from epiphyton. Coarse flocculent sediment > 100 &microm became dominant at higher velocities after a threshold shear stress for bed floc entrainment was exceeded. An increase (by a factor of four) in sediment flux at higher velocities occurred coincident with shedding of vortices that had formed downstream of plant stems. Modeling determined that the potentially entrainable sediment reservoir, 46 g m^{-2}, was similar to the reservoir of epiphyton (66 g m^{-2}) but smaller than the reservoir of flocculent bed sediment (330 g m^{-2}). All suspended sediment was enriched in phosphorus (by approximately twenty times) compared with bulk sediment, indicating that the most easily entrainable sediment is also the most nutrient rich (and likely the most biologically active).

Hauer, **F**. **R**., The University of Montana, Flathead Lake Biological Station, Polson, USA, ric.hauer@umontana.edu

A PAIRED-APPROACH TO ENVIRONMENTAL ASSESSMENT OF A RIVER SYSTEM IN MONTANA AND BRITISH COLUMBIA THREATENED BY PROPOSED MOUNTAIN-TOP REMOVAL COAL MINING

The North Fork of the Flathead River (southeastern British Columbia and northwestern Montana) has been referred to as "America's Wildest River" and in Montana becomes the western boundary of Glacier National Park. Along with Waterton National Park in Alberta, these parks form the first International Peace Park, an International Biosphere Reserve and World Heritage Site.
In the mid 2000s, a mining company proposed an open-pit, mountain-top removal coal mine in the headwaters of the North Fork in British Columbia. We developed an environmental assessment that included a paired watershed design comparing the North Fork headwaters with the Elk River Basin to the north that has over 40 years of open-pit coal mining. We examined water chemistry, algal productivity and macroinvertebrate diversity, abundance and distribution. We found water affected by the coal mines in the Elk River and tributaries had nitrate concentrations often exceeding 1000x, sulfate concentrations more than 100x and selenium 10x the background levels present in the pre-mining North Fork. Species diversity of algae were significantly ($p< 0.001$) reduced while algal biomass and chlorophyll a concentrations of periphyton was significantly ($p<0.05$) increased in the Elk waters. Macroinvertebrate diversity was strongly affected with significant decrease in sensitive species and increased density of tolerant species.

Havel, **J**. **E**., Missouri State University, Springfield, USA, johnhavel@missouristate.edu

DISPERSAL VECTORS FOR THE EXOTIC CHINESE MYSTERY SNAIL

At least 24 species of exotic snails have invaded North American lakes and streams. None are more widespread than the Chinese mystery snail (*Bellamya chinensis*, CMS), which was originally introduced for Asian food markets and now occurs in 32 states and one province (http://nas3.er.usgs.gov/). Surveys reveal that this large viviparid is widespread in some regions, occurring in up to 50% of lakes and river backwaters. Deciphering vectors for dispersal allows a clearer understanding of such patterns. Introductions of at least 10 exotic snail species have been linked to the aquarium and ornamental trades. The numerous web sites offering CMS for sale as a water garden grazer suggests that mail-order purchases followed by intentional or accidental releases may be an important vector for its spread. Desiccation experiments reveal that larger juveniles can survive for two weeks out of water, indicating that this stage is also robust for transport over land. Flow tank experiments indicate that CMS lose hold to the substrate at 0.1-0.7 m/s, flows that occur during flooding of river backwaters, leading to spread into downstream lakes and wetlands.

Havel, **J**. **E**., Missouri State University, Springfield, MO, USA, johnhavel@missouristate.edu

Ramcharan, C. W., Laurentian University, Sudbury, Canada, cramcharan@laurentian.ca

A TRIBUTE TO STANLEY DODSON

This presentation will consist of a brief biography plus a summary of the major scientific contributions of Dr. Dodson

Havens, K. E., Florida Sea Grant College Program and University of Florida, Gainesville FL, USA, khavens@ufl.edu

Beaver, **J**. **R**., BSA Environmental Services, Inc, Beachwood OH, USA, j.beaver@bsaenv.com

Casamatta, D. A., Dept of Biology, University of North Florida, Jacksonville FL, USA, dcasamat@unf.edu

East, T. L., South Florida Water Management District, West Palm Beach FL, USA, teast@sfwmd.gov

Rodusky, A. J., South Florida Water Management District, West Palm Beach FL, USA, arodusk@sfwmd.gov

McCormick, P., South Florida Water Management District, West Palm Beach FL, USA, pmccormi@sfwmd.gov

HURRICANE EFFECTS ON THE PLANKTONIC FOOD WEB OF A LARGE SUBTROPICAL LAKE

Hurricanes Frances and Jeanne, in September 2004 and Wilma in October 2005 created large waves, strong currents, high wind seiches, and uplifted over 3 million metric tons (collectively) of sediments into the water column of Lake Okeechobee. The hurricanes resulted in substantial reductions in biomass of phytoplankton, bacteria and nanoflagellates, both in pelagic and near-shore habitats. There were large increases in dissolved inorganic nitrogen and phosphorus in the water column for years after the hurricanes, coincident with large declines in mean irradiance in the mixed layer. Further, results from laboratory bioassays that exposed the phytoplankton to nutrient additions and a controlled light gradient indicate that the community shifted from being frequently nitrogen limited to almost always light limited after the storms. These results suggest that the major driver of plankton food web dynamics in this system was light limitation. The only plankton component that increased post-storm was the macro-zooplankton, which was strongly dominated by calanoid copepods. We attribute this response to a release from predation pressure, possibly a combined effect of reduced biomass of planktivorous fish and reduced reaction distance of predators caused by turbid water.

Hawkins, **C**. **P**., Utah State University, Logan, Utah, USA, chuck.hawkins@usu.edu

Jin, J., Utah State University, Logan, Utah, USA, jiming.jin@usu.edu

Hill, R. A., Utah State University, Logan, Utah, USA, ryan.hill@usu.edu

Olson, J. R., Utah State University, Logan, Utah, USA, john.olson@usu.edu

RESPONSE OF STREAM INVERTEBRATES TO PREDICTED CLIMATE CHANGE IN CALIFORNIA

To address how stream invertebrate assemblages will likely respond to projected climate change in California, we built RIVPACS-type niche models that described how taxon-specific probabilities of detection vary among 400 reference-quality sites as a function of both climate-sensitive factors (temperature and precipitation) and climate-insensitive factors (e.g., channel slope, watershed geology). We predicted how local temperature and precipitation will likely change at these locations by downscaling global climate model (GCM) projections for California under an intermediate CO_2 increase scenario. We used statistical relationships between historical GCM and PRISM data to downscale climate projections to a spatial resolution of 4km. We used the downscaled climate projections in the RIVPACS models to predict the taxonomic composition at each reference site for the years 1900-1909, 1999-2008, 2041-2050, and 2090-2099. Mean annual precipitation and air temperature changed by -20mm and +1° C between 1900 and 1999. Additional changes of -39mm and +3.8° C are expected by 2090. The RIVPACS model showed that marked changes in both site-specific and regional taxa composition are likely to occur in California streams this century, largely in response to future temperature changes.

Hawkins, **C**. **P**., Utah State University, Logan, UT, USA, chuck.hawkins@usu.edu

Cao, Y., Illinois Natural History Survey, Champaign, IL, USA, yong.cao@illinois.edu

SIMULATING COMMUNITY RESPONSE TO STRESS CAN HELP INTERPRET ECOLOGICAL INDICES AND ANALYSES

The interpretation of analyses and indices used to quantify how ecological communities respond to human-caused stress is hindered by the fact that we never know exactly how real communities have been altered. As a consequence, we have difficulty interpreting (and agreeing on) what specifically our methods assess and to what extent they are successful. We have used simulation as a way of evaluating how sampling effectiveness and known changes in community composition and structure affect different types of assessment endpoints (e.g., estimates of differences in taxa richness, multimetric and O/E index values, and multivariate descriptions of differences among communities). In our past work, we have focused on simulating differences in mortality among resident taxa in response to changes in generalized stress. We are currently extending that work to explore how communities differentially respond to specific types of stress. We have not yet incorporated into our simulations how stress might promote establishment of nonresident taxa that can invade systems following stress.

Hawley, **R**. **J**., Colorado State University; Sustainable Streams, LLC, Louisville, KY, USA, bob.hawley@sustainablestreams.com

Wooten, M. S., Northern Kentucky Sanitation District No. 1 (SD1), Fort Wright, KY, USA, mwooten@sd1.org

ECOLOGICAL IMPLICATIONS OF THE MEASURED HYDROGEOMORPHIC EFFECTS OF LAND-USE CONVERSION IN NORTHERN KENTUCKY STREAMS

Streamflow alteration associated with development in Northern Kentucky has typically been regulated with an exclusive focus on flood control as opposed to promoting geomorphic stability and/or ecosystem function. In an effort to reevaluate management strategies toward more holistic watershed-specific goals, SD1 has recently undertaken a substantial field campaign including biological, chemical, and physical characterizations. This paper focuses on the ecological implications related to the hydrogeomorphic responses that are primarily attributable to land-use conversion from undeveloped to developed. Annually repeated pebble counts and geometric (cross-section and profile) surveys at 24 sites showed that the most dynamic channels tended to be associated with the most developed watersheds as measured by impervious cover. Although many aspects of channel change were captured (e.g. 'bankfull' depth, rate of longitudinal headcut migration, etc.), preliminary analyses showed the most pronounced trends across two metrics: 'bankfull' area tended to increase, while average riffle length tended to decrease with watershed imperviousness. Among other factors, these trends offer physical, processed-based support as to why the most developed watersheds tended to correspond to streams with the most impacted biological communities.

Hayford, **B**. **L**., Wayne State College, Department of Life Sciences, Wayne, Nebraska, USA, bhayford@gmail.com

Bouchard, Jr., R. W., Minnesota Pollution Control Agency, Saint Paul, MN, USA, Will.Bouchard@state.mn.us

PATTERNS IN EMERGENCE OF CHIRONOMIDAE FROM COLD SPRINGS IN OUTER MONGOLIA

Chironomidae pupal exuviae from 19 cold springs in Outer Mongolia were sampled to describe patterns in diversity of chironomids from cold spring habitats at risk from decreased surface water and groundwater permanence due to climate

change. Sites were designated as limnocrenes, rheocrenes, or spring brooks and were located in the Hentii Mountains and Altai Mountains. Patterns in sites and the dominant chironomid taxa were examined using a double dendrogram based on hierarchical cluster analysis. Four distinct community assemblages were identified, three of which were dominated by cold stenotherm taxa and one which was dominated by crenophilic taxa. The cold spring habitats also formed distinct clusters, grouped within the two mountain ranges. For example, five limnocrene and limnocrene/rheocrene sites located in the southern Altai Mountains clustered based on the presence of emerging Pseudodiamesa nivosa and three spring brook/rheocrene sites from the northern Altai Mountains clustered based on emerging Trichotanypus, Corynoneura, and Tokunagaia. Our results indicate that different types of cold spring habitats nestled within different regions in Mongolia support distinct chironomid communities.

Heard, **A**. **M**., University of California, Riverside, Riverside, USA, ahear001@ucr.edu
Sickman, J. O., Univerisity of California, Riverside, USA, james.sickman@ucr.edu
Cobbs-Russell, A., University of California , Riverside, USA,

NUTRIENT-ADDITION EXPERIMENTS TO IDENTIFY NUTRIENT CRITERIA FOR HIGH ELEVATION LAKES OF THE SIERRA NEVADA

The purpose of our research is developing nutrient criteria (phosphorus and nitrogen) for high-elevation lakes in the Sierra Nevada and applying these criteria to existing synoptic surveys. Sierra Nevada land managers will use the criteria to evaluate lake-ecosystem status and trends as part of their ongoing monitoring programs. We based nutrient criteria on the relationship between phytoplankton growth rates, measured as chlorophyll a, and lake nutrient concentrations. We determined these relationships by in-situ fertilization of phytoplankton using limnocorral enclosures at two lakes in the Sierra Nevada---a P-limited and an N-limited lake. We conducted several experiments where we added the limiting nutrient and we conducted one experiment where we added the non-limiting nutrient. We modeled chlorophyll a and nutrient concentration results from the experiments using logistic dose-response curves and then compared the 10, 50, and 90% effective doses calculated from these curves to nutrient data from several Sierra Nevada synoptic surveys. This comparison to existing surveys yields information on the temporal and spatial extent of nutrient-affected lakes in the Sierra Nevada spanning the past 20 years.

Heathcote, **A**. **J**., Iowa State University, Ames, USA, aheathco@iastate.edu
Downing, J. A., Iowa State University, Ames, USA, downing@iastate.edu

IMPACTS OF LANDSCAPE CHANGE ON CARBON BURIAL IN FRESHWATER LAKES

The influence of inland water bodies on the global carbon cycle and the great potential for long term carbon burial in them is an important component of global limnology. We predict that carbon burial in lakes may increase as agricultural practices become more widespread. We used paleolimnological methods to estimate changes in carbon burial rates through time in a suite of natural lakes whose watersheds have been heavily modified over the last two centuries. Our results show increasing carbon burial for all the lakes in our study as agriculture intensified. Our estimates for carbon burial rates prior to land clearance are similar to published worldwide averages for nutrient-poor lakes. In nearly all cases, burial rates increased to very high levels (up to 200 g C m^{-2} y^{-1}) following agricultural development. These results support the idea that increased autochthonous and allochthonous carbon flux, related to anthropogenic change, lead to higher rates of carbon burial. Further, these results imply that the fraction of global carbon buried by lakes will be increasingly important in the future if worldwide trends in anthropogenic eutrophication continue.

Heatherly II, **T**., University of Nebraska Lincoln, Lincoln, USA, heatherly75@yahoo.com
Thomas, S. A., University of Nebraska Lincoln, Lincoln, USA, sthomas5@unl.edu
Flecker, A. S., Cornell University, Ithaca, USA, asf3@cornell.edu
Pringle, C. M., University of Georgia, Athens, USA, cpringle@uga.edu
El-Sabaawi, R., University of Victoria, Vancouver, Canada, rana@uvic.ca
Marshall, M. C., University of Georgia, Athens, USA, trinidad@uga.edu
Lopes-Sepulcre, A., University of California Riverside, RIverside, USA, andresls@ucr.edu
Reznick, D., University of California Riverside, Riverside, USA, david.reznick@ucr.edu

MACROINVERTEBRATE ASSEMBLAGE RESPONSES TO FISH INTRODUCTIONS AND LIGHT MANIPULATION IN TRINIDAD

We conducted whole system manipulations of tropical stream ecosystems to examine the relative strength of bottom-up and top-down forces in influencing invertebrate community structure and function. Specifically, we altered light availability using canopy thinning and predator abundance by introducing guppies (*Poecilia reticulata*) while maintaining control reaches to examine how these change effect invertebrates communities in tropical streams with distinct wet and dry seasons. We found a significant interactive effect between guppies and light resulting in highest invertebrate biomass stocks (1630 mg DM m^2) occurring in the reach with the highest light and no guppies. In contrast, our experimental reach with the lowest light and guppies had the lowest invertebrate biomass (1272 mg DM m^2). There appeared to be no differences between reaches of high light with guppies and low light without guppies. Our results indicate that both top-down and bottom-up forces shape the macroinvertebrate assemblages in these streams and these forces become particularly pronounced in the dry season.

Heffernan, **J**. **B**., Florida International University, Miami, FL, USA, jheffer@fiu.edu
Cohen, M. J., University of Florida, Gainesville, FL, USA, mjc@ufl.edu
Foster, C. R., University of Florida, Gainesville, FL, USA, chadrfos@ufl.edu
Thomas, R. G., University of Florida, Gainesville, USA, rgthomas@ufl.edu

ESTIMATION OF AUTOTROPHIC ASSIMILATION FROM DIEL NITRATE VARIATION

Recent studies from both freshwater and marine habitats highlight the potential for estimation of biogeochemical processes, particularly autotrophic assimilation, from diel variation in nutrients such as nitrate. However, these approaches have been developed and applied to systems (productive oceans and spring-fed rivers) ideally suited to their use. Our goal in this presentation is to extend the range of systems, solutes, and circumstances under which these approaches can be used. Laboratory experiments demonstrate the capabilities of commercially available nitrate sensors to detect diel variation as small as 7 µ g NO_3-N L^{-1} , and the minimal interference by colored dissolved organic matter under all but the highest concentrations (>10 mg DOC L^{-1}). We use these data to bound the ranges of discharge and productivity that should permit estimation of autotrophic assimilation using existing methods in lotic and lentic systems. We also introduce a two-station approach that allows inference of autotrophic assimilation against dynamic inputs from terrestrial systems. Our results suggest that estimation of autotrophic assimilation from diel variation may be possible in a wide range of aquatic environments.

Heilveil, **J**. **S**., SUNY College at Oneonta, Oneonta, NY, USA, heilvejs@oneontta.edu

SECONDARY CONTACT IN NEW YORK POPULATIONS OF *NIGRONIA SERRICORNIS* (SAY): A MEETING OF THE CLADES

The commingling of evolutionarily distinct populations has important consequences for both genetic structure and population stability. Using DNA sequence data from the mitochondrial gene Cytochrome Oxidase I, the New York portion of the zone of secondary contact between the Pennsylvania and Costal clades of Nigronia serricornis (Megaloptera:Corydalidae) was mapped. While the Pennsylvania Clade is found throughout the state, the western maximum of the Coastal clade appears to be between Tomkins and Steuben counties. This means that populations east of Tomkins County can be expected to have higher levels of genetic diversity and be of more use for studies of contemporary impacts on this important indicator species.

Hein, **C**. **L**., Umeå University, Umeå, Sweden, clhein@gmail.com
Englund, G., Umeå University, Umeå, Sweden, goran.englund@emg.umu.se
Öhlund, G., Umeå University, Umeå, Sweden, gunnar.ohlund@emg.umu.se

BARRIERS TO DISPERSAL: A MISSING LINK IN PREDICTING CLIMATE-DRIVEN RANGE EXPANSIONS OF FISHES

Fish distributions are expected to change with a warming climate, but dispersal to new lakes will be limited by the connectivity of river networks. Although dispersal limitations have been cited, mapping river connectivity over large regions is difficult and has not been incorporated into predictions of future fish distributions. We developed a method to map the connectivity of river networks

throughout Sweden, identifying lakes as isolated, upstream or downstream from natural barriers. We then modeled future distributions of pike (*Esox lucius*), a fish native to Sweden, based on climate and habitat and compared our results with and without including dispersal barriers. By 2100, we predicted pike presence in all Swedish lakes. After accounting for dispersal barriers, we predicted pike presence in 44,950 fewer lakes. Dispersal barriers most strongly limited pike invasion in the mountainous regions of Sweden. Without incorporating connectivity, predictions of future fish distributions in a warmer climate might grossly overestimate range expansions. Our approach may be applied to areas for which a digital elevation model is available and to species for which dispersal barriers can be quantified.

Hein, **T**., BOKU, Vienna & WasserKluster Lunz, Vienna, Austria, thomas.hein@boku.ac.at

Bondar-Kunze, E., BOKU, Vienna & WasserKluster Lunz, Vienna, Austria, elisabeth.bondar@boku.ac.at

Habersack, H., BOKU, Vienna, Institute of Water Management, Hydrology and Hydraulic Engineering, Vienna, Austria, helmut.habersack@boku.ac.at

Pinay, G., University of Birmingham, School of Geography, Birmingham, United Kingdom, g.pinay@bham.ac.uk

Schiemer, F., University of Vienna, Vienna, Austria, friedrich.schiemer@univie.ac.at

Tritthart, M., BOKU, Vienna, Institute of Water Management, Hydrology and Hydraulic Engineering, Vienna, Austria, michael.tritthart@boku.ac.at

Welti, N., BOKU, Vienna & WasserKluster Lunz, Vienna, Austria, nina.welti@boku.ac.at

HOW DOES HYDROLOGICAL CONNECTIVITY CONTROL C & N DYNAMICS IN RIVER FLOODPLAIN SYSTEMS?

Riparian zones and floodplains are key components within river ecosystems controlling nitrogen and carbon cycling. The intensity of these processes depends on the exchange conditions (the hydrological connectivity) with the main channel and the morphological setting of the water bodies. At the landscape scale the mode of carbon and nitrogen delivery, increasing residence time and contact area as well as extreme hydrological events control the nutrient uptake and retention. All three factors can be affected by natural disturbances or anthropogenic impacts, through a change in either the water regime and/or the geomorphologic setting. These changes in turn will affect the biogeochemistry of riparian zones and floodplains. The present paper analyses the effects of river side-arm restoration on ecosystem functions and highlights potential effects on the river system. The survey compared the water and sediment nutrient concentrations and denitrification rates in two floodplains of the Danube River. We demonstrated that principles of hydromorphological dynamics control nutrient cycling at the sediment water interface. These findings point to the potential use to assess the consequences of restoration measures on river ecosystem functioning.

Heinrich, **K**. **K**., Southern Illinois University Carbondale/Department of Zoology and Center for Ecology, Carbondale, USA, kalebh@siu.edu

Whiles, M. R., Southern Illinois University Carbondale/Department of Zoology and Center for Ecology, Carbondale, USA, mwhiles@zoology.siu.edu

Roy, C., Wetland Wildlife Populations and Research Group, Minnesota Department of Natural Resources, Bemidji, USA, clroy_50@yahoo.com

INFLUENCE OF AN IN-STREAM RESTORATION PRACTICE ON INSECT EMERGENCE AND RIPARIAN BIRDS

A series of rock weirs was installed in the Upper Cache River, Illinois in 2001 and 2003 to stabilize the channel and control entrenchment. Recent studies found that these structures benefit in-stream communities, increasing aquatic insect diversity and biomass of some insect taxa. We examined whether insect emergence production was enhanced by these structures and if riparian birds responded positively. We quantified insect emergence seasonally during 2009 and made weekly point counts of birds during spring of the same year at 4 weir and 4 non-weir sites. Emerging insect abundance was higher at non-weir sites, but diversity was significantly higher at weir sites. Total emergence production between site types did not differ significantly, but larger-bodied taxa were more common at weir sites. Abundance and emergence production of EPT (Ephemeroptera, Plecoptera, and Trichoptera) taxa was also significantly higher at weir sites. Total bird abundance was significantly higher at weir sites (n=22.02 ha^{-1}) compared to non-weirs (n=19.96 ha^{-1}), and ordinations reflected differences in bird assemblages between weir and non-weir sites. Results indicate that in-stream restoration practices can have far-reaching ecological effects.

Helms, **B**., Auburn University, Auburn, USA, helmsbs@auburn.edu

Stoeckel, J., , Auburn, USA, jas0018@auburn.edu

Cash, E., Auburn University, Auburn, USA, casheri@auburn.edu

BURROWING ABILITIES OF CRAYFISH AND THE INFLUENCE OF SUBSTRATE ON THEIR GROWTH, SURVIVORSHIP, AND BURROW ARCHITECTURE

Despite the recognized importance of crayfish in aquatic systems, details on the burrowing aspects of many species are poorly known. Using artificial burrow chambers (ABCs), we simulated a drying event and evaluated the influence of substrate particle size (fine to coarse) on the survivorship, growth, and burrow architecture of 2 widespread species, *Cambarus striatus* and *Procambarus acutissimus* , that are strong and weak burrowers respectively. ABCs were a modification of an "ant farm" design and constructed of clear acrylic sheets, filled with native substrate, and individually plumbed to a common sump. *Cambarus striatus* readily burrowed and showed 89% survivability with a 7.2% increase in body weight in fine substrates. *Procambarus acutissimus* readily burrowed in fine substrates, but constructed only weak depressions or no burrow at all in coarse sand substrate. Survivability was 100% in fine substrates, 40% in coarse substrates, and overall body weight change of those surviving was -8.7%. These results suggest that crayfish growth and survivorship in semi-aquatic environments is dependent upon environmental context and species-specific burrowing abilities.

Helton, **A**. **M**., Odum School of Ecology, University of Georgia, Athens, GA, USA, amhelton@uga.edu

Poole, G. C., Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT, USA, gpoole@montana.edu

Bernhardt, E. S., Nicholas School of the Environment and Earth Sciences, Duke University, Durham, NC, USA, ebernhar@duke.edu

Wright, M. S., Flathead Lake Biological Station, University of Montana, Polson, MT, USA, meredith.wright@flbs.umt.edu

Stanford, J. A., Flathead Lake Biological Station, University of Montana, Polson, MT, USA, jack.stanford@umontana.edu

SIMULATION OF MULTI-ELEMENT BIOGEOCHEMICAL CYCLES WITHIN RIVER-FLOODPLAIN SYSTEMS

Simulation models are important tools for understanding riverine biogeochemical cycles because biogeochemical processes cannot be measured empirically across whole fluvial landscapes. However, our ability to simulate riverine biogeochemical dynamics has been limited. Landscape-scale modeling approaches tend to simulate steady-state uptake and/or respiration of nitrogen in isolation from other elements. Here we present a linked carbon, nitrogen, and oxygen model that simulates microbial uptake and respiration, as well as biomass accumulation and loss (mineralization). The model operates based on fundamental principles of stoichiometry and thermodynamics: microbial assemblages use the suite of metabolic pathways that maximize microbial growth, given the available electron donors/acceptors and the stoichiometric ratio of carbon and nitrogen required for building biomass. We combined our model with a spatially explicit and temporally dynamic model of surface water flow and hyporheic exchange within floodplains. Initial results suggest the combined models yield realistic patterns of nitrogen, oxygen, organic carbon, and microbial biomass and respiration along hyporheic flow paths. This modeling approach will provide a tool for exploring hypotheses regarding complex biogeochemical dynamics within river-floodplain systems.

Hemond, **H**. **F**., Massachusetts Institute of Technology, Cambridge, USA, hfhemond@mit.edu

MEASUREMENT OF HETEROGENEOUS TIME-VARYING FLUXES AT THE SEDIMENT-WATER INTERFACE

Geochemical conditions in porewaters contrast dramatically with the overlying water column, and the sediment-water interface is typically a region of steep chemical gradients, where modest fluid transport processes can drive geochemically important fluxes. One historic example is sediment oxygen demand, whose importance has been recognized in literature for over a century. Sediment-water fluxes of nutrients, organic and inorganic carbon, metals, and gases such as methane are now also recognized as key ecosystem processes. Measurement of sediment-water fluxes is however an always-problematic task, rendered more difficult by unsteady flow processes, spatial heterogeneity, or the fact that some fluxes are governed by biota or by complex fluid processes such as multiphase flow or unstable density gradients. Appropriate sensor-based

measurement approaches are needed to advance the understanding of such fluxes. New sensing approaches utilizing, for example, low-cost pressure sensors and data systems have led to improved understanding of processes ranging from submarine groundwater discharge to methane ebullition. Beyond these examples, we suggest additional sensor-based stratgegies for measurement of sediment-water fluxes that may prove valuable in the future.

Henderson, **B**. **L**., Texas Christian University, Fort Worth, USA, b.l.henderson@tcu.edu

Chumchal, M. M., Texas Christian University, Fort Worth, USA, m.m.chumchal@tcu.edu

Drenner, R. W., Texas Christian University, Fort Worth, USA, r.drenner@tcu.edu

Diaz, P., Texas State University, San Marcos, USA, pd1017@txstate.edu

Deng, Y., Texas Christian University, Fort Worth, USA, y.deng@tcu.edu

Nowlin, W. H., Texas State University, San Marcos, USA, wnowlin@txstate.edu

MERCURY CONTAMINATION OF MACROINVERTEBRATES FROM PONDS WITH AND WITHOUT FISH AT THE LBJ NATIONAL GRASSLAND, TEXAS, USA

The purpose of this study was to compare the biomass and Hg concentrations of macroinvertebrates from grassland ponds with and without fish communities. Macroinvertebrates were collected from five ponds with fish and five ponds without fish, at the LBJ National Grassland in North Texas. In ponds without fish, the biomass of macroinvertebrates was significantly higher than in ponds with fish. The average Hg concentration of macroinvertebrates from ponds without fish was significantly higher than the average Hg concentration in ponds with fish. Because ponds without fish contained a higher biomass of macroinvertebrates and unique taxa with higher concentrations of Hg, the total amount of Hg in the macroinvertebrate community in ponds without fish was significantly higher than in the ponds with fish. In ponds with fish the average Hg concentration of the fish community was 13 times greater than Hg concentration of the macroinvertebrates community. These data suggest that when fish are present, Hg accumulates in fish rather than in the macroinvertebrate community, which has implications for the movement of Hg into terrestrial ecosystems when macroinvertebrates emerge as aerial adults.

Herbst, **D**. **B**., University of California, Sierra Nevada Aquatic Research Laboratory, Mammoth Lakes CA 93546, USA, herbst@lifesci.ucsb.edu

Cooper, S. D., University of California, Dept Evolution, Ecology and Marine Biology, Santa Barbara CA 93106, USA, scooper@lifesci.ucsb.edu

BEFORE AND AFTER THE DELUGE: RAIN-ON-SNOW FLOODING EFFECTS ON AQUATIC INVERTEBRATE COMMUNITIES OF SMALL STREAMS IN THE SIERRA NEVADA, CALIFORNIA

Climate change is predicted to increase the occurrence of rain-on-snow flooding in mountain streams. Such events can drastically alter stream geomorphology, but less is known about how these floods affect aquatic life. Storm flooding in early January 1997 provided an opportunity to study benthic invertebrate community structure in eastern Sierra streams in the summers before and after this record event. Study sites included streams degraded by livestock grazing and others where grazing was absent or minimal (reference). From 1996 to 1997, the densities of invertebrates increased significantly more at grazed than reference sites, accompanied by loss of bank and riparian stability, and reduced fine sediment at many sites. NMDS analysis indicated reference sites changed relatively little while disturbed sites showed increases in certain midges and net-spinning caddisflies. Trophic structure shifted to higher densities of filterers and small gatherers of fine organic matter in grazing-disturbed streams. These results indicate that invertebrate communities in small streams may be resilient to large rain-on-snow floods, but that collector guilds in some degraded streams may increase in response to sediment-flushing and increases in particulate organic matter.

Herpich, **D**. **C**., Charles Sturt University, Wagga Wagga, Australia, darren.herpich@sa.gov.au

Dehaan, R., Charles Sturt University, Wagga Wagga, Australia, rdehaan@csu.edu.au

Hume, I., EH Graham Centre for Agricultural Innovation, Wagga Wagga , Australia, iain.hume@industry.nsw.gov.au

Wilson, A., Charles Sturt University, Wagga Wagga, Australia, awilson@csu.edu.au

SPATIAL EXTENT OF SGD TO A NEARSHORE AND ESTUARINE ENVIRONMENT WITHIN THE KARST LANDSCAPE OF SOUTH EAST AUSTRALIA: A THERMAL INFRARED PERSPECTIVE

The quantity and quality of groundwater resources influences ecological and hydrological systems. In recent times groundwater discharge to terrestrial aquatic and marine environments, termed Subterranean and/or Submarine Groundwater Discharge (SGD) have received increased interest. The reduced availability of freshwater in many hydrological systems or alternatively increased nutrient supply and/or contamination from SGD has resulted in research focussed on identifying SGD locations, flux and dynamics. Understanding SGD allows resource managers to quantify: discharge for input into hydrological models; impacts of groundwater discharge to receiving environments; anthropogenic inputs to aquatic ecosystems; salt water intrusion risk, and; in some cases identify alternative water resources. Findings are presented from an Australian study utilising an airborne thermal sensor to identify SGD. The project area encompasses the nationally significant Karst groundwater dependent ecosystem, Piccaninnie Ponds and an estuarine environment in south-eastern Australia. Supervised and unsupervised classifications, Principal Component analysis, and Thresholding techniques are tested. Threshold techniques provide the clearest temperature differences between discharging groundwater and surrounding water and represent a cost-effective method to determine the spatial extent of SGD over large areas.

Herrmann, **S**. **J**., Colorado State University-Pueblo, Pueblo, USA, scott.herrmann@colostate-pueblo.edu

Nimmo, D. R., Colorado State University-Pueblo, Pueblo, USA, del.nimmo@colostate-pueblo.edu

Turner, J. A., Colorado State University-Pueblo, Pueblo, USA, jason.turner@colostate-pueblo.edu

Carsella, J. S., Colorado State University-Pueblo, Pueblo, USA, jim.carsella@colostate-pueblo.edu

Lehmpuhl, D. W., Colorado State University-Pueblo, Pueblo, USA, david.lehmpuhl@colostate-pueblo.edu

BIOACCUMULATION OF SELENIUM BY THE BRYOPHYTE *HYGROHYPNUM OCHRACEUM* IN THE FOUNTAIN CREEK WATERSHED, COLORADO, USA

The aquatic bryophyte, *Hygrohypnum ochraceum*, was deployed "in situ" at 14 sites in the Fountain Creek Watershed, spring and fall, 2007 to study their uptake of selenium measured by ICP-MS. Dissolved, total, and pore (sediment derived) water samples were collected and water quality parameters determined while plants were exposed to the water for 10 days. We found that plants accumulated Se showing variable distribution of the metalloid by site and season especially along the stream segment from Colorado Springs to Pueblo, CO. A site at Highway 50 bridge in Pueblo had the highest concentration in plants by site and season in the three water fractions. Selenium uptake by the plants was substantial in the spring between Colorado Springs and Pueblo. Plants bioconcentrated Se from the water as much as 100,000 to 160,000 times. We found direct relationships between the pore and dissolved Se in water in the spring (R^2=0.84) and fall (R^2= 0.95) and dissolved Se and total hardness in the spring and fall (R^2=0.92). We found little differences between Se concentrations in water samples as dissolved vs. total.

Hershey, **A**. **E**., University of North Carolina - Greensboro, Greensboro, USA, aehershe@uncg.edu

Northington, R. M., Virginia Tech University, Blacksburg, USA,

Luecke, C. M., Utah State University, Logan, USA,

Johnson, C. R., University of Alaska, Fairbanks, USA,

DIFFERENTIAL COUPLING OF ZOOBENTHOS TO PELAGIC PRODUCTIVITY IN ARCTIC LAKES: RESULTS FROM FOUR YEARS OF WHOLE LAKE 15N ENRICHMENT.

The relative importance of autochthonous and allochthonous resources for zoobenthos varies between lakes and lake habitats, but is poorly understood relative to resources supporting pelagic consumers. To investigate this problem, we introduced a 15N tracer to 4 arctic lakes during 4 consecutive summers, and examined zoobenthic del 15N responses relative to seston. In the deepest lake, we found that epifaunal profundal consumers accumulated 15N rapidly and, after 4 years, exhibited del 15N values similar to hypolimnetic seston, suggesting tight coupling to pelagic production for this functional group. In contrast, profundal infaunal consumers were slightly enriched above background but showed no long-term trend of 15N accumulation. At 5 m, consumers were 15% - 25% as enriched as seston after 4 years. In three other lakes, ranging from 3.5-6.5 m maximum depth, taxa in all habitats were 15% - 25% enriched compared to seston. These results indicate that coupling of zoobenthos to pelagic production

varies with consumer group and habitat, but that for most benthic consumers, linkage to pelagic primary production is relatively weak, implying that allochthonous production is relatively more important.

Hester, **E**. **T**., Virginia Tech, Blacksburg, USA, ehester@vt.edu
Bauman, K. S., Virginia Tech, Blacksburg, USA,

IMPACT OF THERMAL PERTURBATIONS FROM URBAN RUNOFF DURING SUMMER STORMS ON STREAM AND WETLAND TEMPERATURES

Runoff from heated parking lots during summer storms injects pulses of hot water into receiving water bodies, potentially affecting aquatic organisms and biogeochemical process rates. Such effects may be heightened if climate change raises temperatures, increases storm flows, and reduces baseflow in aquatic systems. While previous studies have shown the impact of summer storm thermal pulses on stream temperatures can be significant, none have fully resolved the magnitude or extent of these impacts in space or time. Here we present temperature data collected near urban storm sewer outfalls using arrays of temperature sensors in both a stream with directional flow and a wetland with minimal current. Observed perturbations ranged up to 5C in the stream and 9C in the wetland and typically lasted 1-2 hours. These impacts are large enough to substantially alter organism level biological process rates in aquatic species and also impact biogeochemical process rates. Temperatures near the storm sewer outfall returned to background more quickly but perturbations traveled further in the stream than in the wetland, indicating impact patterns vary with considerably with water body type.

Heth, **R**. **L**., Missouri State University, Springfield, MO, USA, Heth207@live.missouristate.edu
Bowles, D. E., National Park Service, Republic, MO, USA, David_Bowles@nps.gov
Havel, J. E., Missouri State University, Springfield, MO, USA, johnhavel@missouristate.edu

EFFECTS OF STREAM CROSSINGS ON MACROINVERTEBRATE ASSEMBLAGES OF THE UPPER CURRENT RIVER, OZARK NATIONAL SCENIC RIVERWAYS, MISSOURI

This study examined the impact of road crossings on benthic macroinvertebrate communities in a wadable Ozark river. We collected macroinvertebrates during winter and summer from four riffle locations (upstream, at crossing, downstream, and farther downstream) at each of five sites in the upper Current River (mean discharge 12 cms). Sixteen environmental variables were measured at each location to characterize sites. Using digital photographs from trail cameras, traffic frequencies were calculated and largely consisted of hikers and horses. Based on counts of 68,353 individuals from 111 macroinvertebrte taxa, we calculated four metrics (taxa richness, Shannon's index, EPT, biotic index) combined into the Stream Condition Index and assessed effects of stream crossings with a two-way nested ANOVA for each season. All metrics showed strong differences among sites but inconsistent effects among locations. Multivariate analyses (NMDS and a nested ANOSIM) also revealed strong differences in community composition among sites, as well as among locations. Together the results indicate crossing disturbances during summer and winter 2009 were either too infrequent or small in intensity to impair benthic invertebrates.

Hickford, **M**. **J**., University of Canterbury, Christchurch, New Zealand, michael.hickford@canterbury.ac.nz
Schiel, D. R., University of Canterbury, Christchurch, New Zealand, david.schiel@canterbury.ac.nz

POPULATION SINKS FOR DIADROMOUS FISH FROM MULTIPLE STRESSORS IN THE COASTAL MARGINS OF NEW ZEALAND

Numerous stressors from agriculture, urbanisation and natural disturbances affect coastal margins and the species that rely on particular habitats to complete their life-histories. One of the most widely distributed fish species in the southern hemisphere lays its eggs only in riparian vegetation in the tidal reach of streams and rivers. Sink populations have resulted from alterations to spatially explicit "gateways" in the early life history of this diadromous species, principally through reductions in the quantity and quality of spawning habitat. This has exacerbated population declines by creating life-history bottlenecks in many large rivers. We show that there is a negative correlation between stream/river size and spawning success; the two largest rivers with the greatest adult populations have virtually no egg production. We demonstrate that even a wide-ranging species with many robust adult populations can be compromised if a stage-specific habitat required to complete a life-history is degraded by localised or more diffuse impacts, but that targeted intervention and management might readily improve this.

Hicks, **R**. **E**., University of Minnesota Duluth, Duluth, USA, rhicks@d.umn.edu
Kish, J. L., University of Minnesota Duluth, Duluth, USA, kishx013@umn.edu
Oster, R. J., University of Minnesota Duluth, Duluth, USA, oste0157@d.umn.edu
Reed, A. J., university of Minnesota Duluth, Duluth, USA, ajreed@d.umn.edu
Werne, J. P., University of Minnesota Duluth, Duluth, USA, jwerne@d.umn.edu

PLANKTONIC ARCHAEAL COMMUNITIES LINKED TO AMMONIA OXIDATION IN LAKE SUPERIOR

Molecular information about enzymes produced by planktonic microbes can aid our understanding of in-lake processes like nitrogen cycling. Archaeal community structure was examined in Lake Superior during 2007 and 2008. Two discrete clusters of archaeal assemblages were present under stratified conditions but only one cluster was evident during mixed conditions. The composition of the surface water assemblage changed, but the deeper assemblage remained unchanged in the hypolimnion. Analysis of 16S rDNA clones indicated many non-thermophilic crenarchaea were present and similar to *Nitrosopumilus maritimus* strain SCM1, a marine crenarchaeal ammonia oxidizer. After stratification, there were more copies of the archaeal 16S rDNA gene and a putative archaeal ammonia monooxygenase (*amo*A) gene below the deep chlorophyll maximum than in the epilimnion. The archaeal *amo*A gene became more abundant relative to the archaeal 16S rDNA gene after the water column stratified. The nitrification rate peaked in the hypolimnion below the deep chlorophyll maximum during stratified conditions, where more archaeal and bacterial *amo*A gene copies were found. Some archaeal members of these planktonic microbial communities may contribute to nitrification in the water column.

Higgins, **C**. **B**., Virginia Commonwealth University, Richmond, USA, higginscb@vcu.edu
Piehler, M. F., University of North Carolina at Chapel Hill, Morehead City, USA, mpiehler@email.unc.edu
Smyth, A., University of North Carolina at Chapel Hill, Morehead City, USA, arsmyth@email.unc.edu
Tobias, C., University of Connecticut, Groton, USA, craig.tobias@uconn.edu
Graham, T., Univeristy of North Carolina Wilmington, Wilmington, USA, tbg5311@uncw.edu
Brown, B., Virginia Commonwealth University, Richmond, USA, blbrown@vcu.edu

EFFECT OF OYSTER BIODEPOSITION (CRASSOSTREA VIRGINICA) ON SEDIMENT DENITRIFICATION AND ANAMMOX RATES IN CHESAPEAKE BAY: 15N TRACER AND N2 FLUX MEASUREMENTS

Eutrophication of estuaries and coastal ecosystems has heightened interest in understanding the role filter feeding bivalves play in nutrient cycling. One hypothesis is that biodeposition by bivalves enhances the rate of denitrification, mitigating anthropogenic N pollution by accelerating the net loss of N. This hypothesis is predicated on two main assumptions: (1) increased biodeposition will increase the rate of denitrification and (2) a substantial portion of the TN delivered to marine sediments through biodeposition is denitrified. We measured denitrification rates in sediments at two commercial-scale floating raft oyster aquaculture sites in Chesapeake Bay and compared them to non-aquaculture reference sites. Measurements of denitrification rates (15N Tracer and Membrane Inlet Mass Spectrometry) were taken during spring, summer, and fall over two years, and compared to in situ rates of oyster biodeposition. Experiments inducing interactions between biodeposition and denitrification were performed by forced accumulation of biodeposits underneath rafts and addition of biodeposits to sediment cores in the laboratory. Results concurred that overall, oyster aquaculture does not appreciably increase rates of denitrification in the underlying sediments. A slight increase over baseline rates was observed during one summer sampling event; however, the increase we detected in denitrification due to oyster aquaculture was lower than previously measured and modeled values.

Higgins, **S**. **N**., University of Wisconsin-Madison, Madison, USA, snhiggins@wisc.edu

Vander Zanden, M. J., University of Wisconsin, Madison, USA, mjvanderzand@wisc.edu

Joppa, L. N., Duke University, Durham, USA, joppatri@yahoo.com

Vadaboncoeur, Y., Wright State, Dayton, USA, yvonne.vadeboncoeur@wright.edu

BENTHIC PELAGIC COUPLING BY AN INVASIVE GRAZER: DREISSENID MUSSEL IMPACTS ON PHYTOPLANKTON BIOMASS AND THE CHL:TP RELATIONSHIP

Dreissenid invasion of North American and European freshwaters have transformed benthic and pelagic food webs of these ecosystems. Here, we use meta analysis and a combination of statistical approaches (classical regression, hierarchical modeling) to examine the impacts of these benthic filter feeders on phytoplankton biomass (Chl), total phosphorus (TP), and the Chl:TP relationship across gradients of lake size and trophic status. Overall, dreissenids reduced Chl by 40 to 45%, with the magnitude of impact dependant on ecosystem size in stratified, but not mixed, lakes. Impacts on Chl were prolonged, with no indication of diminishing within 10 years of invasion. In contrast, impacts on TP were much smaller (15% reduction) and only significant in stratified lakes. Across broad trophic gradients (i.e. among lakes) classical regression (ANCOVA) indicated a significant decline in the Chl:TP relationship after invasion, but no change in slope. In contrast, hierarchical modeling, which included individual lake responses, indicated a decline in the slope of the Chl:TP relationship within 24 of the 27 lakes in the study. Our results indicate that 1) Chl:TP regression equations developed prior to invasion will systematically overestimate Chl, 2) at broad scales (among lakes), both top-down and bottom-up mechanisms control phytoplankton biomass in invaded lakes, and 3) within lakes top-down grazing mechanisms dominate in controlling annual variations in Chl in invaded lakes.

Hildrew, **A**. **G**., Queen Mary, University of London, London, United Kingdom, a.hildrew@qmul.ac.uk

Trimmer, M., Queen Mary, University of London, London, United Kingdom,

Grey, J., Queen Mary, University of London, London, United Kingdom, j.grey@qmul.ac.uk

Sanders, I., Queen Mary, University of London, London, United Kingdom, i.a.sanders@qmul.ac.uk

Pretty, J., Queen Mary, University of London, London, United Kingdom, j.l.pretty@qmul.ac.uk

MULTIPLE STRESSORS AND UNEXPECTED OUTCOMES: ECOSYSTEM PROCESSES AND BIOASSESSMENT IN ENGLISH CHALK STREAMS

English chalk streams are the iconic 'gin clear' rivers of dry fly fishermen. Assessed conventionally using benthic invertebrates, they remain largely of excellent ecological status yet have been subject to the twin stressors of increasing loadings of agricultural fertilizers and sediment deposition. Here we show that these streams are generating the greenhouse gases methane and nitrous oxide. There is also evidence that methane, a chemosynthetic source of energy, supports a substantial fraction of the food web. We discuss whether the environmental stressors interact and how the apparently high ecological status of the streams can be reconciled with the unexpected evidence from ecosystem processes.

Hill, **B**. **H**., US Environmental Protection Agency, Duluth, USA, hill.brian@epa.gov

Elonen, C. M., US Environmental Protection Agency, Duluth, USA, elonen/colleen@epa.gov

Seifert, L. R., US Environmental Protection Agency, Duluth, USA, seifert.lindsey@epa.gov

May, A. A., US Environmental Protection Agency, Duluth, USA, may.ashely@epa.gov

MICROBIAL ECOENZYMATIC STOICHIOMETRY AS AN INDICATOR OF NUTRIENT LIMITATION IN US STREAMS AND RIVERS

We compared microbial ecoenzymatic activity at 2122 randomly-selected stream and river sites across the conterminous United States. The sites were evenly distributed between wadeable and non-wadeable streams and rivers. Sites were aggregated into nine larger physiographic provinces for statistical analyses and reporting. We also sampled 233 least-disturbed (reference) sites in order to set ecoenzymatic activity expectations for C, N and P acquisition. Microbial biomass stoichiometry is expected to be 60C:7N:1P, and this ratio should be reflected in the ratios of glycosidase, peptidase, and phosphatase activities. We demonstrate relative N-limitation in 7-33% of the total assessed stream and river length; P-limitation in 35-59% of stream and river length; and no limitation in 26-47% of stream and river length. Ecoenzymatic stoichiometry indicated that the majority of streams (56-70% of total stream length) are not balanced in their C, N, and P acquisition, further suggesting relative nutrient limitation. The ratio of phenol oxidase to glycosidase activity indicated a prevalence of recalcitrant C in 14-34% of stream and river length. There were no differences between streams and rivers in nutrient limitation and stoichiometric balance.

Hill, **W**. **R**., University of Illinois, Champaign, USA, wrhill@illinois.edu

Mulholland, P. J., Oak Ridge National Laboratory, Oak Ridge, USA, mulhollandpj@ornl.gov

LIGHT DRIVES GRAZER STOICHIOMETRY IN WALKER BRANCH

One of the simplifying assumptions of ecological stoichiometry is that the nutrient content of herbivores is relatively homeostatic. As part of a long-term growth study in Walker Branch, phosphorus and nitrogen concentrations in the grazing snail Elimia were measured every two months for four years. The nutrient content of the snails was highly dynamic: phosphorus and nitrogen were consistently low in spring when streambed irradiances were high and consistently high in late summer when irradiances were low. Phosphorus content ranged almost two-fold during a single year. Superimposed on the annual pattern was a longer-term trend of increasing nutrient content as snail densities increased after a scouring spate. Snail growth exhibited temporal patterns opposite of those of nutrient content: it was highly correlated with light and primary production and negatively correlated with density. As a consequence, growth and nutrient content were negatively correlated. Phosphorus and nitrogen concentrations in Elimia appear to be diluted by the accumulation of carbon reserves (lipid and glycogen) during favorable growth periods but concentrated during lean times when carbon reserves are metabolized.

Hines, **J**. **E**., Swiss Federal Institute of Aquatic Science and Technology, Dubendorf, Switzerland, jessica.hines@eawag.ch

Gessner, M. O., Swiss Federal Institute of Aquatic Science and Technology, Dubendorf, Switzerland, Mark.Gessner@eawag.ch

LIFE-HISTORY PLASTICITY IN A DETRITIVORE DETERMINES ECOSYSTEM RESPONSE TO CLIMATE WARMING

Many ectotherms grow faster in warmer environments. However, life history tradeoffs in growth rate, body size, and fecundity can constrain the influence of warming on an individual's resource consumption. Additionally, although higher temperatures can cause phenological shifts in some species, changes in the timing of resource demand may vary across taxa, functional groups, and trophic levels. Using a randomized complete block 2x2 factorial field enclosure experiment, we examined the consequences of increased temperature (+4˚C, ambient), and resource availability (nitrogen subsidized, ambient) on littoral zone communities feeding on *Phragmites australis* leaf litter. We find that life history plasticity of a key benthic consumer (*Limnephilus spp.*, Trichoptera) in response to climate warming can strongly affect rates of leaf litter decomposition. However, community dynamics can buffer species specific responses. Our results demonstrate that experimental field studies that capture species responses in complex communities will be necessary to accurately predict the effects of climate change on ecosystem functioning.

Hinricha, **A**. **P**., St. Olaf College, Norhfield, USA, hinricha@stolaf.edu

Wilkinson, G. M., St. Olaf College, Northfield, USA, wilkinso@stolaf.edu

Marty, M. J., St. Olaf College, Nothfield, USA, micahmarty@gmail.com

Dunn, S. T., St. Olaf College, Northfield, USA, dunns@stolaf.edu

Schmidt, S. N., St. Olaf College, Northfield, USA, schmidts@stolaf.edu

Schade, J. D., St. Olaf College, Northfield, USA, schade@stolaf.edu

TEMPORAL SHIFTS AND NUTRIENT LIMITATION IN RESTORED PRAIRIE WETLANDS

Knowledge of nutrient limitation is important to our understanding of biogeochemical cycling. The goal of our study was to discover how wetland ponds in close regional proximity vary in nutrient limitation temporally. During the sampling period, the wetland ponds were subject to various external influences that included, but were not limited to, rainfall, anthropogenic water runoff, agricultural nutrient inputs, and migrating waterfowl. Surface water from all three ponds was collected weekly and analyzed for NH4, NO3, and

PO4. For the first four weeks of the sampling period, PO4 was highest in all three ponds. In week five, PO4 dropped to zero and NO3 increased considerably in all three ponds. Additionally, in week six, NH4 increased beyond NO3 and PO4 concentrations. These results suggest a shift in nutrient demands, from N-limitation to P-limitation, possibly due to the build-up of N-fixers over time.

Hinsey, **J**. **A**., Heartland Inventory & Monitoring Network, National Park Service, Republic, MO, USA, Jan_Hinsey@nps.gov

Bowles, D. E., Heartland Inventory & Monitoring Network, National Park Service, Republic, MO, USA, David_Bowles@nps.gov

INFLUENCES OF LOCAL AND REGIONAL FACTORS ON AQUATIC INVERTEBRATES IN OZARK TRIBUTARIES AT BUFFALO NATIONAL RIVER AND OZARK NATIONAL SCENIC RIVERWAYS

In 2006, the National Park Service implemented a long-term monitoring program of aquatic invertebrate communities in wadeable tributaries of the Buffalo River, Current River, and Jacks Fork at Buffalo National River (BUFF) and Ozark National Scenic Riverways (OZAR) located in Arkansas and Missouri. Though both parks are located in the Ozarks, tributary watersheds are influenced by a complex set of local and regional environmental factors that affect the aquatic invertebrate communities. Diversity data from 45 tributaries were analyzed to determine similarities among the tributaries and between parks. Preliminary results indicate varying levels of taxa and EPT richness, number of pollution tolerant taxa, and diversity among these tributaries and within each park. Cluster analysis based on similarity of taxa using Sörenson's Similarity Index resulted in two distinct clusters: one being all BUFF tributaries plus three larger OZAR tributaries while the other group included only OZAR tributaries. Correlations and multivariate statistical analysis conducted on the metrics, local and regional factors, and watershed geospatial data further illustrate the relationships of these streams and the potential influences of environmental factors on the respective communities.

Ho , **S**., School of Biological Sciences, Monash University, Melbourne, Australia, susie.ho@sci.monash.edu.au

Thompson, R., School of Biological Sciences, Monash University, Melbourne, Australia, Ross.Thompson@sci.monash.edu.au

Bond, N., School of Biological Sciences, Monash University, Melbourne, Australia, Nick.Bond@sci.monash.edu.au

COMPARATIVE FOOD WEB EFFECTS OF *GAMBUSIA HOLBROOKI* AND *HYPSELEOTRIS* SPP. IN FLOODPLAIN WETLANDS OF SOUTH-EASTERN AUSTRALIA

Food web consequences of invasion are rarely examined due to the potential complexity of outcomes and the difficulty of studying whole communities. While indirect effects can have major impacts on biodiversity values and ecosystem structure and function, they are difficult to disentangle from temporal and spatial environmental variability. *Gambusia holbrooki* is an invasive poeciliid fish which is widespread throughout the waterways of mainland Australia. Little is known about its food web effects, particularly in the context of the seasonal and hydrological variability within the wetlands which it frequently inhabits. While previous studies and anecdotal reports have suggested *G. holbrooki* dominates many invaded habitats, our field data suggests coexistence with several small-bodied native fish and predatory macroinvertebrate species. Whilst *G. holbrooki* may dominate specific habitats for limited periods, interactions with native fish fauna appear much more complex than initially thought. Here we describe a manipulative mesocosm experiment examining the coexistence and comparative top-down effects of *G. holbrooki* and the sympatric *Hypseleotris* spp. We quantify food web shifts under dynamic environmental conditions and discuss the implications of invasion under prolonged wetland drying.

Hoch, **R**. **A**., Biology Department, Appalachian State University, Boone, USA, rh65305@appstate.edu

Gangloff, M. M., Biology Department, Appalachian State University, Boone, USA, gangloffmm@appstate.edu

Hamstead, B. A., Biology Department, Appalachian State University, Boone, USA, Byron.Hamstead@gmail.com

Silvano, A. L., Alabama Cooperative Fish and Wildlife Research Unit, Auburn University, Auburn, USA, silvaal@auburn.edu

Grand, J. B., Alabama Cooperative Fish and Wildlife Research Unit, Auburn University, Auburn, USA, grandjb@auburn.edu

INVENTORY OF CRAYFISH AND MOLLUSK RESOURCES ON ALABAMA STATE-MANAGED LANDS

In 2008, we began a systematic inventory of freshwater crayfish and mollusk populations on 15 state managed lands in Alabama. During year 1 we targeted 4 properties in southern Alabama and during year 2, six properties in central Alabama. For each property, we determined stream orders from GIS layers and then randomly selected sites to sample. In 2008 we collected 936 crayfish (17 species) from 108 sites and in 2009 we collected 1170 crayfish (15 species) from 89 sites. Crayfish abundance was greatest in 1st and 2nd order sites and lowest at 5th and 6th order sites. Crayfish species richness was greatest in 3rd and 4th order streams with headwaters and larger streams typically supporting 1 or 2 taxa. Relatively few properties support mollusk populations, however the Sipsey Forever Wild Tract supports high-density mussel populations, including 24 taxa and the largest remaining population of federally endangered Pleurobema decisum. In 2010, we will complete sampling at 4 remaining sites in North Alabama. Crayfish and mollusk data will be used to guide future land use management strategies on these properties.

Hoeinghaus, **D**. **J**., University of North Texas, Denton, USA, David.Hoeinghaus@unt.edu

Gido, K. B., Kansas State University, Manhattan, USA, kgido@ksu.edu

Evans-White, M. A., University of Arkansas, Fayetteville, USA, mevanswh@uark.edu

Ferrari-Hoeinghaus, A. P., University of North Texas, Denton, USA, anahoeinghaus@yahoo.com

Dodds, W. K., Kansas State University, Manhattan, USA, wkdodds@ksu.edu

ECOSYSTEM EFFECTS OF BIODIVERSITY AND TROPHIC STRUCTURE INTERACT WITH HABITAT HETEROGENEITY IN EXPERIMENTAL STREAMS

Biodiversity and trophic structure may affect ecosystem function, and both aspects of ecological communities are often simultaneously altered by human impacts. To test effects of biodiversity and trophic structure on stream ecosystem function, we manipulated fish assemblage composition and diversity within a trophic level (invertivore species) and trophic structure (piscivore presence or absence) in experimental streams. Response variables included measures of ecosystem structure and function (chlorophyll a, ash free dry mass, algal filament length, benthic organic material accumulation, macroinvertebrate assemblage structure). Piscivores had both direct (consumption) and indirect (habitat use) effects on experimental fish assemblages, which differed among invertivore species and cascaded down to benthic macroinvertebrate and algal assemblages (e.g. invertivore*piscivore*habitat interaction for periphyton chl a, $P = 0.035$). Invertivorous fish composition/diversity and trophic structure significantly affected most measures of ecosystem structure and function, and all structural responses differed among pool and riffle habitats (all $P < 0.05$), often with interactions among factors. Our results indicate that ecosystem effects of biodiversity depend on trophic structure, and may differ spatially in heterogeneous stream ecosystems due to complex direct and indirect effects.

Hoellein, **T**. **J**., Baruch College, City University of New York, New York, USA, timothy.hoellein@baruch.cuny.edu

Zak, Y., Baruch College, City University of New York, New York, USA, yana.zak@gmail.com

Kuang, C., University of Rochester, Rochester, USA, ckuang@u.rochester.edu

SPATIAL VARIATION IN NUTRIENT CONCENTRATION AND LIMITATION IN AN URBAN WATERSHED (BRONX RIVER, NEW YORK)

Eutrophication is a pervasive threat to urban river ecosystems worldwide. The influence of watershed urbanization on longitudinal variation in nutrient concentrations and the capacity of riverine biofilms to absorb excess nutrients have not previously been measured simultaneously. In summer 2009, we quantified the distribution of nitrate and phosphate concentrations throughout the Bronx River watershed (N~200 sites). Also, we quantified biofilm nutrient limitation via experimental nutrient addition on organic and inorganic substrata (N=7 sites). Longitudinal variation in nitrate was low and related to impervious surface cover. In contrast, phosphate concentrations were unrelated to watershed land-use and showed high spatial variation. Biofilm nutrient limitation patterns were consistent with variation in nutrient concentrations. Biofilm growth on organic substrata was limited by phosphate or nitrate and phosphate together at sites with low water column phosphate concentrations. Biofilm growth on inorganic substrata was rarely nutrient-limited. Results

suggest distinct management strategies may be needed to address nitrate and phosphate eutrophication in urban rivers. Furthermore, enhancing retention of organic matter could help mitigate eutrophication via biofilm growth on organic substrata throughout urban river watersheds.

Hogfors, **H**., Stockholm University, Stockholm, Sweden, hedvig@ecology.su.se
Engström-Öst, J., Novia University of Applied Sciences and Åbo Akademi University, Ekenäs, Finland, Jonna.Engstrom-Ost@novia.fi
Vehmaa, A., Novia University of Applied Sciences and Åbo Akademi University, Ekenäs, Finland, Anu.Vehmaa@novia.fi
El-Shehawy, R., Stockholm University, Stockholm, Sweden, rehab@ecology.su.se
De Stasio, B., Lawrence University, Appleton, USA, bart.t.destasio@lawrence.edu
Gorokhova, E., Stockholm University, Stockholm, Sweden, elenag@ecology.su.se

INDUCTION OF TOXIN PRODUCTION IN *NODULARIA SPUMIGENA*, A BLOOM FORMING CYANOBACTERIA

As diazotrophic and toxic primary producers, cyanobacteria are important in biogeochemical cycles and food web interactions that involve microorganisms, algae and grazers. The filamentous cyanobacterium *Nodularia spumigena*, which produces the hepatotoxin nodularin, frequently dominates cyanobacteria blooms in the Baltic Sea. Abiotic factors have been shown to influence toxin production, as well as the cyanobacterial growth. However, effects of biological factors are much less understood, and the ecological function for nodularin is still unknown. In experiments with mixed microorganisms, algae and mesozooplankton grazers, we investigate how the biological interactions influence nodularin production in *N. spumigena*. To do so, we assay changes in both intra- and extracellular toxin concentrations and expression of genes involved in the nodularin production in response to changes in plankton community composition and abundance of different groups. The questions addressed are highly relevant for our understanding of cyanobacteria dynamics and toxicity as well as their food web effects.

Hogsden, K. L., University of Canterbury, Christchurch, New Zealand, kristy.hogsden@pg.canterbury.ac.nz
Harding, **J**. **S**., University of Canterbury, Christchurch, New Zealand, jon.harding@canterbury.ac.nz

SHORT & SIMPLE? FOOD WEBS IN STREAMS IMPACTED BY ACID MINE

The structure of food webs will change within stressed ecosystems. However, the likely nature of this change is not necessarily predictable. We compared food web properties in anthropogenic versus naturally acidic streams by surveying 20 streams in four stream types: 1) AMD (low pH, high metals); 2) naturally acidic (low pH, low metals); 3) naturally high metals (circum-neutral pH, high metals); and 4) circum-neutral (circum-neutral pH, low metals) streams. Basal resources (autochthonous and allochthonous) were comparable in all but naturally high metal streams where biomass was significantly reduced. Depauperate invertebrate communities and the absence of fish characterised consumer communities in AMD streams, while high metal streams also lacked fish. AMD streams had truncated food webs, with less links, and higher connectance than food webs in other streams. Based on food web properties, NMDS analysis distinguished AMD and naturally high metal streams from naturally acidic and circum-neutral streams. Overall, food web structure was substantially different in streams with anthropogenic sources of acidity and metals compared to natural sources due to significant changes in consumer diversity.

Holderman , **C**. **E**., Kootenai Tribe of Idaho, Fish and Wildlife Department, Bonners Ferry, ID, USA, Cholderman@kootenai.org
Gidley, C., Idaho Department of Fish and Game, Coeur d' Alene, ID, USA, cathy.gidley@idfg.idaho.gov

THE KOOTENAI TRIBE OF IDAHO ECOSYSTEM PROJECT: BIOLOGICAL ASSESSMENT AND RESTORATION OF A NUTRIENT-POOR LARGE RIVER

The Kootenai River is a large river located in western North America in Idaho, Montana, and British Columbia. Although moderately nutrient-poor historically, construction of river levees and a large dam have further reduced nutrient availability by separating the river from its historic floodplain and interfering with nutrient transport from upstream sources. As a result, habitat diversity, biological productivity, and other important ecological functions in the Kootenai River have suffered. Presently, important species of cultural significance to the Kootenai Tribe of Idaho are rare or endangered, including Kootenai River white sturgeon (Acipenser transmontanus), burbot (Lota lota) and several salmonid species (Oncorhynchus spp.). Starting in 2002, an annual multi-trophic level and nutrient concentration monitoring program began to determine if nutrient limitation was affecting fisheries. Based on findings of low nutrient levels, algal biomass, and aquatic insects, the Kootenai Tribe and the Idaho Department of Fish and Game initiated a large-scale nutrient addition experiment in the Kootenai River in 2005. After five years of nutrient addition, the initial responses in the algae and macroinvertebrate communities and key fish species have been positive.

Holitzki, **T**. **M**., University of Hawaii at Hilo, Hilo, USA, holitzki@hawaii.edu
MacKenzie, R. A., USDA Forest Service, Hilo, USA, rmackenzie@fs.fed.us
McDermid, K. J., University of Hawaii at Hilo, Hilo, USA, mcdermid@hawaii.edu

ENVIRONMENTAL IMPACTS OF INVASIVE POECILIID FISH ON HAWAIIAN STREAMS

Poeciliids have been identified as one of the top 100 invasive species in the world and have well-established populations (i.e., *Poecilia reticulata*, *Xiphophorus helleri*) in numerous Hawaiian streams. Despite their global prevalence, few studies have quantified their impacts on ecosystem structure and function. Fish, benthic algae and invertebrate community structure, as well as nutrient dynamics were compared among stream reaches with and without poeciliids in Hawaiian streams. Mean densities of native gobies were significantly higher in poeciliid-free streams (1.72±0.31 individuals/m2) than in poeciliid streams (0.69±0.2 individuals/m2, $p<0.05$). In these latter streams, poeciliid densities were 20x higher than native densities. Increased densities of poeciliids were thought to result in higher nitrate and particulate phosphate fluxes, invertebrate densities, and algal biomass. Although, this was only significant for algal biomass ($p<0.05$). The influence that poecilids are having to biodiversity in Hawaiian streams underscores the need to prevent future invasions and also to develop effective eradication techniques.

Hollilland, P., Stockholm University, Stockholm, Sweden, pelle@ecology.su.se
Holmborn, T., Stockholm University, Stockholm, Sweden,
Gorokhova, E., Stockholm University, Stockholm, Sweden,

ASSESSING DIET OF THE NON-INDIGENOUS PREDATORY CLADOCERAN CERCOPAGIS PENGOI USING STABLE ISOTOPES

The predatory cladoceran Cercopagis pengoi is a non-indigenous species in the Baltic Sea that has potential to compete for mesozooplankton with zooplanktivorous fish. In a coastal area of the northern Baltic proper, feeding of C. pengoi was assessed using stable 13C and 15N isotope signatures of the predator and possible prey. Feasible combinations of sources were estimated with the IsoSource mixing model. Temporal and spatial variability in isotope values were used as a further test of likelihood that potential prey groups were involved in C. pengoi nutrition. Contribution of prey was related to ambient zooplankton composition to guage selectivity. The results indicate that C. pengoi is an opportunistic generalist predator with a positive selection towards older copepodites (CIVVI) of Acartia spp. and Eurytemora affinis, which also contribute greatest to its diet. Positive selection towards podonids was also likely. By contrast, evidence for extensive feeding on microzooplankton was weak and bosminids were not found to be an important prey. As the derived diet of C. pengoi overlaps greatly with that of zooplanktivorous fish, food competition between these zooplanktivores is possible.

Holomuzki, **J**. **R**., The Ohio State University, Mansfield, OH, USA, holomuzki.3@osu.edu
Whyte, R. S., California University, California, PA, USA, whyte@calu.edu
Klarer, D. M., Ohio Department of Natural Resources/Wildlife Division, Huron, OH, USA, David.Klarer@dnr.state.oh.us

CONTROLLING INVASIVE REED: HERBICIDE COMPARISONS AND EFFECTS ON MARSH BENTHIC COMMUNITIES

Controlling *Phragmites australis*, the common reed, is a priority of many North American wetland managers because reed spread can potentially adversely affect plant diversity and wildlife habitat. Glyphosate and imazapyr herbicides (e.g., AquaNeat® and Habitat®, respectively) are commonly used to control reed, but it is unclear which is most cost-effective. We compared herbicide effectiveness and examined benthic community structure post-application in 20 x 20 m plots of reed that were either: hand-sprayed with AquaNeat® (30% solution), sprayed with Habitat® (5% solution), or left unsprayed (controls) (n = 5 plots/treatment). Emergent plant diversity (Shannon-Weaver *H'*) was significantly higher in both sprayed treatments than in controls 1-year post-spraying. However, plant *H'*,

emergent plant density, and % *Phragmites* cover were similar between both herbicide treatments. Macroinvertebrate *H'* and assemblage, and juvenile fish captures, were similar among all treatments. Even after 2 years post-spraying, both herbicides had similar effects on plant community recovery and reed control. We estimate AquaNeat® provides 3X more product/dollar than Habitat® at these commonly used dilutions.

Holtgrieve, **G**. **W**., University of Washington, Seattle, USA, gholt@uw.edu
Schindler, D. E., University of Washington, Seattle, USA, deschind@uw.edu
Branch, T. A., University of Washington, Seattle, USA,
A'Mar, Z. T., University of Washington, Seattle, USA,

SIMULTANEOUS QUANTIFICATION OF AQUATIC ECOSYSTEM METABOLISM AND REAERATION USING A BAYESIAN STATISTICAL MODEL OF OXYGEN DYNAMICS

Measuring ecosystem metabolic properties remains a fundamental challenge in ecology, because of restrictive assumptions and disparate measurements needed to estimate relevant physical and biological processes in the field. We will present a model of diel oxygen dynamics at a single station, organized in Bayesian statistical construct, and demonstrate how this model can be used to estimate key physical and biological parameters in aquatic ecosystems including gross primary production (GPP), ecosystem respiration (ER), and reaeration. The model was tested using simulated data and shown to be robust to significant errors in observation (precision) and a wide range of metabolic states. We also apply the model to field data from streams in southwestern Alaska where the annual return of spawning salmon fundamentally changes ecosystem metabolic conditions from having roughly equivalent GPP and ER to a strongly net heterotrophic state (GPP << ER). This model provides a rigorous and generalizable framework for estimating the rates of metabolic processes in aquatic ecosystems, along with their uncertainties, and incorporates prior information on model parameters based on their likelihood given the data.

Holzenthal, **R**. **W**., University of Minnesota, St. Paul, USA, holze001@umn.edu
Mendez, P. K., University of California Berkeley, Berkeley, USA, patina.mendez@berkeley.edu
Steiner, J. W., Josh Steiner Consulting, Oakland, USA, josh@eds.org

THE *TRICHOPTERA LITERATURE DATABASE*: A COLLABORATIVE BIBLIOGRAPHIC RESOURCE FOR WORLD CADDISFLY RESEARCH

Access to primary literature is essential for research in taxonomy. To improve access to bibliographic information, we established the *Trichoptera Literature Database* (http://www.trichopteralit.umn.edu), a database of over 8,000 citations of literature on Trichoptera. In addition, we provided access to almost 400 high quality PDFs of historically important, rare, or out-of-print works as well as current literature. To provide universal web access, we constructed a dynamic, custom-designed web application (PHP, Symfony framework) created to import XML from an EndNote data file. The database allows the user to search by author and year of publication, displays citations in a standard bibliographic format, and provides download links to available PDF literature. Existing bibliographies of Trichoptera literature and online access to *Zoological Record* databases were used to accumulate citations. Protocols for scanning literature, issues regarding copyright, and procedures for uploading citations and PDFs to the database are established. A collaborative framework of contributors from the community of Trichoptera workers with regional, subject, or language specialties is assisting in maintaining this resource with the goal of providing efficient access to taxonomic information.

Honick, **A**. **S**., University of Michigan, Ann Arbor, USA, ashonick@umich.edu
Costello, D. M., University of Michigan, Ann Arbor, USA, dcostel@umich.edu
Burton Jr., G. A., University of Michigan, Ann Arbor, USA, burtonal@umich.edu

IN SITU TESTING OF NICKEL CONTAMINATED SEDIMENTS: DOES DISSOLVED ORGANIC MATTER MODIFY TOXICITY?

Dissolved organic matter (DOM) can be a binding agent for metals, but binding affinities vary with each metal. The potential for DOM to bind nickel from contaminated sediment has not been well established with most experiments conducted under laboratory conditions. Two similar streams in central Michigan that vary in DOM concentration were selected for *in situ* testing of Ni contaminated sediments. Nickel-spiked sediments (210 and 1889 mg/kg dw) and controls were deployed and toxicity was monitored as invertebrate colonization, *Hyalella azteca* survival, and cotton degradation. Invertebrate abundance declined with increasing Ni concentration; high treatment approximately 0.5 x control. However, taxa richness showed no difference. There was evidence of acute toxicity of *H. azteca* in both sediment types (at sediment/water interface), but only at the beginning of the experiment. Cotton degradation suggests that increasing nickel concentrations depress microbial degradation, but this relationship depended on the stream ($p<0.01$). Nickel-spiked sediments influenced invertebrate abundance, acute toxicity, and cotton degradation, and DOM plays a minor role in the amelioration of nickel sediment contamination.

Hood, **J**. **L**., University of Waterloo, Waterloo, Canada, frozenleaf@gmail.com
Taylor, W. D., University of Waterloo, Waterloo, Canada, wdtaylor@uwaterloo.ca
Schiff, S. L., University of Waterloo, Waterloo, Canada, sschiff@uwaterloo.ca

INFLUENCE OF NH4+ AND NO3- FROM WASTEWATER EFFLUENT ON RIVERINE SUBMERSED MACROPHYTE COMMUNITIES

In this study we assess the impact of nitrogen discharged by waste water treatment plants (WWTPs) on the riverine submersed macrophyte community in the Grand R., Ontario using 15N stable isotope tracers of WWTP effluent. Macrophytes, water concentrations of NH4+, NO3- and isotopic samples of NH4+, NO3- and dN2O were collected by canoe along two 10 km reaches of river, up and downstream of two high volume WWTPs. Results clearly demonstrate the response of macrophytes to WWTP effluent with a downstream increase in biomass, an increase in tissue N storage and an enrichment effect on tissue d15N from +6‰ to about +24‰ over 5 km. Results also indicate that macrophytes use WWTP sources of NH4+ when available, rather than NO3-, and that the accumulated macrophyte biomass is one fate of WWTP derived NH4+.

Hood, **J**. **M**., University of Minnesota - Twin Cities, St. Paul, MN, USA, hoodx008@umn.edu
McNeely, C. F., Eastern Washington University, Cheney, WA, USA, fmcneely@mail.ewu.edu
Finlay, J. C., University of Minnesota - Twin Cities, St. Paul, MN, USA, jfinlay@umn.edu
Sterner, R. W., University of Minnesota - Twin Cities, St. Paul, MN, USA, stern007@umn.edu

INFLUENCE OF DIET STOICHIOMETRY ON PARTICULATE NUTRIENT RELEASE BY INVERTEBRATES.

By consuming, processing, and egesting organic matter invertebrates influence the downstream transport of both particulate organic matter and nutrients. Stoichiometric theory predicts that consumers will preferential assimilate limiting elements and release abundant elements to maintain homeostasis, yielding a positive relationship between nutrient release and diet nutrient content with a slope above unity. Thus, invertebrate activity should magnify variation in organic matter stoichiometry. In this study, we examined the relationship between diet carbon:nitrogen (C:N) ratio and egestion C:N in two omnivorous caddisflies, *Psychoglypha* and *Lepidostoma*. Caddisflies were fed six diets of either epilithon or a conditioned litter species. Egestion was measured in short-term incubations after a two-day feeding period. Egestion C:N was positively related to diet C:N but contrary to our predictions the slope of this relationship was shallow (*Lepidostoma*: 0.17; *Psychoglypha*: 0.22). For example, *Lepidostoma* fecal C:N varied little (16 to 27) in response to a wide range of diet C:N (10 to 56). Our results suggest that when caddisfly egestion contributes greatly to nutrient export, these invertebrates may dampen, instead of magnify, variation in organic matter stoichiometry.

Hooks, **T**. **L**., University of Louisiana at Monroe, Monroe, USA, trcyh1971@gmail.com
Minton, R. L., University of Louisiana at Monroe, Monroe, USA, minton@ulm.edu
Hill, A. M., University of Louisiana at Monroe, Monroe, USA, hill@ulm.edu

ABIOTIC INFLUENCES ON FRESHWATER MUSSEL COMMUNITY COMPOSITION

T.L. Hooks, R.L. Minton, and A.M. Hill, University of Louisiana at Monroe. hill@ulm.edu. We are examining how abiotic factors influence community structure (e.g. species richness and abundance) of freshwater mussels in Bayou Bartholomew (Arkansas and Louisiana, USA). Bayou Bartholomew (BB) has high habitat complexity relative to other regional lotic systems. Thus far, analyses indicate significant correlation between species richness and distance from BB's confluence with the Ouachita River. Substrate type affects species richness.

Hope, **A**. **J**., University of New Hampshire, Durham, NH, USA, amandajhope@gmail.com

McDowell, W. H., University of New Hampshire, Durham, NH, USA, bill.mcdowell@unh.edu

ECOSYSTEM PROCESSES IN A PIPED STREAM

Piped streams, or streams that run underground, are common features in urban areas and may become more prevalent in the landscape as urbanization increases. However, there is little empirical evidence to quantify how piped streams contribute to biogeochemical processes and nutrient retention. This study characterizes such processes within Pettee Brook, an urban stream that flows through several pipes under buildings, parking lots, and roads near the University of New Hampshire (Durham) campus. Ecosystem metabolism and nutrient uptake were measured at baseflow in one open and two piped reaches of the stream. Preliminary results indicate that the open reach exhibited more nutrient retention than the piped reaches. However, the piped reaches did exhibit some nutrient retention although not always. The open reach Vf was 0.004 mm/s for ammonium and 0.013 mm/s for phosphate. In instances where nutrient retention was measured in the piped reaches, Vf was 0.006 mm/s for ammonium and 0.005 mm/s for phosphate. Implications of these results and plans for additional experiments during the 2010 field season will be addressed.

Hopkins, **J**. **M**., The University of Akron, Akron, USA, jhopkins@uakron.edu

Miller, C. M., The University of Akron, Akron, USA, cmmiller@uakron.edu

Sanchez, N. P., The University of Akron, Akron, USA, ns40@uakron.edu

EXCITATION-EMISSION-MATRICES (EEM): A POTENTIAL TOOL FOR MONITORING STREAM RESTORATIONS

Fluorescence excitation-emission-matrices (EEMs) have been used to trace the dynamics and characteristics of dissolved organic carbon (DOC) in drinking water sources. EEMs can be integrated with existing tools for evaluating changes in stream ecosystem functions as a result of stream restorations. As DOC passes through aquatic ecosystems, the quantity and quality can be altered by physical, chemical, and biological processes. Thus, DOC characterizations provide an integrative measure of stream ecosystem processes. We used fluorescence EEMs to characterize and quantify DOC along an 1,800-foot channelized reach of Bath Creek (Bath Township, OH, USA) during summer 2009, just prior to a restoration that removed invasive reed canary grass (*Phalaris arundinacea*), simulated natural meander bends, and increased habitat heterogeneity in the stream channel. Prior to restoration, the DOC consisted of mostly humic substances and aromatic proteins with very little microbial by-products. By comparing EEMs pre/post restoration, we may be able to ascertain changes to stream ecosystems more rapidly than when relying on other integrative measures, such as shifts in macroinvertebrate or fish assemblages.

Hopper, **J**. **D**., University of Alabama, Tuscaloosa, USA, jdhopper@crimson.ua.edu

Huryn, A. D., University of Alabama, Tuscaloosa, USA, huryn@bama.ua.edu

A NEW, NON-DESTRUCTIVE SAMPLING TRAP FOR BURROWING CRAYFISH.

Sampling of burrowing crayfish is a difficult and tedious task that usually results in the destruction of habitat. As a consequence, a number of burrowing crayfish traps have been devised over the last few decades. Though many of these traps can be successful, most provide inconsistent results or are potentially destructive to the crayfish burrow. In order to conduct long term studies a new method was needed to non-destructively sample burrows. We describe a new trap design that is based on a reversed pitfall trap. In essence, a covered bucket with a hole in its bottom is placed over the chimney of a crayfish burrow and a funnel is placed within the chimney opening. Crayfish emerging from the burrow fall from the funnel and are trapped within the cover bucket. Preliminary tests have shown that this new trap is more effective in capturing burrowing individuals of *Cambarus diogenes* than other published trap designs. During April 2010 we plan further intensive tests based on two populations of the primary burrowing crayfish species *Fallicambarus danielae* and *Hobbseus prominens* in western Alabama.

Hornbach, **D**. **J**., Macalester College, Dept. Environmental Studies, St. Paul, USA, hornbach@macalester.edu

Hove, M. C., University of Minnesota, Dept. of Fisheries, Wildlife, and Conservation Biology, St. Paul, USA, mark_hove@umn.edu

MacGregor, K. R., Macalester College, Dept. Geology, St. Paul, USA, macgregor@macalester.edu

Colehour, A. M., Macalester College, Dept. Biology, St. Paul, USA, alese.colehour@gmail.com

TEMPERATURE REFUGIA FOR MUSSELS IN RIVERS? BURROW DEEPER.

Freshwater mussels are subjected to both natural and human-made variation in water temperatures. Temperature extremes can influence important metabolic processes including filter feeding. We examined river water and substrate temperatures at three sites with extensive mussel populations: 3 and 7 km below a hydroelectric dam and 15 km upstream of the dam (above the reservoir). IBTag temperature sensors were embedded at 0, 5, 10, and 20 cm depth in the sediment to collect hourly data from June-October 2009. We examined the impact of location relative to the dam and depth in the sediment on temperature when adjusted for water discharge and air temperature. At high discharges, there was a weak relationship between air temperature and sediment temperature, regardless of depth in the sediment. At low discharges, air temperature had a stronger relationship with sediment temperature but was dampened with an increase depth in the sediment. This suggests that temperature changes are buffered by increased depth in the sediment. Mussels that burrow to depths of 10-20 cm may escape the extremes of water temperature variation, especially below the hydroelectric dam.

Hornberger, **M**. **I**., U.S. Geological Survey, Menlo Park, USA, mhornber@usgs.gov

Croteau, M. N., U.S. Geological Survey, Menlo Park, USA,

Cain, D. J., U.S. Geological Survey, Menlo Park, USA,

Luoma, S. N., U.C. Davis John Muir Institute of the Environment, Davis, USA,

BIODYNAMIC MODELING ELUCIDATES MECHANISMS UNDERLYING SPEICES-SPECIFIC CU BIOACCUMULATION IN TWO CADDISFLIES

Two genera of hydropsychid caddisflies (*Hydropsyche* sp., and *Arctopsyche* sp., O: Trichoptera) helped identify spatial and temporal trends of Cu bioavailability in a mine-impacted river. Both are filter-feeders, relatively sessile and inhabit riffle environments, yet where they co-occur, *Arctopsyche* accumulates ~30-40% less Cu than *Hydropsyche*. The difference may be explained by physiological processes affecting uptake and loss of Cu from water and food and or environmental variables like food quality. We conducted laboratory studies coupled with biodynamic modeling to compare Cu kinetics via dissolved and dietary exposures in these taxa. Uptake and loss kinetics were similar in both taxa, eliminating physiology as a cause for different bioaccumulation patterns. Dietary influx accounted for ~70% of accumulated Cu in both taxa. Given that physiological processes controlling Cu bioaccumulation are comparable in both species, and that diet is the dominant route of exposure, then within-site differences in the bioavailability of dietary Cu is the most probable factor controlling the species-specific Cu bioaccumulation patterns observed in the field.

Hotchkiss, **E**. **R**., Program in Ecology, Department of Zoology & Physiology, University of Wyoming, Laramie, USA, ehotchki@uwyo.edu

Hall, R. O., Department of Zoology & Physiology, University of Wyoming, Laramie, USA, bhall@uwyo.edu

MODELING DRIVERS OF DISSOLVED ORGANIC CARBON PRODUCTION, UPTAKE, AND AVAILABILITY IN STREAMS

Dissolved organic carbon (DOC) is a major downstream carbon flux in streams and rivers and an essential resource for heterotrophic microbes. Changes in DOC availability over diel cycles may alter diel ecosystem respiration rates and, consequently, rates of CO_2 evasion into the atmosphere. To understand how changes in light, temperature, and ecosystem metabolism may interact to alter DOC availability throughout 24-hour cycles, we modeled diel DOC availability as a function of algal DOC exudation, heterotrophic DOC uptake, and photo-breakdown of DOC molecules. We updated the preliminary model using DOC transformation rates from the literature, data from ^{13}C tracer studies, and diel rates of photosynthesis and respiration in two open-canopy streams. The contribution of algal exudation to the labile DOC pool is difficult to measure *in situ*, but drove DOC availability, with highest labile and total DOC concentrations in late afternoon (and lowest in early morning). This dynamic DOC model, linked with diel fluxes in DOC production and uptake, can elucidate the relative importance of different biological and physical controls on DOC availability and shape future questions in carbon cycling research.

Houghton, **D**. **C**., Hillsdale College, Hillsdale, USA, david.houghton@hillsdale.edu

PHYSICAL, CHEMICAL, AND BIOLOGICAL CHANGES ALONG THE CONTINUUM OF AN AGRICULTURAL STREAM: INFLUENCE OF A SMALL TERRESTRIAL PRESERVE

This study quantified physicochemical and biological changes along an agricultural stream above, within, and below a small forested preserve. Due to the agricultural landscape, the habitat upstream of all sites was >60% disturbed. The percentage of undisturbed riparian habitat, however, was much higher adjacent to sites within the preserve. All physicochemical factors were unchanged between sites except for a decrease in water temperature and an increase in dissolved oxygen within the preserve. Biological diversity of adult caddisflies was significantly higher within the preserve. Pollution tolerance and percentage of filtering collector metrics were unchanged between sites. The percentage of shredders increased significantly within the preserve, but remained low relative to that of pollution-tolerant filtering collectors. These results suggest that small terrestrial preserves can protect a significant amount of aquatic biological diversity, even without corresponding changes in water quality or trophic composition. Metrics must be chosen carefully when monitoring agricultural streams, however, because they are fundamentally different than undisturbed streams.

Houser, **J**. **N**., USGS Upper Midwest Environmental Sciences Center, La Crosse, USA, jhouser@usgs.gov
Bartsch, L. A., USGS Upper Midwest Environmental Sciences Center, La Crosse, USA, lbartsch@usgs.gov
Richardson, W. B., USGS Upper Midwest Environmental Sciences Center, La Crosse, USA, wrichardson@usgs.gov
Knights, B. C., USGS Upper Midwest Environmental Sciences Center, La Crosse, USA, bknights@usgs.gov
Sullivan, J. F., Wisconsin Department of Natural Resources, La Crosse, USA, John.Sullivan@wisconsin.gov

ECOSYSTEM METABOLISM AND NUTRIENT CONCENTRATIONS IN THE UPPER MISSISSIPPI RIVER: EFFECTS OF CONNECTION TO THE MAIN CHANNEL AND VEGETATION ABUNDANCE

Large floodplain rivers consist of diverse aquatic areas that range from lotic channels to lentic backwaters. Backwater areas vary in hydraulic connectivity to the main channel and aquatic macrophyte abundance. We investigated effects of connectivity and macrophyte abundance on nutrient concentrations, water column (light/dark bottles) and ecosystem (continuous dissolved oxygen measurements) metabolism in the main channel (MC) and four backwaters (BW) of the Upper Mississippi River (UMR). Summer nutrient concentrations were clearly affected by connectivity to the MC; N concentrations were higher and P concentrations were lower in the MC and more connected BW compared to the less connected BW. However, nutrients and connectivity to the main channel were not significant correlates of water column or ecosystem gross primary production (GPP). Rather chlorophyll concentrations, light climate, and the abundance of submersed vegetation explained substantial variability in water column GPP among sites. The contribution of the water column to ecosystem GPP was much greater in the MC, where water column and ecosystem GPP were similar, than in BW where water column GPP was a small portion of ecosystem GPP.

Howe, C., Christian-Albrechts-Universität, Kiel, Germany, christian.howe@gmx.de
Zimmer, **M**., IFM-GEOMAR, Kiel, Germany, mzimmer@ifm-geomar.de

DO BACTERIAL SURFACE BIOFIOLMS AFFECT COLONIZATION OF SUBMERGED WOOD BY THE SHIPWORM *TEREDO NAVALIS*?

Wooden constructions in the marine environment are colonized by numerous organisms. Prokaryotic biofilms start being formed within minutes upon submersion in seawater, whereas settlement of invertebrate animals happens within the range of weeks to years. The shipworm *Teredo navalis* not just settles on the surface but penetrates into the wood, reducing its stability and resistance against mechanical forces, and thus, causing damage to man-made wooden structures. While it is known that some wood types are less susceptible than others, underlying reasons remain rather unclear. We present results of a monitoring of wooden constructions in the Western Baltic Sea, Germany, for (1) the presence of *Teredo navalis*, and (2) wood characteristics that correlate with *Teredo* presence and density. Current results indicate that neither chemical nor mechanical surface characteristics of the wood explain the susceptibility to *Teredo* infestation, whereas the presence of *Teredo* highly correlates with microbiological parameters of the wood surface.

Howell, **E**. **T**., Ontario Ministry of the Environment, Toronto, Canada, todd.howell@ontario.ca

ENVIRONMENTAL RECONNAISSANCE OF THE COASTAL WATERS OF LAKE ONTARIO

The human footprint on Lake Ontario and ongoing ecological change contribute to the challenge of interpreting the coastal environment. During 2008 nearshore surveys and remote data collection coordinated with tributary monitoring were used to examine water quality over coastline of representative land use features. Biological surveys of the lakebed provided context for hypothesized changes in P cycling due to dreissenid mussels. Sharp gradients in water quality were observed from the shoreline to the open lake. Total phosphorus concentrations were generally low in the nearshore but often elevated at the shoreline, tributary mixing areas and some outfalls. Impacts of tributary discharge on the nearshore varied widely with discharge volume and lake circulation. Land-to-offshore gradients in total phosphorus differed among areas suggesting that regional differences in nutrient supply existed. The nearshore lakebed was extensively colonized by dreissenid mussels and overgrown by algae. Obvious effects of mussel filtration on patterns of water clarity or levels of particulate materials were not observed. Wide variability in levels of particulates and nutrients in the nearshore were observed driven by combinations of upwelling, shoreline-lakebed disturbance, runoff and whiting.

Hoyer, **S**. **A**., Colorado State University, Fort Collins, USA, shoyer1980@gmail.com
Myrick, C. A., Colorado State University, Fort Collins, USA, Chris.Myrick@colostate.edu

EVALUATION OF THE RESPONSE OF NEW ZEALAND MUDSNAILS TO COPPER-BASED COMPOUNDS AT VARIOUS WATER TEMPERATURE AND HARDNESS LEVELS

We tested the ability of copper sheet, copper mesh, ablative anti-fouling paint, and non-ablative anti-fouling paint to limit the movements of the invasive New Zealand mudsnail (Potamopyrgus antipodarum) across a range of temperatures (8, 12, 18, and 24° C) and water hardness levels (75, 125, 175, and 300 mg/L as CaCO3). We found that total distance traveled on each surface type did not vary significantly (p-value > 0.05) with water temperature. However, both maximum and mean crawling velocities showed a significant increase with temperature with the greatest velocities found in the 18° C treatment group. Total distance traveled on a substrate along with maximum and mean velocity was found to be significantly greater (p-value < 0.05) in the two lowest water hardness treatments, indicating that increased Ca2+ concentrations did not buffer the effects of copper. Finally, in both the temperature and water hardness experiments, distance traveled and crawling velocity were found to be greatest on the non-ablative anti-fouling paint compared to the other three treatments indicating this substrate has limited potential to function as a barrier to mudsnails.

Hoyle, **G**. **M**., Kootenai Tribe of Idaho, Bonners Ferry, USA, genhoyle@kootenai.org
Holderman, C., Kootenai Tribe of Idaho, Bonners Ferry, USA, cholderman@kootenai.org
Anders, P. J., Cramer Fish Sciences, Moscow, USA, anders@fishsciences.net
Shafii, B., University of Idaho, Moscow, USA, bshafii@uidaho.edu
Ashley, K. I., British Columbia Institute of Technology, Burnaby, Canada, ken.ashley@shaw.ca

FINE-SCALE EVALUATION OF A NUTRIENT ADDITION EXPERIMENT IN THE KOOTENAI RIVER, IDAHO: STATISTICAL ANALYSIS AND ECOLOGICAL IMPLICATIONS

The Kootenai River in ID, MT, and BC has undergone cultural oligotrophication during the past century following diking, channelization, wetland drainage, and upstream impoundment by Libby Dam. A multi-year whole-ecosystem nutrient enrichment experiment was performed to evaluate addition of limiting nutrients as an ecosystem restoration technique. Following three years of pre-treatment multi-trophic level bio-monitoring (2002-2005), experimental whole river nutrient additions began in ID during 2005. The river was dosed with agricultural-grade ammonium polyphosphate (10-34-0), targeting an in-river TDP concentration of 3.0 $\mu g \cdot L^{-1}$. A fine-scale monitoring program was implemented with 8 sites (two upstream reference sites, one injection site, and 5 downstream treatment sites). Nutrient additions increased nutrient availability and primary production. Weekly mean NO_3+NO_2 and TDP concentrations were not significantly different (p>0.05) between downstream monitoring sites. Atomic N:P ratios were significantly lower in treatment sites than reference sites. Total chlorophyll accrual rates ($\mu g \cdot cm^{-2} \cdot day^{-1}$) were significantly higher

in treatment sites than in reference sites. Mean algal biomass and algal cell density were significantly higher at treatment versus reference sites. Diatom representation increased following nutrient addition, whereas blue-green algae representation decreased with nutrient addition.

Hrycik, **J. M.**, Department of Oceanography, Dalhousie University, Halifax, Canada, janelle.hrycik@dal.ca

Chassé, J., Fisheries and Oceans Canada, Dartmouth, Canada, Joel.Chasse@dfo-mpo.gc.ca

Taggart, C. T., Department of Oceanography, Dalhousie University, Halifax, Canada, chris.taggart@dal.ca

Ruddick, B. R., Department of Oceanography, Dalhousie University, Halifax, Canada, barry.ruddick@dal.ca

POPULATION CONNECTIVITY AND DISPERSAL IN THE NORTHUMBERLAND STRAIT, CANADA

Estimates of Lagrangian connectivity were measured at the scale of dispersing early-stage planktonic organisms through the use of magnetically attractive particles (MAPs) and a moored magnetic collector array. Collectors were moored within predicted dispersal domains (nominally 2–4 x 10^3 km^2) and putative "sink" locations based on an empirically-driven, 200-m and 2-km resolution, 3D hydrodynamic model. At the source location, ~10^9 MAPs of size and buoyancy designed to mimic planktonic organisms were released. The MAPs then dispersed over time (nominally 5–7 d) and the numbers of MAPs captured by each collector were used to estimate the relative probability of physically-driven Lagrangian exchange within the dispersal domain. These measures of dispersion and exchange provide the biological null model that is used to validate the hydrodynamic model (real-time conditions) by comparing the time integral of the model-particle concentrations at each of the collector locations (expected) against the MAP abundance at each collector in the field (observed). Deviations between the expected and observed are used to assess the purely passive component of biological connectivity as well as model parameters.

Huang, **J.**, University of Illinois at Urbana-Champaign, Champaign-Urbana, USA, huang98@uiuc.edu

Cao, Y., Illinois Natural History Survey, Champaign, USA, yongcao@uiuc.edu

ASSESSING SAMPLING SUFFICIENCY OF STREAM MUSSEL SURVEYS IN ILLINOIS

Freshwater mussels are the most imperiled taxonomic group in North America. Effective conservation requires reliable sampling data. However, field protocols have not been well developed and tested. In the present study, we evaluate the sufficiency of time-based sampling in Illinois wadeable streams. We intensively sampled 14 sites which differed widely in watershed size and substrate composition. At each site, we conducted a 16 man-hour hand search and measured a range of habitat characteristics (e.g., water depth, channel width, and substrate types). The number of species recorded at a site varied between 5 and 14 with 27-942 individuals collected. Statistical estimations yielded 1-3 more species per site. A four man-hour search, a commonly used effort, captured =80% of the estimated species richness at only 36% of the sites. Twelve man-hours were needed to capture =80% of the species at all sites. We further examined what watershed and habitat variables may affect sampling sufficiency using correlation analysis and regression analysis. Our findings should provide a general guide for mussel sampling in wadeable streams in Illinois and potentially in the Midwest.

Huebner, **J. D.**, University of Winnipeg, Winnipeg, Canada, j.huebner@uwinnipeg.ca

Huebner, E., University of Manitoba, Winnipeg, Canada, ehuebnr@cc.umanitoba.ca

Wiegand, M. D., University of Winnipeg, Winnipeg, Canada, m.wiegand@uwinnipeg.ca

Palitsky, D. J., University of Winnipeg, Winnipeg, Canada, danielpalitsky@gmail.com

Young, D. L., University of Winnipeg, Winnipeg, Canada, d.young@uwinnipeg.ca

Loadman, N. L., University of Winnipeg, Winnipeg, Canada, n.loadman@uwinnipeg.ca

A DETAILED EXAMINATION OF THE HISTOLOGY OF *DAPHNIA MAGNA*

Daphnia are widely used in environmental and toxicological studies. Past studies have relied largely on population and behavioral data. More recently, physiological responses have been examined and the genome of *Daphnia pulex* is now available for molecular and genetic research. Few studies have examined the histology of *Daphnia*. Previous scanning electron microscopy studies have looked primarily at responses to predation pressure. There are a small number of transmission electron microscopy studies of specific organs such as the heart. There are, however, no detailed light microscopic studies of the histology of *Daphnia*. We present a thorough investigation of the histology of normal *Daphnia magna* which will be useful for observing microanatomical responses to environmental changes related to climate change or exposure to contaminants. For this study, *Daphnia magna* were fixed in Karnovsky's fixative, post-fixed in 1% OsO4, dehydrated in ethanol and embedded in epon-araldite. 1.5 micron sections were cut using a JB4 microtome, stained with toluidine blue and examined with light microscopy. Several complete animals were serial sectioned so that all organs could be observed in detail.

Hughes, **J. M.**, Griffith University, Brisbane, Australia, jane.hughes@griffith.edu.au

Huey, J. A., Griffith University, Brisbane, Australia, J.Huey@griffith.edu.au

Marshall, J., Department of Environment and Resource Management, Brisbane, Australia, marshallj@derm.qld.gov.au

Real, K., Griffith university, Brisbane, Australia, K.Real@griffith.edu.au

Schmidt, D., Griffith University, Brisbane, Australia, D.Schmidt@griffith.edu.au

CAN EFFECTIVE POPULATION SIZE (NE) BE USED TO MONITOR POPULATION HEALTH?

Genetic diversity is important for short-term and long-term survival of populations and maintenance of genetic diversity is therefore an important goal of conservation management. Effective size of a population (Ne) is often significantly smaller than the actual population size, because all individuals do not contribute randomly to subsequent generations, sex ratios are unequal or the population fluctuates through time. Genetic diversity is lost from a population due to random processes at a rate that is dependant on Ne. Thus Ne can potentially be used to predict the rate at which a population will lose diversity through drift and also the future health of the population. In this paper we present data for a small freshwater fish, Mogurnda adspersa, in three river systems in central Queensland Australia. We use a range of recently developed statistical approaches for estimating Ne, using 13 microsatellite loci in 10 populations. We discuss the usefulness of each of the methods and the potential for using this measure to monitor the impacts of various management strategies on population health.

Hunt, **C. D.**, Battelle, Duxbury, USA, Huntc@Battelle.org

Nelson, H., Fluid Imaging Technologies, Yarmouth, USA, harry@fluidimaging.com

Michelin, D. M., Battelle, Duxbury, USA, michelind@battelle.org

Curran, P., Battelle, Duxbury, USA, curranp@battelle.org

Neal, M., Battelle, Columbus, USA, nealm@battelle.org

Chitwood, C., Battelle, Columbus, USA, chitwoodc@battelle

Sieracki, C. K., Fluid Imaging Technologies, Yarmouth, USA, chris@fluidimaging.com

IN SITU CHARACTERIZATION OF PHYTOPLANKTON COMMUNITIES USING A NOVEL SUBMERSIBLE IMAGING FLOW CYTOMETER - FLOWCAM

The study of plankton dynamics is limited by a lack of data at the appropriate temporal and spatial scales. This is in part due to the lack of robust, sensitive in situ tools that can continuously characterize plankton communities, forcing researchers to depend on limited data measured by labor intensive laboratory methods or reliance on surrogate parameters. Research and monitoring in ocean and coastal regions and water supply reservoirs would also benefit from an ability to quantify and characterize plankton on a continuous, real-time basis, and at higher spatial resolution. To address these measurement needs, we have adapted a well established, commercially available digital imaging flow cytometer, the Fluid Imaging Technologies' FlowCAM®, for in situ deployment. The new Submersible FlowCAM model retains the capabilities of the popular FlowCAM instrument and can operate autonomously at depths to 200 meters under user controlled operations. The unit characterizes the morphology, chlorophyll, and forward scatter of 20µm to 300µm particles. It takes an image of every analyzed particle for further analysis and cell identification by the user using image recognition algorithms. While the submersible FlowCAM is primarily designed for deployment on moorings/buoys, it can also be operated in a profiling mode and adapted for deployment on AUVs. This presentation describes this new instrument, presenting in situ data from profiling and time-series deployments.

Hunt, **S**. **W**., Michigan State University, East Lansing, USA, huntseth@msu.edu
Miller, S. A., Michigan State University, East Lansing, USA, mill1571@msu.edu
Stevenson, R. J., Michigan State University, East Lansing, USA, rjstev@msu.edu

NUTRIENTS IN SURFACE SEDIMENTS OF STREAMS CORRELATE WITH DISSOLVED OXYGEN IN SURFACE WATER

Benthic communities associated with surface sediments of lotic environments have been shown to be important in the metabolic transformation of materials in the water column. While the effect of nutrients within the water column on this metabolic functioning has been well studied, less attention has been paid to available nutrients entrained within surface sediments. We hypothesized that available nutrients in sediments contribute more to stream metabolic processes and would be stronger drivers of stream dissolved gas components than water column nutrients. Water and sediment samples were collected from twenty-three different sites along two low order rivers in south central Michigan every few days during the summer of 2006. Water samples were analyzed for several different nutrient parameters, while sediments were analyzed for bioavailable P and exchangeable N. Regression analysis showed exchangeable NH4+ and bioavailable P in sediments were important predictors of DO, while water column nutrient measures were only marginally significant. Our results suggest that available nutrients in sediments may be critical to lotic processing and highlight the importance of benthic process in water quality regulation in low gradient streams.

Hunting, **E**. **R**., University of Amsterdam, Amsterdam, Netherlands, e.r.hunting@uva.nl
Van der Grinten, E., National Institute for Public Health and the Environment (RIVM, Bilthoven, Netherlands,
Mulder, C., National Institute for Public Health and the Environment (RIVM, Bilthoven, Netherlands,
van der Geest, H. G., University of Amsterdam, Amsterdam, Netherlands,
Kraak, M. H., University of Amsterdam, Amsterdam, Netherlands,
Breure, A. M., National Institute for Public Health and the Environment (RIVM, Bilthoven, Netherlands,
Admiraal, W., University of Amsterdam, Amsterdam, Netherlands,

LINKING AQUATIC INVERTEBRATES TO DETRITUS PROCESSING AND BIOGEOCHEMICAL DYNAMICS: BACTERIAL FACILITATION, FUNCTIONAL FEEDING GROUPS AND ECOSYSTEM STABILITY

Increasing evidence that loss of biodiversity affects ecosystem functioning has generated a renewed interest in the importance of biodiversity to ecosystem performance. The present study unites detritivorous invertebrate species and detritus degrading microbes. These two groups of organisms are known to be vitally linked through the repetitive digestion of detritus particles and therefore fauna and microbes act strongly facilitating and interdependent. Selective feeding may structure microbial assemblages and faunal presence may indirectly promote microbial activity by adding nutrients due to partial degradation of organic matter. Ecosystem functioning is linked with functional diversity rather than species diversity, yet the assumption of functional similarity between different species may be unrealistic, as functional attributes (e.g. food-preference, bioturbation) of many individual invertebrate species remain poorly understood and the influence of fauna on microbial dynamics and inherent decomposition rates remains shrouded in mist. This study shows that effect traits of invertebrate species with different functional guilds steer microbial assemblages and functional responses in biogeochemical dynamics and detritus processing.

Huntsman, **B**. **M**., University of Alabama, Tuscaloosa, USA, brockhunts@gmail.com
Venarsky, M. P., University of Alabama, Tuscaloosa, USA,
Benstead, J. P., University of Alabama, Tuscaloosa, USA,

RELATING CARRION BREAKDOWN RATES TO RESOURCE LEVEL AND FOOD WEB STRUCTURE IN CAVE STREAM ECOSYSTEMS

Cave ecosystems are largely dependent on allochthonous resources for trophic support. However, caves vary greatly in the quantity and quality of detrital resources they receive, potentially affecting cave consumer biomass and the rate at which detrital inputs are utilized. We tested two alternative hypotheses about the role of ambient resource level and cave food web structure on detrital processing rate. Systems with relatively low resource levels may support communities more efficient at locating and utilizing high-quality carrion. Alternatively, systems with high resource levels support higher consumer biomass, driving higher carrion processing rates. To test these hypotheses, standing crop organic matter (OM) and breakdown rates (k) for mouse carrion were estimated in four cave streams in north Alabama and south Tennessee, U.S. Although no significant difference in k-values existed among cave systems, a significant positive trend was found between k-values and standing crop OM (range in k-values 0.024-0.046), supporting our second hypothesis. Higher carrion breakdown in caves with higher resource levels was likely driven by higher consumer biomass, underscoring the pervasive bottom-up limitation of cave food-web structure.

Huryn, **A**. **D**., University of Alabama, Tuscaloosa, USA, huryn@bama.ua.edu
Benstead, J. P., University of Alabama, University of Alabama, USA, jbenstead@bama.ua,.edu
Ramsey, J. B., University of Alabama, University of Alabama, USA, jb.ramsey@gmail.com

ANNUAL CYCLES OF LIGHT AVAILABILITY DRIVE PATTERNS OF COMMUNITY RESPIRATION IN AN ARCTIC SPRING STREAM (NORTH SLOPE, ALASKA)

We investigated the productivity of a perennial, Arctic spring-stream. Ivishak Spring has the stable discharge (~131 L/s) and temperature (~4-8°C) typical for springs. It is unusual, however, in having an annual cycle of daylight from 24 hrs/d (summer) to 0 hrs/d (winter). We tested the hypothesis that stored detritus would buffer carbon limitation during winter when gross primary production (GPP) is minimized, resulting in constant rates of community respiration (CR) year-round due to constant temperatures. We used open-channel methods to measure GPP and CR monthly from March 2007 to August 2009. Mean annual GPP was 458 gC/m^2. Such a level is typical for temperate desert-streams but was surprising for an Arctic stream. Annual CR (887 gC/m^2) was also remarkable. The high metabolism of this stream is explained by an open canopy, moderate year-round temperatures, stable bed, and high bryophyte biomass (48 $gAFDM/m^2$). Strong seasonal cycles of GPP were mirrored by CR (r=0.65) indicating the possibility of carbon limitation during winter. This result falsified our hypothesis that CR would be relatively stable year-round due to a detritus buffer and constant temperature.

Hyman, **A**. **A**., Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT, USA, amanda.hyman@msu.montana.edu
Kurt-Mason, S., Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT, USA, seth_kurt_mason@hotmail.com
Poole, G. C., Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT, USA, gpoole@montana.edu

EFFECTS OF INTENSIVE STREAM RESTORATION ON STREAMBED METABOLISM: A BEFORE-AND-AFTER APPROACH

Silver Bow Creek, Montana, is undergoing remediation for past contamination by mine tailings and provides an excellent opportunity to investigate the effects of channel restoration on streambed metabolism. Restoration efforts include replacing the streambed and floodplain surface deposits with clean sediments, followed by reconstruction of a meandering channel. We are using reaeration rates derived from tracer releases (NaBr and SF6) combined with open-channel measures of diurnal dissolved oxygen concentrations to document differences in metabolism prior to, one week following, and one year following restoration actions. We predict that these restoration actions will ultimately increase total floodplain streambed metabolism due to increased channel area, but that loss of fine-scale habitat variation and associated metabolic "hot-spots" will yield reductions in mean per unit area respiration rates. Results from our research will document recovery of streambed metabolism after intensive restoration. Such studies concerning metabolism are highly consequential; streambed metabolism is an indicator of stream's potential for storing and processing solutes including nutrients, dissolved carbon, and bio-reactive pollutants.

Ibelings, **B**. **W**., Netherlands Institute of Ecology, Nieuwersluis, Netherlands, b.ibelings@nioo.knaw.nl
Pomati, F., Eawag, Kastanienbaum, Switzerland, francesco.pomati@eawag.ch
Matthews, B., Eawag, Kastanienbaum, Switzerland, blake.matthews@eawag.ch

REGIME SHIFTS IN PLANKTON COMMUNITY ASSEMBLY: LONG TERM DATA FROM LAKE ZURICH, SWITZERLAND

With the aim of understanding algal blooms in a changing world, we have designed a lake monitoring platform for the characterisation of algal cells (scanning flow-cytometry coupled with image analysis), augmented with measurements of the physical environment. This cutting-edge technology for deep lake profiling is producing automated, high frequency monitoring data enabling us to study the relationship between phytoplankton community assembly and ecosystem change. We classify phytoplankton into morphology based functional groups to produce ecologically relevant categories, which we use in the modelling and prediction of algal dynamics. Data from Lake Zurich spring blooms are presented. We also investigate the relationship between environmental change and plankton community structure in a 36 years time-series from Lake Zurich. We detected a regime shift in the lake in 1996, linked to a change towards a warmer, more oligotrophic environment. The regime shift was associated with a corresponding abrupt increase in plankton diversity and a shift in plankton community assembly towards higher levels of species co-occurrence. Community assembly was significantly different from a random null model in which all species or functional groups are deemed neutral. High frequency monitoring data from the multisensor platform (employed in lakes Lugano and IJsselmeer) will afford precious insight into phytoplankton community assembly and its drivers on a day-to-day basis.

Imberger, **S**. **J**., Monash University, Clayton, Australia, samantha.imberger@sci.monash.edu.au

Thompson, R. M., Monash University, Clayton, Australia, ross.thompson@sci.monash.edu.au

Grace, M. R., Monash University, Clayton, Australia, mike.grace@sci.monash.edu.au

A QUESTION OF SCALE: THE EFFECTS OF URBANISATION AND RIPARIAN VEGETATION ON COARSE PARTICULATE ORGANIC MATTER TRANSPORT AND STANDING STOCKS

Urbanisation severely impacts stream structure including hydrology, biotic integrity and water quality. However, the effects of urbanisation and coupled riparian restoration on organic matter processing are poorly understood. Organic matter represents a vital heterotrophic energy pathway in aquatic ecosystems and its availability has implications for energy transfer through microbial communities and higher trophic levels. This study investigated the effects of both urbanisation and riparian cover on coarse particulate organic matter (CPOM) retention in 6 streams located along an urban gradient (including 4 paired 'open'/'closed' canopied reaches). Retention was assessed via replicate releases of *Eucalyptus* leaves where retention distance, mechanism and habitat unit were recorded. Coarse benthic organic matter (CBOM) standing stocks and wood volume were also measured via cores and direct count respectively. Additional correlates including stream discharge, velocity, depth and width were also assessed. Preliminary results indicate a significant negative correlation between CBOM standing stocks and urbanisation. It is anticipated the findings of this research will ultimately allow more targeted management actions to both protect the ecological integrity of streams vulnerable to urbanisation and restore those already affected.

Irmscher, **P**., University of Oklahoma/Oklahoma Biological Survey, Norman, OK, USA, Pascal.Irmscher-1@ou.edu

Vaughn, C. C., University of Oklahoma/Oklahoma Biological Survey, Norman, OK, USA, cvaugn@ou.edu

SIMULATING UNIONID DRIFT DISPERSAL USING FLUORESCENT DYE

Flow is the distinguishing characteristic of natural lotic systems. The constant movement of water creates hydraulic forces that act on any organism living in this environment. Immobile animals are especially vulnerable to dislodgement and subsequent downstream displacement. However, flow may also facilitate dispersal. To identify the effects of flow, we used native freshwater mussels (Bivalvia: Unionidae) as model organisms to investigate drift distances and rates. We simulated juvenile dispersal by adding fluorescent dye to a natural stream to quantify its spread. Spatial overlap of dye plumes with the boundaries of an existent mussel bed was recorded by aerial photography and analyzed using GIS. Our results support the hypothesis that flow determines the dispersal of juvenile and ultimately, the distribution of adult mussels. Additional trials are planned for the summer of 2010.

Netto, I., Ryerson University, Toronto, Canada, isabelle.netto@ryerson.ca

Vadim Bostan, Ryerson University, Toronto, Canada, vbostan@ryerson.ca

McCarthy, L. H., Ryerson University, Toronto, Canada,

Laursen, A. Ryerson University, Toronto, Canada,

EXAMINING ACUTE BEHAVIOURAL RESPONSES OF THE PROTIST *EUGLENA GRACILIS* UNDER TOXICANT STRESS USING AUTOMATED IMAGE ANALYSIS

Short term impacts of Atrazine (herbicide) and Tributyltin (organometal) on the swimming behaviour of the flagellate *Euglena gracilis* were determined as part of a larger project looking at the use of acute behavioural responses as early warning indicators of water quality. Cells were incubated in contaminant-containing solution for a 5 minute period, and responses were measured during the 6th minute. A 20% increase in the number of cells swimming up was detected at 60µg/L of Atrazine, while at 210µg/L it was found to increase swimming velocity by 16%. Tributyltin produced a 16% increase in cells swimming up at 12µg/L and a 19% increase in swimming velocity at 24µg/L. The possible use of ECOTOX image analysis software (D.-P. Häder, Real Time Computer, Möhrendorf, Germany) for early warning detection is considered. Impacts of further toxicants will be tested, namely copper, ciprofloxacin (pharmaceutical antibiotic) and PBDE (organobromine).

Islam, **M**. **S**., Beacon Institute for Rivers and Estuaries, Beacon, USA, sislam@bire.org

Bonner, J. S., Clarkson University, Potsdam, USA, jbonner@clarkson.edu

DEVELOPMENT AND FIELD-APPLICATION OF A THREE-DIMENSIONAL PARTICLE AGGREGATION AND TRANSPORT MODEL

The understanding of particle dynamics can assist in examining the processes controlling ecosystem health. Therefore, a three-dimensional particle aggregation and transport model was developed in this study using the advection-dispersion transport equation and fractal particle aggregation kinetics. The system of governing partial differential equations describing particle size dynamics in three-dimensions are discretized using a finite segment method and are resolved through fourth-order Runge-Kutta method. Simulation results indicate that model predictions agree with that of the analytical solution for transport of poly-dispersed particles in a three-dimensional water column. In addition, field-scale application of this model for Corpus Christi Bay (TX) helps to test various hypotheses in understanding particle driven processes causing hypoxia (dissolved oxygen <2 mg/l) in the south-east part of the bay. Data collected from our real-time sensor networks in the bay are used in setting the initial and hydrodynamic condition of the model. Simulation results suggest that aggregation plays a significant role in vertical transport mechanisms which has greater implications in controlling observed vertical gradient in dissolved condition including the particle residence time in the water column.

Jabiol, **J**., EcoLab; CNRS, Université de Toulouse, Toulouse, France, jabiol@cict.fr

Bruder, A., Eawag; Department of Aquatic Ecology, Dübendorf, Switzerland, Andreas.Bruder@eawag.ch

McKie, B. G., Department of Aquatic Science & Assessment, Uppsala, Sweden, brendan.mckie@vatten.slu.se

Gessner, M. O., Eawag; Department of Aquatic Ecology, Dübendorf, Switzerland, gessner@eawag.ch

Chauvet, E., EcoLab; CNRS, Université de Toulouse, Toulouse, France, echauvet@cict.fr

BIODIVERSITY EFFECTS ON LITTER BREAKDOWN IN A MULTITROPHIC CONTEXT

A major limitation of previous experiments designed to test for biodiversity effects on ecosystem processes has been their restriction to single trophic levels. We constructed simplified detrital food webs to conduct a fully crossed experiment aimed at assessing effects of species richness on leaf litter breakdown in streams when diversity is altered both within and across three trophic levels. Species richness of aquatic fungi was varied from 0 to 1 to 5 species, shredder richness from 0 to 1 to 3 species and predatory fish richness from 0 to 1 (presence/absence). Oak leaf breakdown was affected by diversity both within and across trophic levels, with the fastest leaf breakdown occurring in food webs with the highest complexity. Fungal richness increased leaf consumption by shredders, and the effect of shredder richness depended on fungal community composition. Strikingly, fish presence modified the relationships between litter breakdown and diversity at lower trophic levels. We conclude that effects on

ecosystem processes resulting from complex food-web interactions are clearly important, suggesting that biodiversity effects cannot be realistically assessed from single trophic level experiments.

Jackson, **J. K.**, Stroud Water Research Center, Avondale, USA, jkjackson@stroudcenter.org
Sweeney, B. W., Stroud Water Research Center, Avondale, USA, sweeney@stroudcenter.org
Calvo, J., Instituto Tecnológico de Costa Rica, Cartago, Costa Rica, jucalvo@itcr.ac.cr
Newbold, J. D., Stroud Water Research Center, Avondale, USA, newbold@stroudcenter.org
Kaplan, L. A., Stroud Water Research Center, Avondale, USA, lakaplan@stroudcenter.org

SEASONALITY IN THE TROPICS – AN IMPORTANT LOCAL PHENOMENON FOR STREAMS IN NORTHWESTERN COSTA RICA

We assessed seasonality in monthly precipitation and air temperature from three sites that were 12-23 km apart in the Area de Conservacion Guanacaste, and compared it to seasonality in stream discharge, riparian leaf fall, and stream macroinvertebrate densities and reproduction. Monthly precipitation ranged from slightly to strongly seasonal across these nearby sites (Seasonality Index range=11.4-19.6), and almost equaled the range of precipitation seasonality observed across the contiguous United States (range=9-16). Air temperature exhibited little seasonality. Seasonality for discharge and leaf fall was generally similar to precipitation. While we have seen little evidence of seasonality in life histories for most multivoltine stream insects, two long-lived macroinvertebrates appear to reproduce more frequently in specific seasons (e.g., the mayfly *Euthyplocia hecuba* in Jun-Oct during the wet season and the freshwater crab *Ptychophallus tumimanus* in Oct-Feb during the transition between wet and dry seasons). In addition, body size and therefore fecundity of the multivoltine mayflies *Leptohyphes zalope* and *Lephohyphes nanus* also peak in Dec-Feb during the dry season. Thus, seasonality can be a locally variable characteristic for streams in some tropical regions.

Jacobsen, **R. E.**, Unaffiliated, Denver, USA, Pahayokeensis@aol.com

DISTRIBUTIONS OF CERATOPOGONIDAE ALONG THE NUTRIENT GRADIENT IN WATER CONSERVATION AREA 2A AND IN MARSHES NEAR RETENTION PONDS IN EVERGLADES NATIONAL PARK

Everglades Ceratopogonid communities change near retention ponds and near outflows from the L-31W canal, which are potential sources of phosphorus enrichment for ENP marshes. Taxa that are otherwise rare in healthy ENP habits were abundant near these water sources. While the tolerances of chironomid midge species to nutrient enrichment are well known, no information is documented for ceratopogonid species. To obtain data on ceratopogonid species response to enrichment, we surveyed midge communities by collecting midge pupal exuviae (MPE) along the steep nutrient gradient present in Water Conservation Area 2A (WCA-2A). Our objectives were: 1) to observe overall community response, 2) note species distributions along this gradient to determine potential indicators of water quality, and 3) compare distributions of species in WCA-2A with those present in ENP near retention ponds and L-31W canal outflow. Our results indicate, when MPE are collected, Ceratopogonids can be highly informative for detecting enrichment. The abundance of species associated with highly enriched marsh sites in WCA-2A in marshes near retention ponds and canals corroborates other indicator data, suggesting these marshes may be undergoing enrichment.

Jacobson, **M.**, University of Minnesota, St. Paul, USA, funk0062@umn.edu
Cotner, J., University of Minnesota, St. Paul, USA, cotne002@umn.edu

CARBON WITHOUT OXYGEN: THE EFFECT OF DISSOLVED OXYGEN ON CARBON QUALITY IN LAKES

The dissolved oxygen concentration in freshwater ecosystems is highly sensitive to changes in human activities and climate yet, little is known about how changes in dissolved oxygen concentration influence the cycling of organic carbon. Dissolved organic carbon (DOC) is the dominant pool of organic carbon in freshwater ecosystems and the majority of this carbon is recalcitrant. This project investigated how dissolved oxygen concentration affects the formation of recalcitrant DOC. DOC was formed under anaerobic and aerobic conditions during laboratory decomposition incubations. Irradiated and non-irradiated DOC was inoculated with bacteria and bacterial respiration was measured over several days. The change in bacterial respiration between the irradiated and non-irradiated DOC from the anaerobic decompositions was consistently less than, or more negative than, the aerobic decompositions. Positive changes in bacterial respiration imply that the initial DOC is more recalcitrant. Therefore, the results from this study suggest that DOC formed under aerobic conditions is more recalcitrant than DOC formed under anaerobic conditions. This study suggests that anaerobic conditions decrease the proportion of recalcitrant DOC in freshwater ecosystems, potentially increasing carbon emissions to the atmosphere.

Janetski, **D. J.**, University of Notre Dame, Notre Dame, USA, djanetsk@nd.edu
Chaloner, D. T., University of Notre Dame, Notre Dame, USA, dchalone@nd.edu
Moerke, A. H., Lake Superior State University, Sault Ste. Marie, USA, amoerke@lssu.edu
Lamberti, G. A., University of Notre Dame, Notre Dame, USA, glambert@nd.edu

ECOSYSTEM EFFECTS OF PACIFIC SALMON SPAWNERS IN A GREAT LAKES TRIBUTARY STREAM

Large numbers of introduced Pacific salmon (*Oncorhynchus* spp.) spawn annually in Great Lakes tributaries, yet little is known about their impacts on stream ecosystems. In two Lake Michigan tributaries, we measured periphyton and macroinvertebrate biomass, as well as the diets and movement patterns of tagged stream-resident brook trout (*Salvelinus fontinalis*) before and during the salmon run. Compared to a nearby stream lacking salmon, streamwater concentrations of NH_4^+-N and SRP increased 10x and 3x, respectively, when salmon arrived, while periphyton chlorophyll a and macroinvertebrate biomass decreased by 90% and 75%, respectively. Brook trout feeding habits and movement also changed with the arrival of salmon; diets shifted from fish (95% wet mass) to salmon eggs (85%), and daily movements >200m increased two orders of magnitude. No significant changes were observed for any metrics in the non-salmon stream. These data suggest that salmon can reduce abundances at lower trophic levels and alter pathways of energy acquisition and expenditure at upper trophic levels. Intentionally introduced species, especially those capable of transporting nutrients and altering habitats, can affect multiple components of aquatic ecosystems.

Jankowski, **K. J.**, University of Washington, Seattle, USA, kathijo@u.washington.edu
Schindler, D. E., University of Washington, Seattle, USA, deschind@u.washington.edu

ASSESSING NON-POINT NITROGEN LOADING AND NITROGEN FIXATION WITH STABLE NITROGEN ISOTOPES IN LAKES

Nutrients from undisturbed watersheds are typically found at high N:P ratios, leading to persistent P limitation of primary production. Human sources of nutrients affect the nitrogen and phosphorus cycles of lakes because they have low N:P ratios, often far below the Redfield ratio, and can drive lakes to N-limited conditions. Because human-derived N is often enriched in 15N relative to watershed inputs, the δ15N in nutrient pools can be used to estimate inputs of human N to ecosystems. We show that a two-source mixing model (human and watershed sources) performs poorly in explaining the observed variation in δ15N of seston in 22 lakes across a human density gradient in western Washington (R2 = 0.48). However, by allowing a third N source (N-fixation) that is facultatively induced below a critical N:P ratio, the mixing model performs extremely well at describing the observed variation in seston δ15N among lakes (R2 = 0.75). In lakes with hypolimnetic P concentrations > 0.02 mg/L (N:P mass ratio < 21) N-fixation becomes an increasingly important component of the N cycle, accounting for > 50% of the N budget.

Jarman, **K.**, University of North Carolina-Chapel HIll, Chapel HIll, USA, jkristen@email.unc.edu
Ghobrial, S., University of North Carolina-Chapel HIll, Chapel Hill, USA, reef@email.unc.edu
McKee, B., University of North Carolina-Chapel HIll, Chapel HIll, USA, bmckee@unc.edu

CONNECTIVITY AND MARSH ACCRETION IN A COASTAL PLAIN RIVER ESTUARY

Small coastal plain river estuaries exhibit high connectivity with their associated watersheds, which makes them more sensitive to anthropogenic disturbances.

This sensitivity is compounded by the population increases expected within the coastal zone. The Newport River, a small coastal plain river in North Carolina, is in close proximity to Morehead City's industrial port, and active silviculture areas, both of which appear to have a strong impact on the estuary. Marshes in the Newport River estuary are accreting seaward while marsh retreat is well documented around the globe. Quantification of sedimentation rates within these marshes is necessary to better understand how marshes respond to accelerating sea level rise and increasing anthropogenic activity. Using aerial photography from previous studies that documented the growth history of Newport marshes, we collected cores from different marsh development stages. These cores were analyzed for Pb-210, Be-7, Cs-137 and K-40 to quantify recent marsh accretion rates, which ranged from 0.82 to 3.15 cm y-1. Factors governing marsh accretion under conditions of accelerated sea-level rise and increasing population pressure will be discussed.

Jellyman, **P**. **G**., University of Canterbury, Christchurch, New Zealand, phillip.jellyman@pg.canterbury.ac.nz

McIntosh, A. R., University of Canterbury, Christchurch, New Zealand, angus.mcintosh@canterbury.ac.nz

INDEPENDENT INFLUENCES OF HABITAT SIZE AND TERRESTRIAL SUBSIDIES ON STREAM FOOD-WEB STRUCTURE

Habitat size is likely to be a key determinant of food-web structure. The size of a habitat imposes limits on basal resource availability, and the biomass of consumers/predators a food web can support. In aquatic habitats, unstable food-web structures where more predator than consumer biomass is present are often observed, and one proposed mechanism for their persistence is the input of terrestrial subsidies. To investigate food-web structure and the role of subsidies we measured food webs in forty grassland and forested New Zealand streams. Food-web structure significantly changed across the stream size gradient for both stream types. As streams became larger, there was an increasing proportion of fish biomass relative to invertebrate biomass, in effect, larger streams were able to support more predator biomass. Forested stream food webs also supported greater fish biomass, probably due to the increased biomass of drifting terrestrial invertebrates. These results indicate reductions in stream habitat size or alterations to riparian conditions will likely change the structure of food webs, potentially resulting in stream food webs with a reduced capacity to support predatory fishes.

Jencso, **K**. **G**., Montana State University, Bozeman, USA, kelseyjencso@gmail.com

McGlynn, B. L., Montana State University, Bozeman, USA, bmcglynn@montana.edu

HILLSLOPE HYDROLOGIC CONNECTIVITY CONTROLS RIPARIAN GROUNDWATER TURNOVER: IMPLICATIONS OF LANDSCAPE STRUCTURE FOR CATCHMENT SOURCE WATER COMPOSITION

Our understanding of the spatial distribution of landscape hydrologic connectivity and how it relates to the location and character of water and solute contributions to streams is unclear. We monitored hillslope-riparian-stream (HRS) shallow groundwater connectivity and specific conductance (SC) dynamics along four HRS well transects within Tenderfoot Creek Experimental Forest (TCEF), MT. The degree of riparian SC decline (i.e. turnover) during the snowmelt hydrograph was proportional to the duration of HRS connectivity and inversely related to the riparian: hillslope area ratios (buffer ratio; r2 = 0.95). We applied this relationship to the stream network in 7 sub-catchments to better understand the spatial and temporal distribution of hydrologic contributions and riparian buffering. Riparian groundwater contributions estimated using source water separations were linearly related (r2 = 0.92) to the median catchment turnover time. Our observations suggest that the arrangement of hillslope and riparian zones along a stream network and the timing and duration of groundwater connectivity between them is a first order control on stream water composition. These findings are also an important consideration when assessing biogeochemical cycling within catchments.

Jensen, **O**. **P**., University of Washington, Seattle, USA, ojensen@u.washington.edu

FISHING FOR SCIENCE: FISHERIES AS ECOSYSTEM-SCALE EXPERIMENTS

Fishing represents one of the largest and best documented perturbations to fish populations in the world's oceans. While the ecological costs of fisheries receive most of the attention, fisheries also provide a unique opportunity to learn about the dynamics of populations, communities, and ecosystems. A new global stock assessment database is a powerful resource for testing ecological questions. We present two examples - ranging in scale from species to ecosystems. Information on population status elucidates the relationship between life history characteristics of species and their vulnerability to overfishing. In contrast with previous studies based on catch data alone, we find that longevity and age at maturity are poor predictors of vulnerability. At the ecosystem scale, changes in productivity, summed across all fished species, provide a metric of resilience/stability. Negative correlations in productivity among species result in greater stability of fish productivity for the ecosystem as a whole – a phenomenon known as the portfolio effect. However, environmental forcing can result in coherence in productivity. Meta-analysis across 19 LMEs shows them roughly evenly split between positive and negative coherence in fish productivity.

Jeong, **H**., Seoul National University, Seoul, Republic Of Korea, hjjeong@snu.ac.kr

Seong, K., Seoul National University, Seoul, Republic Of Korea,

Kang, N., Seoul National University, Seoul, Republic Of Korea,

Yoo, Y., Seoul National University, Seoul, Republic Of Korea,

Glibert, P., University of Maryland, Cambridge, USA,

FEEDING BY THE RAPHIDOPHYTES ON THE CYANOBACTERIUM *SYNECHOCOCCUS*

We investigated feeding by the raphidophytes *Chattonella ovata*, *C. subsalsa*, *Fibrocapsa japonica*, and *Heterosigma akashiwo* on the cyanobacterium *Synechococcus* sp.. Both *C. ovata* and *H. akashiwo* were able to ingest single *Synechococcus* cells. However, both TEM and video-microscopy did not show any *Synechococcus* cell inside or ingested by *F. japonica*. High resolution video-microscopy showed *C. ovata* and *H. akashiwo* engulfing a single *Synechococcus* cell captured by the mucus excreted from mucocysts. The ingestion rates of *C. ovata*, *C. subsalsa* or *H. akashiwo* on *Synechococcus* sp. increased continuously with increasing mean prey concentration. At the given prey concentration, the highest ingestion rates of the raphidophytes on *Synechococcus* were 18.6 cells raphidophyte^{-1}h^{-1} for *C. ovata*, 20.5 cells raphidophyte^{-1}h^{-1} for *C. subsalsa*, and 3.9 cells raphidophyte^{-1}h^{-1} for *H. akashiwo*. The calculated grazing coefficients attributable to *H. akashiwo* on co-occurring *Synechococcus* spp. were up to 1.24 d^{-1}. The results of the present study suggest that raphidophytes sometimes has a potentially considerable grazing impact on populations of *Synechococcus*

Jeong, **J**., Seoul National University, Seoul, Republic Of Korea, samo0797@snu.ac.kr

Kim, J., Seoul National University, Seoul, Republic Of Korea, posseidon21@snu.ac.kr

Kim, I., Seoul National University, Seoul, Republic Of Korea, ttol0731@snu.ac.kr

Kim, G., Seoul National University, Seoul, Republic Of Korea, gkim@snu.ac.kr

TRACE ELEMENT FLUXES THROUGH SUBMARINE GROUNDWATER DISCHARGE FROM A VOLCANIC ISLAND, JEJU

In order to evaluate the importance of trace element fluxes through submarine groundwater discharge (SGD) in the coastal waters off the volcanic island of Jeju, Korea, we measured trace elements in groundwater, porewater, and coastal seawater in the summer and winter of 2009. The concentrations of trace elements were determined using ICP-MS following Chelex-100 Resin extractions. The concentrations of most of the trace elements in groundwater were generally 1 to 2 orders of magnitude higher than those in coastal water, and were considerably higher in summer than in winter. The fluxes of trace elements were determined by multiplying trace element concentrations in groundwater by the SGD fluxes gauged using a radon mass balance model. Our results show that trace element fluxes through SGD are considerably higher than those via diffusion from bottom sediments, and that SGD is a major pathway of terrestrial trace elements to the ocean in volcanic islands where large rivers are absent. More extensive studies are necessary to understand the large seasonal changes in trace element concentrations in groundwater, in conjunction with evaluations of redox conditions and meteoric groundwater contributions.

Jessen, **G**. **L**., University of Concepcion, Concepcion, Chile, gjessen@udec.cl
Pantoja, S., University of Concepcion, Concepcion, Chile, spantoja@udec.cl
Gutierrez, M. A., University of Concepcion, Concepcion, Chile, magutier@udec.cl
Quiñones, R. A., University of Concepcion, Concepcion, Chile, rquinone@udec.cl
Gonzalez, R. R., University of Concepcion, Concepcion, Chile, rogonzal@udec.cl
Sellanes, J., Universidad Católica del Norte, Coquimbo, Chile, sellanes@ucn.cl
Kellermann, M., University of Bremen, Bremen, Germany, m.kellermann@uni-bremen.de
Hinrichs, K. U., University of Bremen, Bremen, Germany, khinrichs@uni-bremen.de

METHANE PRODUCTION IN SHALLOW COLD SEEPAGES AT MOCHA ISLAND OFF CENTRAL CHILE

We describe for the first time the intertidal and subtidal gas seepage system in Mocha Island off Central Chile. Emanations contain 70 % methane, and estimated methane fluxes to the atmosphere amounted to 815 Ton yr^{-1} for all detected seepages in the Island, equivalent to the emission rate of all vehicle traffic in Chile of 940 metric tons of methane per year. Gas fluxes were ca 50 m^3 h^{-1}, which, to the best of our knowledge, are the highest ever reported for intertidal shallow/subtidal cold seeps. The isotope compositions of methane from the intertidal seeps averaged at –43.8 ± 0.4 ‰ and are suggestive of a substantial fraction derived from thermogenic sources. Adjacent to one of the subtidal seeps, rocky substrates support a diverse community of microbial filaments, macroalgae, and benthic organisms. While stable carbon isotopic compositions of marine benthic organisms indicate a dominant photosynthesis-based food web, those of some hard-substrate invertebrates were in the range –36.8 ‰ to –48.8 ‰, suggesting assimilation of methane-derived carbon by some selected taxa. This study is being supported by FONDECYT Grant 1080623 (CONICYT).

Jinggut, **T**., Monash University, Selangor, Malaysia, tylim6@student.monash.edu
Yule, C. M., Monash University, Selangor, Malaysia, catherine.yule@sci.monash.edu.my
Yap, W. L., Monash University, Selangor, Malaysia,

ALTITUDINAL VARIATION OF SHREDDER COMMUNITIES IN MALAYSIA: SIMILARITIES WITH TEMPERATE COMMUNITIES AT HIGHER ALTITUDES

Contrary to the popular consensus that shredders are scarce in the tropics, leaf litter decomposition in tropical Malaysian streams is often strongly driven by shredder involvement. To investigate altitudinal variations, macroinvertebrate shredder communities of pristine forested streams (including a cloud forest stream) were sampled along a gradient from 55 – 1800m asl. In Peninsular Malaysia, cooler, higher altitude sites supported higher abundance and diversity of shredders (9-15 species/site) than lowland sites (3-8 species/site). Higher altitude streams were dominated by taxa similar to those observed in temperate forested streams (e.g. caddisflies: Lepidostoma sp., nemourid stoneflies and Tipula sp. – plus cockroaches), but crabs, cockroaches and snails were common lowland shredders. In East Malaysia (Borneo), higher streams generally also supported richer shredder communities, with the highest site sampled (1032 m) supporting highest shredder diversity (13 species). In Borneo lowland and highland shredder communities supported cockroaches, Elmidae and Lepidostoma sp., however, Calamoceratidae were exclusive to the highland stream, while isopods shredded leaves in lower altitude streams. Malaysian shredders tend to have large body sizes, possibly an adaptation to eating tough, toxic leaves.

Johnson, E., University of New Mexico, Albuquerque, USA, johnsone@unm.edu
Burdett, A. S., University of New Mexico, Albuquerque, USA,
Turner, T. F., University of New Mexico, Albuquerque, USA,

LARVAL FISHES AS PREDATORS DURING RIVER DRYDOWN: DIET AND STABLE ISOTOPES REVEAL IMPORTANT SPATIAL AND TEMPORAL EFFECTS ON MEIOFAUNA

Larval fishes are highly abundant during seasonal drydown in arid-land rivers like the Rio Grande, New Mexico. Almost nothing is known about ow larval fishes affect invertebrate standing stocks despite the fact that they are numberically dominant predators in productive backwater habitats. This study focuses od diet (i.e., gut content analysis) and stable isotopic ratios (C, N) of larval fish predators over a simulated six-week drydown period in a mesocosm experiment. Twelve replicate tanks were stocked naturally with algae and invertebrates, and each tank was subject to one of four treatments: leaf litter and larvae, larvae and no leaf litter, leaf litter and no larvae, or no leaf litter and no larvae. Mesocosms with fish larvae had roughly a ten-fold reduction in meiofaunal abundance but no change in species diversity attributable to fish effects. Gut content analysis showed that larval fishes eat small invertebrates in proportion to their abundance (i.e., display no feeding preference except for size). Preliminary analysis of isotopic data suggests that larval fishes facilitate a shift in invertebrate grazing from algal to terrestrial sources.

Johnson, **B**. **R**., United States Environmental Protection Agency, Cincinnati, OH, USA, johnson.brent@epa.gov
Fritz, K. M., United States Environmental Protection Agency, Cincinnati, OH, USA, fritz.ken@epa.gov
Price, R., Federal Energy Regulatory Commission, Washington, D.C., USA, rachel.price@ferc.gov
Maxwell, C. F., Virginia Tech, Blacksburg, VA, USA, cfmaxwe@vt.edu
Benfield, E. F., Virginia Tech, Blacksburg, VA, USA, benfield@vt.edu
Webster, J. R., Virginia Tech, Blacksburg, VA, USA, jwebster@vt.edu

ASSESSMENT OF CORN AND BANANA LEAVES AS POTENTIAL STANDARDIZED SUBSTRATES FOR LEAF DECOMPOSITION IN STREAMS AFFECTED BY MOUNTAINTOP REMOVAL COAL MINING

Mountaintop removal and valley filling is a method of coal mining that buries Central Appalachian headwater streams. A 2007 Federal court ruling highlighted the need for measurement of both ecosystem structure *and function* when assessing streams for mitigation. Rapid functional assessment methods are therefore needed. We measured breakdown rates of commercially available corn (*Zea maize*) and banana (*Musa acuminata*) leaves to develop a standardized measure of decomposition. Litterbags of each species were deployed in 10 streams (5 forested/5 downstream of valley fills) in the Twentymile Creek, WV watershed and replicate bags collected monthly from December 2007 through June 2008. Red maple (*Acer ruber*) and white oak (*Quercus alba*) litterbags were deployed similarly for comparisons. There was no significant mining effect on corn or banana leaf decomposition. Banana leaf breakdown rates were significantly faster than corn. When compared to oak and maple, breakdown rates (k–values) were: maple>oak=banana>corn. Only red maple indicated a mining effect on decomposition. Litter breakdown rates were highly variable and evidence suggests differences in hydrology and geomorphology may contribute to greater physical breakdown in mined streams.

Johnson, **C**. **R**., University of Alaska Fairbanks, Fairbanks, USA, cody.johnson@alaska.edu
Giblin, A. E., Marine Biological Laboratory, Woods Hole, USA, agiblin@mbl.edu
Kling, G. W., University of Michigan, Ann Arbor, USA, gwk@umich.edu

PULSE OR PRESS, DO SECONDARY LANDSCAPE DISTURBANCES FOLLOWING A LARGE TUNDRA WILDFIRE PROLONG DISTURBANCE IMPACTS ON ARCTIC LAKES?

The Anaktuvuk River fire of 2007 in Arctic Alaska was an extensive wildfire (>1000 km^2). This fire is the largest wildfire recorded in a region underlain by continuous permafrost. Rapid thawing of ice-rich permafrost, post-fire, has triggered landscape slumping (thermokarsts) on shorelines of many lakes within the burned area. As vegetation recovers, elevated nutrient loading to lakes from fire-disturbed catchments has attenuated. However, sediment and nutrient discharge from thermokarsts has remained high two years after the initial wildfire disturbance, and thermokarsts within the burned area continue to increase in size and number. During the summer of 2009 we observed a thermokarst double in area from 1400 m^2 to 3000 m^2, and measured thermokarst sediment loads of 1000 kg d^{-1}. We quantified potential ecosystem impacts from shading and fertilization on lake benthic respiration and primary productivity. In laboratory experiments, thermokarst discharge shaded out benthic primary production and simultaneously increased oxygen consumption by 7 mmol O2 m^{-2} d^{-1}. Higher sediment respiration coupled with a cessation of primary production will potentially drive hypolimnia anoxia, thus increasing the ratio of CH_4 to CO_2 produced.

Johnson, **L. T.**, Indiana University, Bloomington, IN, USA, latjohn@indiana.edu
Royer, T. V., Indiana University, Bloomington, IN, USA, troyer@indiana.edu
Edgerton, J. M., Kent State University, Kent, OH, USA, jedgerto@kent.edu
Leff, L. G., Kent State University, Kent, OH, USA, lleff@kent.edu

EFFECT OF A LABILE DOC ADDITION ON NITROGEN CYCLING IN AN AGRICULTURAL STREAM

We conducted a 5-day injection of acetate and formate into an Indiana agricultural stream in September 2009 to examine linkages between carbon and nitrogen cycling as mediated by microbial communities. We increased DOC concentrations across a 120m reach two-fold (to 5 mg/L) and measured effects on dissolved nitrogen availability, nitrate uptake, denitrification rates, and microbial density and community structure. The DOC addition significantly reduced mean ammonium concentrations relative to the upstream reference reach (from 82 to 36 µg N/L, $P<0.05$). However, mean nitrate concentrations were similar in the enriched (55 µg N/L) vs. reference reaches (48 µg N/L, $P>0.05$). Ammonium and nitrate concentrations on day 5 of the addition decreased longitudinally resulting in uptake lengths of 16m and 107m, respectively. Six-hour ^{15}N-nitrate additions (enrichment=20,000‰) indicated a nearly 6-fold increase in nitrate uptake velocity, from 0.012 mm/s prior to the addition to 0.063 mm/s on day 5. The addition of labile DOC had only a modest effect on bacterial density, suggesting the nitrogen cycling response was driven by metabolic changes or subtle changes in the structure of the community.

Johnson, **L. B.**, University of Minnesota Duluth, Duluth, USA, ljohnson@d.umn.edu
Axler, R., University of Minnesota Duluth, Duluth, USA, raxler@d.umn.edu
Blumenfeld, K., University of Minnesota, Minneapolis, USA,
Card, V., Metropolitan State University, St. Paul, USA, Virginia.Card@metrostate.edu
Henneck, J., University of Minnesota Duluth, Duluth, USA, jhenneck@d.umn.edu
Olker, J., University of Minnesota Duluth, Duluth, USA, jolker@d.umn.edu
Newman, R., University of Minnesota, St. Paul, USA, rnewman@umn.edu
Pereira, D., MN Department of natural Resources, St. Paul, USA, Don.Pereira@dnr.state.mn.us
Skaggs, R., University of Minnesota, Minneapolis, USA, skaggs@geog.umn.edu
Schneider, K., University of Minnesota, St. Paul, USA, ewell002@umn.edu
Stefan, H., University of Minnesota, Minneapolis, USA, stefa001@umn.edu
Swain, E., MN Pollution Control Agency, St. Paul, USA, edward.swain@state.mn.us
Welle, P., Bemidgi State University, Bemidgi USA, PWelle@bemidjistate.edu
Will, N., University of Minnesota, Duluth, USA, nwill@nrri.umn.edu
Zandlo, J., State Climatology Office, St. Paul, USA, jzandlo@umn.edu

IMPACTS ON MINNESOTA'S AQUATIC RESOURCES FROM CLIMATE CHANGE

We examined historic records (> 100 y) for > 4500 Minnesota, USA lakes and developed a database incorporating climate, lake water levels, water quality, fish species distributions, and walleye spawning phenology. The following climate trends are evident: temperatures are increasing but changes have accelerated since the 1980s, are much greater in the northern third of the state. Precipitation in the form of both rain and snow has been increasing since the 1930s, with variation across the state. Lake evaporation has increased in some regions but not others. Trends in lake levels are not consistent across the state, but across the state lake ice-out is occurring earlier. A sizeable fraction of lakes with many years of data indicated a warming of surface waters. Other trends, found in a smaller fraction of lakes, suggest that the summer thermocline of lakes is becoming somewhat more stable consistent with the warming trend. Patterns associated with hot-dry, hot-wet, cool-dry, and cool-wet periods were examined. Walleye spawning dates are correlated with ice out date and there is evidence that fish communities are changing.

Johnson, **R. A.**, University of Wisconsin-Madison, Madison, USA, johnson.robert.333@gmail.com
Powers, S. M., University of Wisconsin-Madison, Madison, USA, smpowers@wisc.edu
Stanley, E. H., University of Wisconsin-Madison, Madison, USA, ehstanley@wisc.edu

SPATIAL AND TEMPORAL CONTRASTS IN NITRATE UPTAKE FOR A WETLAND STREAM

Some models of large-scale river networks assume nutrient uptake homogeneity in space and time. However, changes in internal physical and biological characteristics may cause spatial and temporal differences in nutrient uptake. We examined nitrate uptake velocity in space and time in North Creek, Wisconsin, a wetland stream whose internal physical and biological characteristics vary greatly between an upper and lower study reach. Between May and October 2009, six stepped nitrate injections were performed, and uptake was estimated from time series modeling. Over the course of the study, in-stream vegetation increased dramatically and average water velocity decreased (from 0.069 m s-1 to 0.049 m s-1 in the lower reach). The transient storage zone of each reach always had a greater uptake velocity, but typically played a smaller role in whole stream nitrate assimilation. Whole stream nitrate uptake velocity varied spatially and temporally (decay rate coefficient of 0.00023 s-1 to 0.00007 s-1, and 0.00012 s-1 to 0.00008 s-1 for the upper and lower reaches respectively), perhaps due to temporal changes in background chemistry rather than morphology or vegetation.

Johnson, **R. K.**, Swedish University of Agricultural Sciences, Uppsala, Sweden, richard.johnson@vatten.slu.se
Angeler , D. G., Swedish University of Agricultural Sciences, Uppsala, Sweden, david.angeler@vatten.slu.se

TRACING RECOVERY UNDER CHANGING CLIMATE: RESPONSE OF PHYTOPLANKTON AND INVERTEBRATE ASSEMBLAGES TO DECREASED ACIDIFICATION

Phytoplankton and littoral invertebrate assemblages in four boreal lakes recovering from acidification and four minimally disturbed reference lakes studied over two decades were used to determine the pathways and trajectories of change under the influence of climatic variability. Assemblage composition (species presence – absence data), but not dominance patterns in assemblages (invertebrate abundance/phytoplankton biovolume), of acidified lakes became more similar to those of reference lakes (distance decreased with time), indicating that the detection of recovery varies as a function of chosen metrics. Acidified lakes exhibited more pronounced shifts in assemblage composition than reference lakes. The most marked differences were noted for phytoplankton assemblages, with assemblages of acidified lakes having mean between-year Euclidean distances of almost twice those of reference lakes. Although trends in water chemistry show unequivocal recovery, response of phytoplankton and invertebrate assemblages, measured as between-year shifts in assemblage composition, was correlated with interannual variability in climate (e.g. North Atlantic Oscillation, water temperature) in addition to decreased acidity. The finding that recovery pathways and trajectories of individual acidified lakes and the environmental drivers explaining these changes differed between assemblages shows that biological recovery is complex and the influence of climatic is poorly understood.

Johnson, **R. C.**, University of Louisville, Louisville, USA, r0john07@gwise.louisville.edu
Jin, H., University of Louisville, Louisville, USA, hsjin001@gwise.louisville.edu
Carreiro, M. M., University of Louisville, Louisville, USA, m.carreiro@louisville.edu
Jack, J. D., University of Louisville, Louisville, USA,

STREAM MACROINVERTEBRATE SECONDARY PRODUCTION DYNAMICS ALONG AN URBAN DEVELOPMENT GRADIENT

Urban population growth and expansion can drastically alter stream ecosystem structure and function. In this study, we estimated macroinvertebrate production in six streams along an urban development gradient (UDG), and linked changes in production to in-stream environmental characteristics and catchment land use/cover (LUC) patterns along the UDG. Total production was highest on the urban fringe in a stream dominated by pastureland and developed-open green spaces and lowest in the most highly urbanized stream (75% Urban). Forested streams exhibited intermediate production levels. Regression analysis indicated nutrient enrichment, leaf litter availability, and chloride concentrations were the in-stream variables most related to production along the UDG. In-stream environmental variables were also strongly related to catchment-scale LUC. Our results suggest that total production first increases along the UDG due to increased nutrient enrichment. However, once development has reached a threshold, other stressors associated with the UDG ultimately cause decreases in total production to levels below forested stream production. These changes in macroinvertebrate production along the UDG could greatly alter food webs, energy flow, and the cycling of matter in these human-dominated ecosystems.

Johnson, **S. L.**, SUNY College of Environmental Science and Forestry, Syracuse, USA, sljohn06@syr.edu
Ringler, N. H., SUNY College of Environmental Science and Forestry, Syracuse, USA, neilringler@esf.edu

THE LITTORAL ZONE MACROINVERTEBRATE COMMUNITY IN ONONDAGA LAKE AND THE INFLUENCE OF INVERTEBRATE DRIFT

Few studies have examined the benthic macroinvertebrate community in Onondaga Lake, Syracuse, NY. The Lake has undergone significant changes to the littoral zone habitat and is the site of a large-scale remediation effort. Sampling of benthic macroinvertebrates was conducted in Onondaga Lake and its tributaries during summer 2007: (1) to describe the littoral zone macroinvertebrates in the lake, (2) to assess the influence of downstream drift on the lake community, and (3) to identify potential colonizers into the lake as conditions continue to improve. Samples in the lake were collected at 1 m and 3 m depths. Mollusks were the most abundant taxon. Depth did not have a significant effect on diversity or biotic index scores. Stable substrate and the presence of aquatic macrophytes positively influenced macroinvertebrate diversity and density. Habitat and the invertebrate communities in the tributaries were similar to sites sampled in the lake. Invertebrate colonization by stream drift appears highly probable. Initial results suggest that improvements to tributary habitat are also needed to ultimately improve invertebrate diversity in Onondaga Lake. This study could have important implications for remediation and restoration efforts in lakes.

Johnson, **S. L.**, Pacific Northwest Research Station, US Forest Service, Corvallis, OR, USA, sherrijohnson@fs.fed.us
Ashkenas, L. R., Oregon State University, Corvallis, OR, USA, linda.ashkenas@oregonstate.edu
Li, J. L., Oregon State University, Corvallis, OR, USA, judyli@comcast.net
Dunham, J., USGS FRESC, Corvallis, OR, USA, jdunham@usgs.gov
Adams, M. J., USGS FRESC, Corvallis, OR, USA, michael_adams@usgs.gov

WHERE IS THE GREATEST SEASONAL AND SPATIAL VARIATION IN NATURAL ABUNDANCE OF 15N AND 13C ISOTOPES ACROSS TROPHIC LEVELS IN TRASK RIVER WATERSHED STUDY?

We are exploring the variability of natural abundances of 15N and 13C isotopes in stream food webs across 14 headwater basins, 4 downstream sites and 3 seasons to better understand resource availability and linkages among trophic levels. The Trask River Watershed Study is a multi-disciplinary, multi-year research project designed to evaluate the impacts of current forest management practices on headwater and downstream aquatic ecosystems. Preharvest we are characterizing variability versus consistency of isotopes and standing stocks and processes driving these food web dynamics. Across seasons, potential shifts in diet and isotopes can occur from pulsed availability of autotrophs before leaf out and seasonal lags as resources move through food webs. We are also examining site specific factors and adjacency among basins and finding similar δ13C for taxa in headwaters versus downstream, despite increased light and primary production in downstream reaches. Narrow ranges of δC13 occur for FBOM, amphibians (dicamptodon) and sculpin (cottus) across sites but surprisingly high variation for δC13 and δ15N in epilithon and needles. Variation in δ15N for trout fry was wider than for older trout.

Jones, **C. M.**, University of North Carolina - Greensboro, Greensboro, USA, cmjones9@uncg.edu
O'Brien, W. J., University of North Carolina - Greensboro, Greensboro, USA,
Hershey, A. E., University of North Carolina - Greensboro, Greensboro, USA, aehershe@uncg.edu

PISCIVORE EFFECT ON SIZE DISTRIBUTION AND PLANKTIVOROUS BEHAVIOR OF SLIMY SCULPIN IN ARCTIC ALASKAN LAKES

Slimy sculpin (Cottus cognatus) are known as bottom-dwelling fish that feed primarily on benthic invertebrates. In arctic lakes, these fish have also been captured in traps suspended above the bottom, and zooplankton distribution patterns suggest that they are also somewhat planktivorous. Previous studies have shown that sculpin benthic habitat is modified by lake trout (Salvelinus namaycush), a potential piscivore. Here, we hypothesized that lake trout and another potential piscivore, arctic char (Salvelinus alpinus), which is also more planktivorous than lake trout, alter sculpin behavior to restrict planktivory and reduce growth. Results show that sculpin were significantly larger in lakes lacking potential piscivores, consistent with our hypothesis. However, sculpin consumption of zooplankton was not affected by piscivores. These results suggest that use of planktonic food resources by sculpin is more complex than would be expected from simple presence or absence of a potential piscivore.

Jones, **E. L.**, University of Waterloo, Waterloo, Canada, eljones@engmail.uwaterloo.ca
Smith, R. E., University of Waterloo, Waterloo, Canada, rsmith@sciborg.uwaterloo.ca
Craig, J. J., University of Waterloo, Waterloo, Canada, jrcraig@uwaterloo.ca

ONE- AND THREE-DIMENSIONAL MODELING OF NUTRIENT-PHYTOPLANKTON-ZOOPLANKTON DYNAMICS IN LAKE ERIE

A three-dimensional hydrodynamic model, ELCOM, was coupled with the ecological model, CAEDYM, to simulate physical and biological processes within Lake Erie. This model is effective in predicting large scale processes in the lake including the development of summer stratification and the seasonal succession of phytoplankton populations.

Two zooplankton groups (calanoid copepods and cladocerans) have been recently incorporated into the model, but have made the model even more complex, raising the need for systematic sensitivity analysis. Here we present a sensitivity screening of the CAEDYM parameters using a one-dimensional hydrodynamic driver to represent the West Basin of Lake Erie. This 1-D approach is much faster to compute, which allows for a more thorough investigation of the effects of the ecological parameters. Output variables of interest in this sensitivity analysis include zooplankton groups, total chlorophyll, and phosphorus. The results of the analysis are discussed and applied to the 3-D model.

Jones, **J. B.**, University of Alaska Fairbanks, Fairbanks, USA, Jay.Jones@alaska.edu
Balcarczyk, K. L., University of Alaska Fairbanks, Fairbanks, USA,
Betts, E. F., University of Canberra, Canberra, Australia,
Rinehart, A. J., University of Alaska Fairbanks, Fairbanks, USA,
Harms, T. K., University of Alaska Fairbanks, Fairbanks, USA,

DISSOLVED ORGANIC MATTER IN STREAMS DRAINING WATERSHEDS UNDERLAIN WITH DISCONTINUOUS PERMAFROST IN SUBARCTIC ALASKA

In the subarctic, watersheds are commonly underlain with discontinuous permafrost, which has a dominant control on catchment hydrology and the resulting input of dissolved organic matter (DOM) into streams. Wildfires also are common in subarctic Alaska, have been increasing in frequency and severity with recent warming, and have the potential to alter the delivery of DOM to streams. We have been studying DOM in a number of streams draining subcatchments with varying extents of underlying permafrost in the Caribou-Poker Creeks Research Watershed in interior Alaska. DOM in soil water and ground waters feeding stream flow varied markedly in quantity (1.5 - 35 mgC/L) and composition. Streams draining lower permafrost catchments have a lower concentration than streams draining high permafrost subcatchments. Following a wildfire in the CPCRW, stream DOM concentration significantly declined compared with a control stream, suggesting that the fire either resulted in a loss of soil organic matter or altered hydrologic flowpaths through catchments. With climatic warming, permafrost thaw and changing fire frequency will interact to determine DOM concentration and composition in streams of the subarctic.

Jones, **S. E.**, Michigan State University, W.K. Kellogg Biological Station, Hickory Corners, USA, stujones@msu.edu
Lennon, J. T., Michigan State University, W.K. Kellogg Biological Station, Hickory Corners, USA, lennonja@msu.edu

DORMANCY MAINTAINS DIVERSITY AND STRUCTURES COMPOSITION OF AQUATIC MICROBIAL COMMUNITIES

Dormancy is a bet-hedging strategy used by a variety of organisms to overcome unfavorable environmental conditions. By entering a reversible state of low metabolic activity, dormant individuals become members of a seed bank, which can determine community dynamics in future generations. We used a theoretical model to develop expectations for how dormancy may influence microbial communities. We then evaluated the model predictions by conducting a molecular survey of bacterial and eukaryotic microbial communities in a set of north temperate lakes. Our simulations and empirical data suggest that regional environmental cues and dormancy can synchronize the composition of active communities across the landscape, while decoupling active microbes from the total community at local scales. Furthermore, we observed that rare bacterial taxa were disproportionately

active relative to common bacterial taxa, suggesting that microbial rank-abundance curves are more dynamic than previously considered. We propose that repeated transitions to and from the seed bank may help maintain the high levels of microbial biodiversity that are observed in aquatic ecosystems.

Jordan, **C. J.**, Massey University, Palmerston North, New Zealand, c.jordan@wellingtonfishgame.org.nz
Death, R. G., Massey University, Palmerston North, New Zealand, R.G.Death@Massey.ac.nz
Death, F., Massey University, Palmerston North, New Zealand, F.Death@Massey.ac.nz

DECLINE OF NEW ZEALAND TROUT POPULATIONS: CHANGE IN THE WEATHER OR CHANGE IN THE LAND

A number of trophy brown trout (Salmo trutta) fisheries in rivers of the central North Island of New Zealand have shown rapid decline over the last decade. Over this decade there have been a number of large flood events during or just following spawning, however, there has also been increasing water abstraction, waste disposal and land use intensification in these same catchments. We have examined population data collected from drift dive surveys, electrofishing and spawning surveys to assess the current state of the trout fishery in the Hutt and Mangatainoka Rivers. We also compiled data on changes in flow regime, water quality and habitat characteristics and used regression tree analysis to link these potential drivers with population declines. Not surprisingly it seems that it is a combination of change both flow regimes and water quality that is leading to the declines. We present some potential solutions to improve the fishery.

Judd, **K. E.**, Eastern Michigan University, Ypsilanti, USA, kjudd2@emich.edu
Francoeur, S. N., Eastern Michigan University, Ypsilanti, USA, sfrancoeu@emich.edu
Clemans, D. L., Eastern Michigan University, Ypsilanti, USA, dclemans@emich.edu
Johnson, A. C., Eastern Michigan University, Ypsilanti, USA, ajohns24@emich.edu

IMPACTS OF LAND USE ON STREM ECOSYSTEM STRUCTURE AND FUNCTION IN SOUTHEAST MICHIGAN

To determine how land use influences stream ecosystem structure and function, we studied streams draining natural, agricultural, and urban catchments. We predicted that land use would impact functional characteristics, such as leaf-litter decomposition rates, through two pathways: nutrient enrichment and shifts in decomposer community composition. We used course and fine mesh bags to separate effects of microbes and macroinvertebrates on litter decomposition in 12 streams (4 of each land use). We surveyed chemical and physical characteristics of these streams throughout the year and assessed bacterial community structure and fungal biomass. We found no significant effect of macroinvertebrates, indicating that microbial processes dominate decomposition in these streams. There was a weak but significant relationship between litter loss and fungal biomass ($R2 = 0.19$, $p < 0.05$), but land use had no significant effect on litter decomposition or stream chemistry. Our results suggest that spatial arrangement (i.e., proximity to stream) is important in determining stream responses to land use.

Judson, **S. W.**, Brigham Young University, Provo, USA, swjudson@gmail.com
Nelson, C. R., Brigham Young University, Provo, USA, rileynelson@byu.edu

APPLIED AND PREDICTIVE BIOGEOGRAPHY OF MONGOLIAN PLECOPTERA, WITH AN INVESTIGATION OF THE POTENTIAL EFFECTS OF CLIMATE CHANGE ON DISTRIBUTIONS AND RICHNESS

Using adult Plecoptera specimens collected and identified in conjunction with the Mongolian Aquatic Insect Survey, we created maps of the documented range for each species along with predicted distributions, as well as projected distributions for the year 2050 based on HadCM3 climate projections and other climate scenarios. The predicted maps were combined to highlight areas of high potential richness and those with significant changes in extent or richness in the different climate scenarios. Initial analysis indicates the contraction of many species ranges and a general northward or elevational migration. From quantitative assessment of the amount of change between current and future climatic conditions, we have identified species and habitats of particular concern including *Suwallia teleckojensis* which has already been noted to have an alpine restricted range due to the effects of climate change. To make our results accessible to native scientists and non-profit organizations, we also developed a custom geo-spatial analysis to determine the likeliness of encountering each species at a particular site based on documented frequency and predicted probability of encounter.

Julien, **H. N.**, University of Wyoming, Laramie, USA, julienh@uwyo.edu
Krist, A., University of Wyoming, Laramie, USA, krist@uwyo.edu

INTERACTIONS BETWEEN THE INVASIVE NEW ZEALAND MUDSNAIL (POTAMOPYRGUS ANTIPODARUM) AND A NATIVE SNAIL (FOSSARIA SP.)

Invasive species are a leading cause of biodiversity loss. The invasive New Zealand mudsnail (Potamopyrgus antipodarum) can have dramatic effects on aquatic ecosystems by competing with native macroinvertebrates and by dominating nitrogen cycling, secondary production, and consumption of primary productivity. We conducted two laboratory experiments to study interactions between the invasive P. antipodarum and a co-occurring native snail Fossaria sp. In the first experiment we used low ambient biomass for each snail species to determine the type of interaction occurring. We found that the specific growth rate (SGR) of P. antipodarum was minimally affected by interspecific competition at both densities but SGR of Fossaria was reduced at high densities and more by interspecific than intraspecific competition. Since the purpose of the second experiment was to calculate interspecific and intraspecific interaction strengths, we used total ambient snail biomass. This biomass was much higher than the first experiment and consequently SGR's were an order of magnitude higher in P. antipodarum than Fossaria. These experiments suggest that the two snails are competing asymmetrically; the native is more affected by competition than the invasive.

Negishi, J., Hokkaido University, Sapporo , Japan, negishi@ees.hokudai.ac.jp
Katsuki, K., Hokkaido Universtiy, Sapporo, Japan,
Kume, M., Aqua Restoration Research Center, Kakamigahara, Japan,
Sagawa, S., Aqua Restoration Research Center, Kakamigahara, Japan,
Miyashita, T., Aqua Restoration Research Center, Kakamigahara, ,
Nagayama, S., Aqua Restoration Research Center, Kakamigahara, Japan,
Yuichi Kayaba, Aqua Restoration Research Center, Kakamigahara, ,

UNDERSTANDING FOOD WEB STRUCTURES OF FLOODPLAIN PONDS IN RELATION TO RIVER AND GROUNDWATER CONNECTIVITY

Floodplains are among one of the most imperiled ecosystems on earth. Hydrological connectivity via surface water exchanges with main channels has been recognized as one of key processes that characterize ecological integrity of floodplain ponds. Another potentially important process for maintaining pond ecosystems is the hydrological and biogeochemical inputs originating from groundwater sources. This study elucidated mechanisms by which food webs of floodplain ponds are structured by examining stable isotope ratios of water (D/H and 18O/16O ratios) and endangered unionoida mussels as well as their potential basal food resources (15N/14N and 13C/12C). A total of 9 floodplain ponds in a 15-km section of Kiso River, Japan, were sampled in spring through fall. Ponds had varying levels of contribution of groundwater inputs relative to that of river water from the main channel based on results of water quality such as silica concentration and D/H and 18O/16O ratios. Base of food web in ponds with a high contribution of groundwater was characterized with an exceedingly depleted 13C (<-35 ‰), suggesting some systems were dependent more on groundwater than river sources and connectivity.

Junker, **J. R.**, Montana State University, Bozeman, USA, james.junker1@gmail.com
Cross, W. F., Montana State University, Bozeman, USA, wyatt.cross@montana.edu

WILL RECOVERY OF RIPARIAN VEGETATION IN YELLOWSTONE'S NORTHERN RANGE ALTER TROPHIC SUPPORT OF STREAM CONSUMERS?

The importance of allochthonous inputs from riparian to aquatic ecosystems has been widely documented. Changes in riparian community growth and extent may have strong direct and indirect effects on population-, community-, and ecosystem-level dynamics of linked stream ecosystems. Over the past decade, riparian communities in the northern range of Yellowstone National Park have experienced significant recovery relative to previous decades. Yet, implications for stream ecosystem structure and function remain uncertain. To address this uncertainty, we are combining estimates of secondary production with stable isotope ratios and C:nutrient ratios of dominant invertebrate consumers and basal resources in West Blacktail Deer Creek, Wyoming, USA. Here, we present seasonal patterns of basal resource quality and quantity, together with isotopic signatures of major food web components to assess the relative importance of riparian detritus in supporting stream food web production. Our initial results suggest that detritus supports a significant component of stream consumer

production, however, this pattern varies seasonally. These findings provide an important benchmark from which to assess the implications of future changes in Yellowstone's riparian communities for stream ecosystem structure and function.

Jürgens, **K**., Leibniz Institute for Baltic Sea Research Warnemünde, Rostock, Germany, klaus.juergens@io-warnemuende.de
Breithaupt, P., Leibniz Institute of Marine Sciences IFM-GEOMAR, Kiel, Germany, p.breithaupt@pediatrics.uni-kiel.de
Scheibner, M. v., Institute for Baltic Sea Research Warnemünde, Rostock, Germany, markus.scheibner@io-warnemuende.de
Walther, K., Institute for Baltic Sea Research Warnemünde, Kiel, Germany, Walther.K@oldenbourg.de
Sommer, U., Leibniz Institute of Marine Sciences IFM-GEOMAR, Kiel, Germany, usommer@ifm-geomar.de
Hoppe, H. G., Leibniz Institute of Marine Sciences IFM-GEOMAR, Rostock, Germany, hhoppe@ifm-geomar.de

IMPACT OF RISING TEMPERATURES ON PHYTOPLANKTON-BACTERIA INTERACTIONS DURING EARLY SPRING BLOOM CONDITIONS: RESULTS FROM INDOOR MESOCOSM EXPERIMENTS

There is evidence that autotrophic and heterotrophic processes are affected differently by temperature. Therefore, it is generally assumed that the predicted increasing winter water temperatures of temperate marine systems will result in a closer phytoplankton-bacteria coupling during the early spring bloom. To test this hypothesis, we performed indoor mesocosm experiments with whole plankton assemblages from the Baltic Sea along a temperature gradient. In all experiments bacterial activity and biomass production showed a much higher increase with higher temperature than the primary production of the induced diatom bloom. Overall, this resulted in an increased carbon flow to the microbial food web, a tighter coupling between phyto- and bacterioplankton and a shift towards an increased heterotrophy in the system. By using 16S rRNA fingerprints, clone libraries, and CARD-FISH, we examined whether the bacterial community composition and potential bacterial key players changed with increasing temperature. The results obtained so far indicate that there occurred only modest temperature-dependent shifts in the bacterial assemblage, and that the phase of the phytoplankton bloom had a stronger impact on the bacterial community structure than the rising temperature.

Justic, **D**., Lousiana State University, Baton Rouge, USA, djusti1@lsu.edu
Wang, L., Lousiana State University, Baton Rouge, USA, lxwang@lsu.edu
Hoda, A., Lousiana State University, Baton Rouge, USA, ahoda1@lsu.edu
Das, A., Lousiana State University, Baton Rouge, USA, adas1@lsu.edu

FROM BOX MODELS TO MEGA MODELS: CAN BIOLOGY AND PEOPLE KEEP UP WITH COMPUTERS?

Over the past several decades, coupled hydrodynamic-water quality models have become major research tools across the aquatic sciences. The size and the complexity of these models have been steadily increasing due to developments in computer technology and computational techniques. This transition from simple box models to 2-dimensional and 3-dimensional mega models has had a number of advantages and drawbacks. An advantage of complex models, if they are well-formulated and tested, is that they can provide understanding of cause-effect mechanisms over large spatial scales that are impossible to derive solely from observational data. A disadvantage of complex models is their extensive data requirements for inputs, calibration and validation. Consequently, it is much more difficult to apply complex models for long periods of record and demonstrate their robustness over the full range of conditions for which they were developed. We discuss some fundamental challenges in developing complex hydrodynamic-water quality models that pertain to the coupling of physics and biology, model data requirements, calibration and validation issues.

Jyvasjarvi, **J**., University of Jyväskylä, Department of Biological and Environmental Science, Jyvaskyla, Finland, jussi.p.jyvasjarvi@jyu.fi
Aroviita, J., Finnish Environment Institute, Freshwater Centre, Monitoring and Assessment Unit, Jyvaskyla, Finland,
Hamalainen, H., University of Jyväskylä, Department of Biological and Environmental Science, Jyvaskyla, Finland,

COMPARING AN *A PRIORI* TYPOLOGY WITH PREDICTIVE MODELS FOR ASSESSMENT OF TAXONOMIC COMPLETENESS OF LAKE PROFUNDAL MACROINVERTEBRATE ASSEMBLAGES

Macroinvertebrate communities are frequently used for assessment of freshwaters. That such assessments should control for natural variation of abiotic characteristics, either by categorical typologies or by predictive models, has been demonstrated for streams but not for lakes. We compared the Finnish *a priori* lake typology with 3 modelling approaches (RIVPACS, MRT, LED), for assessment of taxonomic completeness (O/E index of taxon richness) of profundal macroinvertebrates using 74 undisturbed calibration sites and 34 validation sites in Finnish lakes. All 3 models yielded accurate (mean O/E = 0.993-1.043) but imprecise (SD = 0.306-0.341) expectations (E) for the fauna actually observed (O) in reference sites. The models performed only marginally better than a null-model (mean 1.095, SD 0.368) or the typology approach (mean 1.041, SD 0.351), suggesting that the fauna expected in undisturbed conditions can be equally well predicted with a simple lake typology as with more complex models. However, as there is apparently much unpredictable variation in the fauna, some other metric than the O/E-taxa index, that encompasses quantitative aspects, might be preferable for assessing these species-poor communities.

Kainz, **M**. **J**., WasserCluster - Biologische Station Lunz, Lunz am See, Austria, martin.kainz@donau-uni.ac.at
Schultz, S., WasserCluster - Biologische Station Lunz, Lunz am See, Austria, sebastian.schultz@wkl.ac.at
Koderbauer, B., WasserCluster - Biologische Station Lunz, Lunz am See, Austria, a0301459@unet.univie.ac.at
Watzke, J., WasserCluster - Biologische Station Lunz, Lunz am See, Austria, joerg.watzke@wkl.ac.at
Guschina, I. A., Cardiff University, School of Biosciences, Cardiff, United Kingdom, guschinaia@cardiff.ac.uk

DIET SOURCE-DEPENDENT RETENTION AND BIOCONVERSION OF POLYUNSATURATED FATTY ACIDS IN COMMON CARP (CYPRINUS CARPIO)

Omnivorous common carp (Cyprinus carpio) is an important diet fish that supplies proteins and important lipids to humans worldwide. We conducted feeding experiments to test the effect of different diets (natural zooplankton, crop-based feeds, and marine-based feeds) on retention and bioconversion of polyunsaturated fatty acids (PUFA) in muscle tissues of carp. It was hypothesized that increasing dietary PUFA supply will increase PUFA concentrations, but decrease the enzymatic ability of carp to bioconvert PUFA itself. Results showed that carp obtaining only 2% marine fish oil in their diet resulted in 2X higher omega-3 PUFA concentrations than carp feeding on natural zooplankton. Higher proportions of dietary marine fish oil (6% and 14%) did not result in higher omega-3 PUFA concentrations, but docosahexaenoic acid (22:6n-3) was the mostly retained PUFA in carp of all treatments. Biomolecular analyses of liver cells revealed strongly decreased elongase and desaturase gene expression with PUFA-enriched diets. These results show that carp efficiently increase its PUFA concentrations when supplied by diet, yet can only partially bioconvert its PUFA when dietary PUFA supply is scarce.

Kamenir, **Y**., Bar-Ilan University, Ramat-Gan, Israel, kamenir@mail.biu.ac.il
Mikhailyuk, T., N.G. Kholodny Institute of Botany, National Academy of Science of Ukraine, Kiev, Ukraine, t-mikhailyuk@ukr.net
Popova, A., N.G. Kholodny Institute of Botany, National Academy of Science of Ukraine, Kiev, Ukraine, afpopova@ukr.net
Kemp, R., University of Wales, Aberystwyth, United Kingdom, rbk@aber.ac.uk
Dubinsky, Z., Bar-Ilan University, Ramat-Gan, Israel, dubinz@mail.biu.ac.il

EFFECTS OF ANTHROPOGENIC POLLUTION ON KANEV RESERVOIR (UKRAINE) PHYTOPLANKTON. COMPARISON OF SIZE SPECTRA

The aim of this study was to compare phytoplankton assemblage from two parts of the Kanev Reservoir (Ukraine), constructed in the middle part of the Dnepr - one of the largest rivers of Europe. Station 1 was situated in a relatively clean area, while station 2 was at the mouth of a small river, Syrets, which carries the outflow of the Ukraine metropolis (Kiev) sewage. The biomass size spectrum (BSS), the normalized size spectrum (NBS) and the traditional taxonomic size spectrum (TTSS) were developed on the basis of a routine 2-year monitoring project. The investigated stations were characterized by markedly different phytoplankton composition and annual dynamics. While the BSS curves were very diverse, the NBS and TTSS curves had similar general patterns, with some differences evidenced in the fine structure of each spectrum. The obtained shapes and similarity indices of the traditional taxonomic size spectrum are compared with the same of the main Israeli fresh-water reservoir (Lake

Kinneret). The impact of urban pollution, as evidenced in deformations of the size spectrum patterns, is discussed

Kang, **M**., University of British Columbia, Dept. Forest Sciences, Vancouver, Canada, misun.kang@ubc.ca

Sakamaki, T., University of the Ryukyus, Okinawa, Japan, sakamaki@lab.u-ryukyu.ac.jp

Richardson, J. S., University of British Columbia, Dept. Forest Sciences, Vancouver, Canada, john.richardson@ubc.ca

THE RELATIVE INFLUENCE OF A COMMON DETRITIVOROUS SPECIES, *PTERONARCYS CALIFORNICA*, ON ORGANIC MATTER PRODUCTION AND PROCESSING IN RIPARIAN ECOSYSTEMS

Common species (i.e., widespread and abundant species) may be effective indicators of community structure and ecosystem function trends given that they are detectable and account for large proportions of global and regional biomass and productivity. Common species may be major regulators of ecosystem function/services. We compared growth rates, leaf litter breakdown, and fine particulate organic matter (FPOM) production rates of the common larval stonefly, *Pteronarcys californica*, with larval caddisflies (*Lepidostoma unicolor*, *Clostoeca disjuncta*, *Psychoglypha* sp.). We experimentally assembled the detritivores into communities differing in richness and evenness (i.e., even, caddisfly-dominant, and *Pteronarcys*-dominant) and maintained equivalent metabolic capacities among individuals. Growth rates per unit resource consumed were higher for *Pteronarcys* than caddisflies ($p<0.05$, $n=6$). There was significantly higher leaf litter breakdown in *Pteronarcys*-dominant treatments than even and control treatments ($p<0.05$, $n=6$ for both). Caddisfly-dominant treatments had significantly higher leaf litter breakdown than control treatments ($p<0.05$, $n=6$). *Pteronarcys*-dominant treatments produced significantly more FPOM than even treatments ($p<0.05$, $n=6$). Common species, such as *Pteronarcys*, may account for more downstream organic matter production and transport than rare species.

Kang, **M**. **J**., Department of Watershed Sciences, Utah State University, Logan, USA, m.kang@aggiemail.usu.edu

Wurtsbaugh, W. A., Department of Watershed Sciences, Utah State University, Logan, USA, wayne.wurtsbaugh@usu.edu

Baker, M. A., Department of Biology and Ecology Center, Utah State University, Logan, USA, michelle.baker@usu.edu

INFLUENCE OF UPSTREAM LAKES ON DOWNSTREAM PRODUCTIVITY OF A WATERSHED

Spatial characteristics of a lake's watershed may be an important factor influencing its overall productivity and stability. Hydrology, nutrient (P) concentrations and phytoplankton abundance (chlorophyll a) of the lowest elevation lakes of five watersheds in the Sawtooth Mountains (Idaho) were examined in relation to upstream lake cover. Lakes in watersheds with many upstream lakes had 44-69% lower nutrient inputs from inflows and lower phytoplankton biomass (0.6 -0.8 µg/L Chl. *a*) than lakes with few or no upstream lakes (1.1-1.3 µg/L Chl. *a*). Although upstream lakes decreased primary producers downstream, the seasonal variability range in phytoplankton was less in watersheds with more upstream lakes (0.5–0.9 µg/L) than in those with few or no upstream lakes (1.2 -1.6 µg/L). Watersheds with more lakes have the capacity to store nutrients and in these watersheds spring blooms of phytoplankton in lower elevation lakes can be reduced. However, slow releases of nutrients from upstream lakes can prolong production lower in the watershed. These results indicate that spatial arrangement of lakes within a watershed influence nutrients and primary productivity downstream.

Kangas, **P**., University of Maryland, College Park, USA, pkangas@umd.edu

Garrett, M., University of Maryland, College Park, USA,

House, R., University of Maryland, College Park, USA,

Husain, S., University of Maryland, College Park, USA,

Johnson, A., University of Maryland, College Park, USA,

Keschner, Y., University of Maryland, College Park, USA,

Shilts, G., University of Maryland, College Park, USA,

Winfrey, B., University of Maryland, College Park, USA,

PLANT COMMUNITY STRUCTURE ON ARTIFICIAL FLOATING ISLANDS IN MARYLAND, USA

Artificial floating islands are ecologically engineered systems designed to support wetland communities and to provide water quality benefits. Although there are natural analogs for artificial floating islands, this is a new technology that uses recycled plastic as a buoyant substrate for wetland ecosystem development. In this study plant communities were surveyed on artificial floating islands at three locations in Maryland, USA. A total of 23 emergent plant species were sampled on the floating islands and the average biomass was comparable to natural wetlands. Volunteer species generally dominated the commuunities but intentionally planted species made significant contributions to the diversity on two of the three floating island systems. Analysis of the community data is used as a basis for recommendations concerning future planting plans for this new technology.

Kaplan, **L**. **A**., Stroud Water Research Center, Avondale, USA, lakaplan@stroudcenter.org

Newbold, J. D., Stroud Water Research Center, Avondale, USA, newbold@stroudcenter.org

COMPARISON OF WHOLE-STREAM MEASUREMENTS OF DOM UPTAKE WITH LABORATORY SCALE SYSTEMS

Laboratory tools can facilitate measurements of phenomena that cannot be made in situ, but require appropriate scaling to convert laboratory rates to in situ rates. We have used biofilm reactors and chambers with recirculating water to measure aspects of dissolved organic matter (DOM) utilization and compared these results to values derived from whole-stream tracer additions. The bioreactors provide uptake measurements for stream water DOM without the confounding issues of algal growth and excretion, photolysis, inputs from groundwater, and leaching of benthic organic matter. Chamber incubations allow the isolation of different types of substrata (sediments versus rocks) and thus an ability to identify differences in the activities associated with communities colonizing the substrata. Estimates of DOM lability classes with the bioreactors agreed within 1% of whole-stream determinations while estimates of mass transfer coefficients of a semi-labile DOM form in chambers with streambed sediments agreed to within 20% of the whole-stream values. These comparisons give us confidence that the laboratory devices are good models systems for various in situ processes and that the scaling rules applied to the laboratory measurements are robust.

Kara, **E**. **L**., University of Wisconsin-Madison, Madison, USA, kara@wisc.edu

Hanson, P., University of Wisconsin-Madison, Madison, USA, pchanson@facstaff.wisc.edu

McMahon, K. D., University of Wisconsin-Madison, Madison, USA, tmcmahon@cae.wisc.edu

Hamilton, D., University of Waikato, Hamilton, New Zealand, davidh@waikato.ac.nz

Hipsey, M., University of Western Autralia, Perth, Australia, matt.hipsey@uwa.edu.au

Bertilsson, S., Uppsala University, Uppsala, Sweden, Stebe@ebc.uu.se

Wu, C., University of Wisconsin-Madison, Madison, USA, chinwu@engr.wisc.edu

Hseih, Y., University of Wisconsin-Madison, Madison, USA, yhsieh2@wisc.edu

Carey, C., Cornell University, Ithaca, USA, ccc99@cornell.edu

Rose, K., Miami University of Ohio, Miami, USA, rosekc@muohio.edu

MODELING PHYTOPLANKTON BLOOM DYNAMICS IN LAKE MENDOTA, WI WITH DYRESM CAEDYM

The Dynamic Reservoir Simulation Model (DYRESM), a hydrodynamic model, and the Computational Aquatic Ecosystem Dynamics Model (CAEDYM), a water quality model, were coupled and configured for Lake Mendota, WI, for the year 2008. We aim to simulate phytoplankton bloom dynamics, to identify antecedent bloom conditions in silico, and to gain insight into process controls (eg phytoplankton limitation functions) for this hyper eutrophic system. The model was setup, calibrated and validated for 2008 using biological and water quality observations resolved at a biweekly interval. Additionally, automated high-frequency observations of temperature, dissolved oxygen, pH, and chlorophyll-a for 2008 at finer temporal resolution are used for model validation. The scales at which the model accurately simulates in-lake conditions were assessed by validation of model output against observed data aggregated to different temporal and spatial scales. For 2008, we attain good agreement observed and simulated phytoplankton succession, and we speculate that the cyanobacterial bloom and senescence in Lake Mendota are not driven by nutrient inorganic nutrient limitations but by other factors.

Karam, **H**., Massachusetts Institute of Technology, Cambridge, USA, hnkaram@mit.edu
Abarca, E., Massachusetts Institute of Technology, Cambridge, USA, eabarca@MIT.EDU
Puckett, K., Massachusetts Institute of Technology, Cambridge, USA, kap@mit.edu
Hemond, H. F., Massachusetts Institute of Technology, Cambridge, USA, hfhemond@MIT.EDU
Harvey, C., Massachusetts Institute of Technology, Cambridge, USA, charvey@mit.edu

SEAWATER CIRCULATION THROUGH THE BEACH AT WAQUOIT BAY, MA: FLOW AND BIOGEOCHEMICAL DYNAMICS

Regular field surveys in the Summer of 2009 showed that a saline groundwater zone grows and wanes with a monthly period in the intertidal region at Waquoit Bay, MA, overlying fresh groundwater that flows towards the bay. The development of this saline circulation cell, originating from bay water that infiltrates into the sand at high tide, was found to track the lunar cycle which controls the tidal range. Furthermore, preliminary field data showed that infiltrated bay water does not flow conservatively through the beach: dissolved oxygen is consumed, pH drops and nitrate concentrations rise, in a manner that suggests decomposition of organic matter at elevated rates. Here we present data from an intensive field campaign to understand the flow and biogeochemical dynamics within this shallow subsurface circulation cell. Sampled porewater salinities and results from a tracer injection experiment are used to constrain a variable density groundwater flow model that successfully captures the tidal control on the development of this cell. High-resolution chemical measurements are used to model the biogeochemical transformation of bay water as it circulates through the beach, and to quantify the contribution of this circulation to nutrient cycling in the bay.

Karatayev, **A**. **Y**., Buffalo State College, Buffalo, USA, karataay@buffalostate.edu
Burlakova, L. E., Buffalo State College, Buffalo, USA, burlakle@buffalostate.edu
Mastitsky, S. E., Buffalo State College, Buffalo, USA, aliensinbelarus@gmail.com
Padilla, D. K., Stony Brook University, Stony Brook, USA, padilla@life.bio.sunysb.edu
Mills, E. L., Cornell Biological Field Station, Bridgeport, USA, elm5@cornell.edu
Karatayev, V. A., City Honors School, Buffalo, USA, vkaratayev@gmail.com

COMPETITIVE ABILITY VERSUS INVASION RATE: WHICH IS A BETTER INVADER, *DREISSENA POLYMORPHA* OR *DREISSENA ROSTRIFORMIS BUGENSIS*?

Although *Dreissena polymorpha* and *D. r. bugensis* are closely related, have similar dispersal potential, and share a native habitat, *D. polymorpha* has been a better invader than *D. r. bugensis* both in Europe and North America. However during recent decades, quagga mussels are expanding and often displacing zebra mussels where the two co-occur. We found that the zebra mussel has a higher invasion rate than the quagga mussel at regional, local, and waterbody scales throughout their invasion history. We also found that the time lag between when a species was first detected in a waterbody and it reached its maximum population density was much shorter for the zebra mussel (2-4 years) than for the quagga mussel (6-19 years). Although in many waterbodies *D. r. bugensis* has been reported to outcompete *D. polymorpha*, local competition may be much more dependent upon local environmental conditions and will determine which dreissenid species is to become dominant. However, even lakes where quagga mussel dominate (e. g. lakes Erie and Ontario), could act as sources for the zebra mussels invasion.

Karimi, **R**., Stony Brook University, Stony Brook, USA, rkarimi@notes.cc.sunysb.edu
Fisher, N. S., Stony Brook University, Stony Brook, USA, nfisher@notes.cc.sunysb.edu

EFFECTS OF SELENIUM ON METHYLMERCURY BIOACCUMULATION IN *DAPHNIA*

Selenium (Se) is thought to protect against methylmercury (MeHg) bioaccumulation and toxicity. However, there have been few controlled studies addressing Se-MeHg interactions in lower trophic level organisms. We tested for the effect of Se concentration on MeHg bioaccumulation in the freshwater zooplankton, *Daphnia pulex*, a major source of MeHg for lake fish. Using a MeHg radiotracer, we measured changes in MeHg concentrations in juvenile *Daphnia pulex* fed phytoplankton (*C. reinhardtii*) with high, low, or no Se for 5 d. Our results show that *Daphnia* exposed to the high Se concentration had greater short term MeHg loss through fecal production compared to *Daphnia* exposed to low or no Se. However, Se had no effect on longer term MeHg release rate. Overall, these findings suggest that while elevated Se concentrations can reduce *Daphnia* MeHg bioaccumulation and trophic transfer, these effects are unlikely at low Se concentrations commonly found in undisturbed, natural systems.

Karwan, **D**. **L**., Yale University, New Haven, USA, diana.karwan@yale.edu
Saiers, J. E., Yale University, New Haven, USA,

COMPARISON OF SOLUTE TRANSPORT AND VERY FINE PARTICLE TRANSPORT IN A NEW ENGLAND STREAM

Solute transport models have been used to quantify the downstream movement of conservative and reactive chemical species. This study compares conservative solute transport to the movement of a tracer composed of very fine suspended particles. Fine particle tracers, such as titanium dioxide and kaolinite, have diameters less than one micron, and settling velocities that are negligible when compared to streamflow rates. Results of reach scale injection experiments indicate streamflow matters when comparing the transport of solutes and sub-micron particles. Under high flow conditions, when transient storage is negligible, very fine particle transport mimics that of a conservative solute. However, as flow decreases, and hyporheic exchange increases, the transport of these particles and solutes differs. Further modeling, which incorporates sub-surface particle transport, gives insights into the transport differences and quantifies fine particle filtration by streambed sands. When entering the streambed, approximately 50 – 75% of particles are retained while the conservative solute exits. In addition to answering questions about particle transport, comparing solute and sub-micron particle movement elucidates differences in transient storage between stagnant surface areas and the hyporheic zone.

Kashian, **D**. **R**., Wayne State University, Detroit, USA, dkashian@wayne.edu
Oates, R. H., Wayne State University, Detroit, USA, hunter.oates@gmail.com
Johengen, T. H., University of Michigan, Ann Arbor, USA, Tom.Johengen@noaa.gov
Burtner, A. M., University of Michigan, Ann Arbor, , aburtner@umich.edu
Robinson, S. R., Wayne State University, Detroit, USA, ee0541@wayne.edu

BIOTIC AND PHYSICAL INFLUENCES ON INTERNAL PHOSPHORUS LOADING IN A GREAT LAKES COASTAL ECOSYSTEM.

Saginaw Bay is a eutrophic embayment of Lake Huron with excess nutrient loading from a largely agricultural watershed. Despite ongoing efforts to reduce nutrient loads, phosphorus levels remain elevated. We assessed the potential importance of internal phosphorus loading; focusing on influences of sediment type, oxygen levels and dreissenid mussels on sediment phosphorus fluxes. Sediment cores were collected from three regions of the bay, and assessed for carbon, nutrients, porosity and bulk density. These cores were utilized in two separate incubation experiments evaluating: 1) sediment P flux under aerobic and anaerobic conditions, and 2) nutrient remineralization from mussel biodeposits when added to the surface of the cores. Anaerobic treatments exhibited significantly higher P release back to overlying waters ($p < 0.05$) when compared to aerobic treatments. This release was greatest in sediments collected from the depositional zone. These results may indicate that contributions of P from sediments in Saginaw Bay are controlled by episodic anoxic events in this region. Results from the second experiment found no P release from dreissenid biodeposits in the timeframe of the study. This may raise further questions of remineralization rates of biodeposits when assessing loading effects.

Katz, **R**. **A**., University of Georgia, Athens, USA, rakatz@uga.edu
Freeman, M. C., USGS Patuxent Wildlife Research Center, Athens, USA, mary@ttrout.ecology.uga.edu

EFFECT OF LOW FLOW EVENTS, CAUSED BY DROUGHT AND WATER WITHDRAWALS, ON NET-SPINNING CADDISFLY LARVAL INSTAR DENSITIES

Streamflow alterations, such as drought or managed flow, can influence the abundance and production of aquatic taxa. To assess ecological impacts of changes in flow, it is essential to estimate the importance of flow features, such as frequency and duration of flow events, in regulating flow-dependent macroinvertebrates. We evaluated the influence of differing aspects of reduced streamflow, caused by the coupling of drought and water withdrawals (2007 – 2008), on two net-spinning caddisfly genera (Hydropsychidae: *Hydropsyche spp*. and *Cheumatopsyche spp*.)

in a Piedmont river shoal near Athens, Georgia (US). Results indicated that the frequency and duration of low-flows, flow variability, and mean depth alternately provided best predictions of larval densities and depended on genus and instar. Contrary to expected, most instars had higher densities at sites most vulnerable to periodic dewatering, rather than in nearby microhabitats with more consistent flow during pulsed low-flow events. We hypothesize that low-flow periods decreased fast-velocity habitats preferred by net-spinning caddisflies, resulting in declines in hydropsychid abundance (85 %) and production (88 %) when compared to previous (1991-92) estimates at the study site.

Kaufmann, **P. R.**, U.S. Environmental Protection Agency, Corvallis, Oregon, USA, kaufmann.phil@epa.gov
Peck, D. V., U.S. Environmental Protection Agency, Corvallis, Oregon, USA, peck.david@epa.gov
Paulsen, S. G., U.S. Environmental Protection Agency, Corvallis, Oregon, USA, paulsen.steve@epa.gov

PHYSICAL HABITAT STRUCTURE OF THE LAKE SHORELINE AND LITTORAL ZONE --- HOW IMPORTANT IS IT?

The recent National Lakes Assessment (NLA) included the first national assessment of littoral and lakeshore physical habitat. It quantified water depth, surface characteristics, bank morphology, lake level fluctuations, substrate, fish concealment features, aquatic macrophytes, lakeshore vegetation, and human land use. We summarized this data with four integrative measures of lake condition: 1) lakeshore human disturbance extent and intensity; 2) riparian vegetation cover and structure; 3) littoral cover complexity, including woody snags and aquatic macrophytes; and 4) a combined index of littoral and riparian habitat structural complexity. In this first nationwide lakes assessment, we concluded that lack of vegetative cover and near-shore habitat complexity are the most important of the physical and chemical stressors we evaluated in lakes and reservoirs, both in terms of numbers of lakes affected and relative risk to biota. Attributable-risk analysis suggested that in 42% of lakes with poor biological condition, nationwide (22%), poor condition could be attributed to poor vegetation cover. These results suggest that management of littoral and lakeshore physical habitat should receive emphasis more in line with that traditionally placed on nutrients and acidification.

Kawanishi, **R.**, Ehime University, Matsuyama, Japan, v855001m@mails.cc.ehime-u.ac.jp
Inoue, M., Ehime University, Matsuyama, Japan,
Miyake, Y., Ehime University, Matsuyama, Japan,

IMPORTANCE OF HYPORHEIC REFUGIA DURING DRYING TO PERSISTENCE OF A BENTHIC FISH POPULATION IN AN INTERMITTENT BRADED RIVER, SOUTHWESTERN JAPAN

In lotic systems, hyporheic zone is regarded as refugia for some aquatic animals during disturbances. However, few studies have reported use of hyporheic refugia by fishes during drying. In this study, we present circumstantial evidence that hyporheic zone has an important role in persistence of a benthic fish (spinous loach *Cobitis shikokuensis*) in an intermittent braded river by providing refugia during drying periods. In an intermittent reach (2.2 km in length) of the Shigenobu River, we monitored presence/absence of surface flow and spinous loach densities at 14-17 sites during a period when surface flow repeatedly dried and recovered (July-September 2009). Loaches captured from isolated pools were marked and released. Further, we sampled hyporheic water with a hand bilge pump when surface water dried up. The monitoring revealed rapid recolonization by spinous loach after drying. During drying, two individuals were caught from underground of dried channels by the bilge pump sampling. When water recovered, a marked individual was recaptured from a pool that had been completely dried. These results strongly suggest the importance of hyporheic refugia in the intermittent river.

Keller, **K. A.**, Rochester Institute of Technology, Rochester, USA, kellerkev14@comcast.net
Waud, J. M., Rochester Institute of Technology, Rochester, USA, jmwscl@rit.edu
Neuderfer, G. N., NYSDEC, Rochester, USA, gneuderfer@gmail.com

A 2009-2010 SIXTEEN YEAR FOLLOW-UP: BIOLOGICAL MONINTERING ASSESSEMT OF OATKA AND SPRING CREEKS IN UPSTATE NEW YORK

Continued development in Rochester, New York and in the surrounding Monroe County area, represents a threat to Oatka Creek's water quality and the trout fishery it supports. In addition to the trout fishery and many other important fish populations that call the creek home, Oatka Creek also has the unique position of supporting many human settlements at points along its banks. The polluting of the creek would not only harm the fish and other wildlife, but would affect the human populations living in the area as well. Macroinvertebrates were sampled and identified from each of four sites along Oatka Creek. From the data taken from the various samples, several indices of the stream health can be derived: Percent Model Affinity (PMA); Ephemeroptera, Plecoptera, and Trichoptera value (EPT); Hilsenhoff Biotic Index (HBI); Relative Abundance (RA); and Family Biotic Index (FBI). These indices present a clear and complete picture of the state of health at Oatka Creek. The presentation will present the calculated indices and interpret them with respect to water quality in the Oatka Creek.

Kelley, **C. A.**, University of Missouri, Columbia, USA, kelleyc@missouri.edu
Poole, J., University of Missouri, Columbia, USA, jpyq9@mail.missouri.edu
Chanton, J. P., Florida State University , Tallahassee, USA, jchanton@fsu.edu
Tazaz, A., Florida State University, Tallahassee, USA, tazaz@ocean.fsu.edu
Bebout, B. M., NASA Ames Research Center, Moffett Field, USA, Brad.M.Bebout@nasa.gov

METHANOGENESIS IN HYPERSALINE ENVIRONMENTS

Motivated by the Mars rovers' findings of past hypersaline environments and the discovery of methane in the atmosphere of Mars, we examined methanogenesis in hypersaline ponds in Baja California Sur and in the Don Edwards National Wildlife Refuge in northern California. Salinities of the ponds ranged from 55 to 320 ppt. In lower salinity ponds, well-laminated microbial mats grew; in higher salinity ponds, crusts of gypsum and halite occurred. We found methane production occurring at all sites, with some of the highest production occurring within the gypsum crust. We were also able to obtain methane-rich bubbles from these sites. The carbon stable isotopic composition of the methane in these bubbles ranged from -30 to -63 o/oo, initially suggesting a range of substrate use. To determine the dominant substrate used by the methanogens, 13C-labeled substrates were incubated with mat, sediments or crust. In all case, the methylamines and methanol appeared to be the main substrate incorporated. Rather than a range in substrate use, as initially thought, the 13C-enriched methane produced at these sites may instead indicate near-complete substrate utilization.

Kelly, **J. L.**, University of Hawaii at Manoa, Honolulu, USA, jlkelly@hawaii.edu
Glenn, C. R., University of Hawaii at Manoa, Honolulu, USA, glenn@soest.hawaii.edu

DETERMINATION OF CHLOROFLUOROCARBON APPARENT AGES IN GROUNDWATER FROM THE WEST SIDE OF THE ISLAND OF HAWAII

Large quantities of nutrient-enriched groundwater are supplied to coastal west Hawaii via point-sourced and diffuse groundwater seepage sites as submarine groundwater discharge. These inputs are especially important given that they are the only freshwater source to the coastal zone due to the absence of perennial streams. It has been suggested that discharging groundwaters are less than 50 years old; yet, the apparent ages of these groundwaters have not been investigated, despite the copious water volumes discharging to the coastal zone. Apparent age data is crucial to fully understand nutrient transformations along groundwater flow paths and will help constrain groundwater residence times. Water samples from eighteen locations were collected in triplicate for apparent age determination. Sample chlorofluorocarbon concentrations were modeled using single, duel, and multiple water source models. The single water source model does not fit the data, given the area's complex aquifer geometries and flow networks. The dual and multiple water source models fit the data and indicate that some water is greater than 50 years old, and that average residence times can vary greatly from location to location.

Kennedy, **T**. **A**., USGS, Flagstaff, USA, tkennedy@usgs.gov
Cross, W. F., Montana State University, Bozeman, USA, wyatt.cross@montana.edu
Baxter, C. V., Idaho State University, Pocatello, USA, coldenbaxter@gmail.com
Donner, K., Idaho State University, Pocatello, USA, evolve_h20@yahoo.com
Rosi-Marshall, E. J., Cary Institute of Ecosystem Studies, Millbrook, USA, rosimarshalle@caryinstitute.org
Hall, R. O., University of Wyoming, Laramie, USA, bhall@uwyo.edu
Behn, K. E., University of Wyoming, Laramie, USA, kbehn@uwyo.edu
Kincaid, D., Cary Institute of Ecosystem Studies, Millbrook, USA, dustinkincaid@gmail.com
Copp, A., USGS, Flagstaff, USA, acopp@usgs.gov

THE USE OF INVERTEBRATE DRIFT IN COMBINATION WITH FLOW FOOD WEBS TO EVALUATE THE EFFECTS OF A CONTROLLED FLOOD ON A TAILWATER TROUT POPULATION

Flow food webs and production-budget analyses can be used to assess the potential for food limitation in salmonid populations, but invertebrate production may overestimate available food if prey are invulnerable to predation because they rarely drift. We evaluated the effects of a March 2008 controlled flood on food availability for the rainbow trout population below Glen Canyon Dam (Colorado River, Arizona) by evaluating invertebrate production, drift and diets of trout two years before and one year after the flood. We found the flood strongly reduced total invertebrate production (from 29 to 13 g AFDM m^2 yr^{-1}) but production of two less-common taxa increased (chironomidae—0.6 to 0.9 g AFDM m^2 yr^{-1}; simuliidae—0.2 to 1.2 g AFDM m^2 yr^{-1}). In contrast, invertebrate drift loads increased by 2X after the flood (from ~27 to 54 mg sec^{-1}). Moreover, proportionately more chironomidae and simuliidae production was found in drift relative to other taxa (10-15% vs. <1-3%), and consumption of these taxa increased in trout diets after the flood. Our comparisons highlight the strength of using both invertebrate production and drift to assess food availability for salmonids.

Kerfoot, **W**. **C**., Michigan Technological University, Houghton, USA, wkerfoot@mtu.edu
Churchill, J. H., Woods Hole Oceanographic Institution, Woods Hole, USA, jchurchill@whoi.edu
Chen, C., University of Massachusetts-Dartmouth, New Bedford, USA, c1chen@umassd.edu

CLIMATE AND FOOD WEB INTERACTIONS IN TIME AND SPACE

A combination of physical exchange modeling and experimental paleoecological approaches offer opportunities to test interactions in space and time. Linked embayment-coastal zone models (FVCOM, upwelling/downwelling reversals of flows) offer insight into effects of climate change and mechanisms of dispersal of both endogenous and introduced species. Diapausing eggs can be retrieved from embayment sediment cores to document long-term predator and prey exchanges, quantify colonization and extinction rates, and permit calculation of species site-specific turn-over rates. Dating of embayment sediments allows determination of timing and successional responses to site-specific perturbations (deforestation, mining, eutrophication). Moreover, diapausing eggs can be hatched from different sediment levels for genetic characterization (allozyme electrophoresis, mDNA 12S/16S, microsatellite sequences) and "common garden" experiments. We can begin to inquire how rates of evolution allow prey and predators to coexist or if associations are too transitory to permit coexistence.

Kernan, **M**., Environmental Change Research Centre, University College London, London, United Kingdom, m.kernan@ucl.ac.uk

THE EFFECTS OF INTERACTIONS BETWEEN CLIMATE CHANGE AND OTHER KEY DRIVERS OF CHANGE ON FRESHWATER ECOSYSTEMS – THE MESSAGE FOR MANAGERS

This presentation is concerned with the science required to understand and manage the ecological consequences for freshwater ecosystems of the interactions between key drivers of aquatic ecosystem change (land-use, nutrients, acid deposition and toxic substances) and climate, change. Here we summarise research focused on improving our understanding of these interactions can change the structure and functioning of freshwater ecosystems. Currently, climate change is an additional stressor adding to these impacts. In future, however, the effects of climate change are expected to become more prominent. This has implications for managers and those tasked with implementing environmental legislation. We focus on; i) the use of predictive, testable catchment models, for catchment management; ii) the use of ecological indicators for monitoring freshwater ecosystem health; and iii) the development of methods for defining reference conditions and restoration strategies which take into account the probable impacts of future climate change. The tools generated by these approaches provide a framework for managers to incorporate the effects of climate into remediation and adaptation measures.

Kicklighter, **D**. **W**., Marine Biological Laboratory, Woods Hole, MA, USA, dkicklighter@mbl.edu
Wollheim, W. M., University of New Hampshire, Durham, NH, USA, wil.wolheim@unh.edu
Fekete, B. M., City University of New York, New York City, NY, USA, bfekete@ccny.cuny.edu
Melillo, J. M., Marine Biological Laboratory, Woods Hole, MA, USA, jmelillo@mbl.edu
Peterson, B. J., Marine Biological Laboratory, Woods Hole, MA, USA, bpeterson@mbl.edu
Vörösmarty, C. J., City University of New York, New York City, NY, USA, cvorosmarty@ccny.cuny.edu

IMPORTANCE OF LAND-WATER INTERACTIONS FOR CARBON AND NITROGEN BALANCE OF TERRESTRIAL ECOSYSTEMS WITHIN THE MISSISSIPPI RIVER BASIN

Complete carbon and nitrogen budgets for terrestrial ecosystems must not only account for exchanges of these elements between the land and the atmosphere, but also for movement from the land to adjacent river networks. Preliminary estimates using the Terrestrial Ecosystem Model (TEM) indicate that the export of DOC from terrestrial ecosystems to the Mississippi River network may account for as much as 50% of the atmospheric carbon normally assumed to be sequestered by these ecosystems over the 20th century. Furthermore, the export of DON from these ecosystems may account for as much as 15% of the nitrogen added to the watershed through fertilizer application, atmospheric nitrogen deposition and nitrogen fixation, and may be five times larger than concurrent export of DIN. After coupling TEM with an aquatic ecosystem model to route material through the river system, preliminary comparisons with observations at the Mississippi basin mouth suggest that the derived DOC estimates are reasonable, while DIN is underestimated. Linkage of terrestrial and aquatic process models will be necessary to understand the fate of carbon and nitrogen with continuing global change.

Kilroy, **C**., National Institute of Water & Atmospheric Research Ltd., Christchurch, New Zealand, c.kilroy@niwa.co.nz
Bothwell, M. L., Environment Canada, Nanaimo, Canada, max.bothwell@dfo-mpo.gc.ca

ENVIRONMENTAL CONTROL OF STALK LENGTH IN THE BLOOM-FORMING FRESHWATER BENTHIC DIATOM *DIDYMOSPHENIA GEMINATA*

Blooms of the stalked diatom *Didymosphenia geminata* typically occur in oligotrophic, unshaded waterways. Observations that proliferations comprise primarily stalk material composed of extracellular polymeric substances (EPS) led us to ask whether EPS production is favoured by nutrient limitation and high light. We conducted experiments in outdoor flumes colonised with *D. geminata* using water from the *D. geminata*-affected, oligotrophic Waitaki River, South Island, New Zealand, to determine the relationship between stalk length, cell division rates (as frequency of dividing cells, FDC) and light intensity under nutrient-poor and nutrient-enriched conditions. While FDC responded positively both to increasing light intensity and to nutrient additions, stalk lengths responded to light intensity and nutrient additions in opposite directions. Under nutrient-poor conditions, stalk length increased as light level increased. However, nutrient enrichment resulted in shorter stalks, with lengths generally negatively correlated with FDC. Our results suggest that extensive stalk generation in *D. geminata* occurs when cell division rates are nutrient-limited and photosynthetic rates are high. This pattern of EPS production in *D. geminata* could contribute to the development of very high biomass in oligotrophic waters.

Kim, **D**., The University of Adelaide, Adelaide, Australia, dae.h.kim@adelaide.edu.au
Aldridge, K. T., The University of Adelaide, Adelaide, Australia, kane.aldridge@adelaide.edu.au
Brookes, J. D., The University of Adelaide, Adelaide, Australia, justin.brookes@adelaide.edu.au
Ganf, G. G., The University of Adelaide, Adelaide, Australia, george.ganf@adelaide.edu.au

THE EFFECT OF SALINITY ON THE GERMINATION OF SEEDS AND TURIONS OF RUPPIA TUBEROSA IN THE COORONG, SOUTH AUSTRALIA

Ruppia tuberosa is a critical macrophyte of the Coorong ecosystem, a coastal lagoon of South Australia. However R. tuberosa distribution and abundance has declined substantially, coinciding with a period of salinisation. The effect of salinity on the germination of seeds and turions of R. tuberosa were examined under controlled conditions for a 3 month period at salinities of 0 to 240 mS cm-1. Seed germination was greatest between 0 and 125 mS cm-1 (26-29% of seeds germinated), but no seeds germinated above 125 mS cm-1. In comparison, the germination of turions occurred at salinities between 0 and 165 mS cm-1 and was greatest at 65 mS cm-1 with 74% germinating. Seeds that did not germinate at initial salinities above 125 mS cm-1 did germinate when transferred to lower salinities. This suggests that high salinity inhibits seed germination but they remain viable. Seed germination of R. tuberosa is likely to be restricted to the less saline northern half of the Coorong. In contrast, turion germination should be possible throughout the Coorong, although the time taken to achieve maximum germination would decrease from 74 % in 24 days to 14 % in 55 days in as the salinity increases. The study suggests that germination failure induced by increased salinity is one of the principal factors causing the observed decline of the distribution of R. tuberosa in the Coorong.

Kim, **G**., Seoul National University, Seoul, Republic Of Korea, gkim@snu.ac.kr
Koo, S., Seoul National University, Seoul, Republic Of Korea, skfkr802@snu.ac.kr
Kim, I., Seoul National University, Seoul, Republic Of Korea, ttol0731@snu.ac.kr
Oh, Y., Seoul National University, Seoul, Republic Of Korea, lsjlov@hanmail.net
Kim, J., Seoul National University, Seoul, Republic Of Korea, posseidon21@snu.ac.kr
Lee, Y., Pusan National University, Pusan, Republic Of Korea, wbluesea@hanmail.net

GEOCHEMICAL AND ECOLOGICAL CONSEQUENCES OF SUBMARINE GROUNDWATER DISCHARGE IN THE OCEAN

We evaluated the consequences of submarine groundwater discharge (SGD) in terms of the following three aspects: (1) behavior of U, REE, and trace elements in subterranean estuaries; (2) behavior of nutrients, DON, amino acids, and colored dissolved organic matter in subterranean estuaries; and (3) ecological consequences (red tide outbreaks, primary production, and benthic production) in the coastal ocean. SGD plays a central role as a U source/sink, REE source, and trace element source in the coastal environment, particularly in volcanic islands. In subterranean estuaries, the transformations of nutrients (adsorption, desorption, and degradation) are complex and often more significant than in surface estuaries, and SGD is the dominant source of excess nutrients in many coastal bays in Korea. Most of the dissolved organic matter in subterranean estuaries is of marine origin in tidal flat environments; however, it includes significant humic-like DOM, which might have been introduced directly from the atmosphere or surface runoffs to marine sediments. We found that SGD plays an important role in benthic and water-column production in tidal flat environments and in coastal red tide outbreaks in the southern sea of Korea.

Kim, **I**., Seoul National University, Seoul, Republic Of Korea, ttol0731@snu.ac.kr
Kim, J., Seoul National University, Seoul, Republic Of Korea, posseidon21@snu.ac.kr
Jeong, J., Seoul National University, Seoul, Republic Of Korea, samo0797@snu.ac.kr
Kim, G., Seoul National University, Seoul, Republic Of Korea, gkim@snu.ac.kr

SUBMARINE GROUNDWATER DISCHARGE AS AN IMPORTANT SOURCE OF RARE EARTH ELEMENTS IN SEAWATER OFF A VOLCANIC ISLAND, JEJU

We determined submarine groundwater discharge (SGD) associated discharge of REE into two semi-enclosed bays off the volcanic island of Jeju, Korea. The REE concentrations in brackish groundwater were 1 to 2 orders of magnitude higher than those in coastal seawater. The groundwater samples showed elevated MREE patterns when normalized to the PAAS, and the MREE enrichments were clearly evident in bay waters as a consequence of mixing between groundwater and offshore seawater. SGD was estimated using a ^{222}Rn mass balance, and the REE (i.e., Nd) fluxes through SGD were determined by multiplying the SGD fluxes by REE end-members. The calculated fluxes of Nd through SGD were 2 to 3 orders of magnitude higher than those through all other sources. The magnitudes of SGD based on a Eu_{SN}/Lu_{SN} mixing model, assuming conservative $MREE_{SN}/HREE_{SN}$ ratios during inner-bay mixing processes, agreed well with those from ^{222}Rn tracer analysis. Our results imply that the contribution of SGD to the REE budget in the ocean could be considerably larger than previously thought, and that REE may serve as a good SGD tracer off volcanic islands.

Kimbirauskas, **R**. **K**., Michigan State University, East Lansing, USA, kimbira1@msu.edu
McIntosh, M. D., Michigan State University, East Lansing, USA, mcinto57@msu.edu
Benbow, M. E., University of Dayton, Dayton, USA, benbowme@notes.udayton.edu
Merritt, R. W., Michigan State University, East Lansing, USA, merrittr@msu.edu

BENTHIC MACROINVERTEBRATE METRICS ASSOCIATED WITH MYCOBACTERIUM ULCERANS IN GHANA, WEST AFRICA

Buruli ulcer (*Mycobacterium ulcerans* infection) is an emerging skin disease resulting in ulcerations that can lead to severe and lasting morbidity. Mode of transmission is unclear; however, incidence of human infection is commonly linked to freshwater environments, with high prevalence associated with increased land use and decreased water quality. Research has implicated aquatic invertebrates as environmental reservoirs of *M. ulcerans* (MU) and some Hemiptera as potential vectors of Buruli ulcer; yet, much is still unknown regarding the ecology of these insect communities and pathogen distribution. The purpose of our study was to 1) identify macroinvertebrate community metrics (MCMs) associated with MU, and 2) identify potential relationships between specific macroinvertebrates and MU. We found that after accounting for lentic and lotic habitats, there were significant differences in specific MCMs in relation to MU. Indicator Species Analysis also revealed several taxa to be associated with MU presence. Results from this large survey of aquatic environments in Ghana suggest that macroinvertebrate communities and individual taxa may be useful sentinels for initial identification of pathogen presence or habitat conditions associated with disease agent transmission.

King, **R**. **S**., Baylor University, Waco, TX, USA, ryan_s_king@baylor.edu
Baker, M. E., University of Maryland-Baltimore Co., Baltimore, MD, USA, mbaker@umbc.edu

CONSIDERATIONS FOR ANALYZING ECOLOGICAL COMMUNITY THRESHOLDS IN RESPONSE TO ANTHROPOGENIC ENVIRONMENTAL GRADIENTS

Aggregate-community metrics, such as taxa richness or multimetric indices, may not be reliable indicators of ecological community thresholds. We offer an alternative approach, Threshold Indicator Taxa ANalysis (TITAN), designed to identify the location of synchronous changes in the distribution of taxa as evidence for a community threshold. To illustrate, we first examine macroinvertebrate-community response to an impervious-cover gradient to show that representative community metrics are relatively insensitive to synchronous-threshold declines of individual taxa revealed by TITAN. We then reproduce these relationships using a simulated data set with similar properties to demonstrate that linear or wedge-shaped responses of community metrics to anthropogenic gradients can occur as an artifact of aggregating multiple taxa, despite strong nonlinearity in community response. TITAN is both sensitive and precise, whereas the broader analysis framework underscores that we care about which taxa are affected by stressors, both from a conservation standpoint and because taxon-specific life-history traits help us understand relevant mechanisms. Taxa should only be aggregated into threshold 'metrics' after distinguishing the magnitude, direction, and uncertainty in the response of individual members of the community.

Kinsman, **L**. **E**., Kellogg Biological Station, Hickory Corners, USA, kinsmanl@msu.edu
O'Brien, J. M., University of Canterbury, Christchurch, New Zealand, obrien97@msu.edu
Hamilton, S. K., Kellogg Biological Station, Hickory Corners, USA, hamilton@kbs.msu.edu

WETLAND SEDIMENT BIOGEOCHEMISTRY DETERMINES EFFECT OF DRYING AND REWETTING ON PHOSPHORUS FLUX

Wetlands and shallow freshwater ecosystems are often relied upon to retain excess phosphorus. Such ecosystems are subject to natural water level fluctuations, and human modifications often cause unnatural fluctuations and/or stabilization, which may alter sediment P dynamics. Phosphorus binding and release is controlled by many factors including redox, iron, sulfur, and organic matter quantity and quality, with relative importances varying greatly among wetlands. The net effect of hydrologic regime is likely contingent on sediment biogeochemistry. We subjected sediments from sixteen biogeochemically diverse wetlands to either stabilized flooding or drying and re-flooding using lab cores. Sediment P flux responses significantly depended on sediment type. In most sediment types, dried and re-flooded sediment released more P than continously flooded sediment, but in two sediment types flooded treatments released more, and in some there was no effect. Changes in pore water iron, sulfide, nitrate, and sulfate, and in sediment characteristics provide insight into mechanisms behind the variable responses. The response of wetland sediment P binding to alterations in hydrologic regime could be better predicted with prior knowledge of specific sediment biogeochemistry.

Kirk, **J**. **L**., Environment Canada, Burlington, Canada, Jane.Kirk@ec.gc.ca
Muir, D., Environnment Canada, Burlington, Canada, Derek.Muir@ec.gc.ca
St. Louis, V. L., University of Alberta, Edmonton, Canada, Vince.StLouis@ualberta.ca
Lehnherr, I., University of Alberta, Edmonton, Canada, lehnherr@ualberta.ca
Lamoureux, S., Queen's University, Kingston, Canada,
Stewart, K., Queen's University, Kingston, Canada,
Lewis, T., Queen's University, Kingston, Canada,
Yang, F., Environment Canada, Burlington, Canada, Fan.Yang@ec.gc.ca
Iqaluk, D., , Resolute, Canada,

THE TRANSFER OF TERRESTRIAL MERCURY TO FRESHWATER AQUATIC ECOSYSTEMS OF THE CANADIAN HIGH ARCTIC

We are examining the impact of climate change on the release of terrestrial mercury (Hg) to two adjacent Canadian Arctic lakes of Melville Island, Nunavut, (West and East) which are undergoing climate-related changes at different rates. West catchment, for example, experienced severe permafrost degradation in 2007-2008 while East catchment experienced only minor disturbances. Preliminary calculation of total Hg exports to the lakes from their major inflows indicate that between 2007 and 2008, West River exports doubled (~37 versus 87 g/year) while East River exports remained constant (65 versus 61 g/year). Hg concentrations in Arctic Char of West Lake (0.148 ug/g) were significantly higher than those in East Lake (0.104 ug/g). However, lake water methylmercury (MeHg; the bioaccumulative form of Hg) concentrations were slightly higher in East than in West lake (0.07±0.50 versus 0.04±0.02 ng/L) suggesting that MeHg availability is not driving differences in Char Hg. $\delta^{13}C$ and $\delta^{15}N$ analysis indicate that Char in the two lakes have different food sources, potentially explaining their differences in Hg concentrations; we are therefore analyzing MeHg in lower foodweb organisms to test this hypothesis.

Kirsch, **K**. **M**., Oklahoma State University, Stillwater, USA, katrina.kirsch@okstate.edu
Dzialowski, A. R., Oklahoma State University, Stillwater, USA, andy.dzialowski@okstate.edu

EXPERIMENTAL IMPACTS OF THE INVASIVE ZEBRA MUSSEL (DREISSENA POLYMORPHA) ON WATER QUALITY PARAMETERS AND ALGAL COMMUNITY COMPOSITION

Zebra mussels have been shown to impact invaded ecosystems in a number of important ways. Few experiments, however, have been conducted to quantify the effects of zebra mussels on reservoirs relative to other aquatic habitats. Individual, short-term (96 hour) laboratory microcosm experiments were conducted to determine how zebra mussels affected several water quality parameters and algal community composition in water collected from three Kansas reservoirs of varying trophic states (mesotrophic to eutrophic). Zebra mussels significantly reduced algal biomass (measured as chlorophyll a and total algal biovolume) and turbidity in each of the three microcosm experiments. While zebra mussels were also able to reduce the total biovolume of cyanobacteria in each experiment, the effects on other major algal groups (diatoms, flagellates, and green algae) were varied. Similarly, the effects of zebra mussels on nutrient concentrations varied across the three experiments. Combined, our results suggest that zebra mussels have the potential to significantly impact water quality in reservoirs of varying trophic states. However, additional studies are needed to verify these results under conditions that better mimic natural systems.

Kissman, **C**. **E**., Miami University, Oxford, USA, kissmac@muohio.edu
Williamson, C. E., Miami University, Oxford, USA, willia85@muohio.edu
Saros, J. E., University of Maine, Orono, USA, jasmine.saros@maine.edu
Rose, K. C., Miami University, Oxford, USA, rosekc@muohio.edu

THE ROLE OF CLIMATE INDUCED TROPHIC FORCING IN ALPINE LAKE ECOSYSTEMS: COUPLING PLANKTON DYNAMICS TO SEDIMENT SIGNALS

We investigated two mechanisms by which climate change affects lake ecosystems to account for recent changes in sediment diatom assemblages in Central Rocky Mountain alpine lakes. Climate forcing alters physical conditions within lakes, i.e. temperature and dissolved organic material (DOM) that directly influence diatom communities. Alternatively, climate change may modify higher trophic levels, and through altered food web interactions, result in the trophic forcing of diatom communities. To test these mechanisms, we simulated climate change conditions (± DOM and varying temperature) and trophic forcing (± zooplankton) in a field experiment to determine effects on plankton. Laboratory and field zooplankton grazing and sedimentation experiments where the dominant zooplankton species were varied helped to identify how climate induced changes in the zooplankton assemblage may shape sediment diatom assemblages. Climate change conditions increased zooplankton biomass yet decreased grazing rates. Trophic forcing altered the phytoplankton community. Grazing and sedimentation experiments revealed evidence of selective grazing by the two dominant zooplankton species, and subsequent differential sedimentation of fragmented diatoms. These results suggest the importance of trophic forcing when assessing evidence of climate change from lake sediments.

Kitchell, **J**., Univ. of Wisconsin, Madison, USA, Kitchell@wisc.edu

CLIMATE CHANGE INCREASES IMPACT OF SEA LAMPREY IN LAKE SUPERIOR

Adult sea lamprey size has increased substantially during the period of 1960 to present. Three causative agents contributed. Establishment of the lamprey control program and closure of commercial fisheries in the late 1950's allowed recovery of the remaining lake trout stocks to levels now approximating pre-lamprey abundance. The third agent owes to climate change effects. Lake Superior's average annual surface temperature has sharply increased since 1980 and is now exhibiting the most rapid warming rate of all lakes (1.2 C per decade). Food web interactions have intensified due to an extended period of positive thermal stratification. Growth rates of lamprey have increased in response to temperature changes. Although lamprey abundance remains low, larger lampreys kill more hosts and have increased fecundity. Both raise the challenges of management for Great Lakes resources.

Klim, D. M., Arcadia University, Glenside, USA, dklim@arcadia.edu
Sei, **M**., Miami University, Oxford, USA, seim@muohio.edu
Berg, D. J., Miami University Hamilton, Hamilton, USA, bergdj@muohio.edu
Lang, B. K., New Mexico Department of Game and Fish, Santa Fe, USA, brian.lang@state.nm.us

COMPARISON OF BIODIVERSITY PATTERNS AMONG FOUR NORTHERN CHIHUAHUAN DESERT SPRINGS

Aquatic habitats within arid ecosystems support high endemism. They are also at elevated risk of habitat deterioration due to human population pressure. We surveyed four permanent springs in the northern Chihuahuan Desert four times of southeastern New Mexico in 2007-08, in order to estimate species biodiversity. We took benthic grabs and submergent vegetation sweeps, varying sampling intensity according to the size of the springhead. We also took grab and sweep samples downstream of the springheads. For each combination

of location, sampling method and season, we calculated species diversity, evenness, and dominance. We also calculated taxonomic similarity between pairs of locations, sampling methods and seasons. We found that sweep samples captured larger biodiversity than benthic grab samples. Communities captured by benthic grabs and sweeps were also dissimilar. Diversity and similarity did not significantly change by season or location within a stream continuum, although Trichoptera were only captured during colder months in lower-elevation springs. We strongly recommend combination of sampling methods and inclusion of multiple seasons for biodiversity monitoring implementation.

Knights, **B**. **C**., U.S. Geological Survey, La Crosse, USA, bknights@usgs.gov
Richardson, W. B., U.S. Geological Survey, La Crosse, USA, wrichardson@usgs.gov
Bartsch, L. A., U.S. Geological Survey, La Crosse, USA, lbartsch@usgs.gov
Decker, J. I., Fordham University, Armonk, USA, jismith@fordham.edu
Houser, J. N., U.S. Geological Survey, La Crosse, USA, jhouser@usgs.gov
Bartsch, M. R., U.S. Geological Survey, La Crosse, USA, mbartsch@usgs.gov
Vallazza, J., U.S. Geological Survey, La Crosse, USA, jvallazza@usgs.gov
Gutreuter, S. J., U.S. Geological Survey, La Crosse, USA, sgutreuter

PHYTOPLANKTON DYNAMICS ALONG A HYDRAULIC CONNECTIVITY GRADIENT IN THE UPPER MISSISSIPPI RIVER

Growing evidence suggests that phytoplankton rather than allochthonous carbon is the dominant source of nutrition for consumers in large rivers. In these systems, hydraulic connectivity is a driver of physicochemical regimes that regulate phytoplankton. Connectivity is often manipulated as part of habitat restoration in the Mississippi River System. Phytoplankton assemblages and nutrients sampled across a gradient of connectivity in the Upper Mississippi River exhibited temporal variation consistent with strong hydraulic control. Connected sites with high dissolved inorganic nitrogen (DIN) and soluble reactive phosphorus (SRP) exhibited a Bacillariophyta peak in May and Cyanophyta and Bacillariophyta peaks in August. The phytoplankton response varied at more isolated sites with low DIN and either high or low SRP. An isolated site with high SRP exhibited an August bloom of Cyanophyta followed by Bacillariophyta. This Cyanophyta bloom was 2 orders of magnitude greater than others. At the isolated site with low SRP, phytoplankton biovolume was low with no prominent peaks. These results suggest that connectivity can have significant effects on phytoplankton dynamics that likely have consequences for the production of higher trophic levels.

Knoll, **L**. **B**., Miami University, Oxford, USA, knolllb@muohio.edu
Vanni, M. J., Miami University, Oxford, USA, vannimj@muohio.edu
Cable, E. K., North Carolina State University, Raleigh, USA, ekcable@ncsu.edu
Renwick, W. H., Miami University, Oxford, USA, renwicwh@muohio.edu

PARTICULATE AND DISSOLVED CARBON LOADING, EXPORT, AND RETENTION IS RELATED TO WATERSHED LAND USE AND HYDROLOGY IN TWO MIDWESTERN US RESERVOIRS

Many studies suggest that freshwaters are large sinks of carbon, but this is likely dependent on which carbon form (particulate vs. dissolved; inorganic vs. organic) is considered and the temporal scale. We examined how watershed land use and hydrology affects carbon loading via streams, export via dams, and retention in two Ohio reservoirs using a high resolution sampling regime over two years. The reservoirs contrast in watershed land use; Acton is dominated by agriculture (89% of land), while Burr Oak is dominated by forest (81%). During base flow, DIC comprised the largest percentage of carbon loading in both watersheds. However, during storm events POC became the dominant form in Burr Oak while DIC remained dominant in Acton. Peak loads for Acton and Burr Oak varied for DIC (1400, 160 tonnes/month, respectively), DOC (100, 40), and POC (400, 25). Carbon retention also differed with a greater percentage of retention in Burr Oak than Acton for all forms. Results indicate that watershed land use and hydrology both play large roles in the relative contribution of carbon form loading, export, and retention.

Koch, **B**. **J**., University of Wyoming, Laramie, USA, bkoch@uwyo.edu
Hall, R. O., University of Wyoming, Laramie, USA, bhall@uwyo.edu
Peckarsky, B. L., University of Wisconsin, Madison, USA, peckarsky@wisc.edu

SUBLETHAL EFFECTS OF A TROUT PREDATOR ON MAYFLY SECONDARY PRODUCTION

Sublethal effects by predators can change prey behavior, life history, and morphology, but can these proximate effects also alter the secondary production of a prey population? Using a model that tracks the mean body size and abundance of a larval mayfly cohort, we estimated cohort secondary production for scenarios representing a range of potential sublethal effects of a trout predator. The model predicted that a shift toward earlier emergence of mayflies under threat of predation will decrease interval production during the emergence period, both by reducing numbers and sizes of larvae remaining in the stream. To test this prediction, we added trout chemical cues to a fishless stream reach. Effects of fish cues on *Baetis* mayfly secondary production were small, but supported model predictions. Interval production in the unmanipulated reference reach exceeded that of the fish-cue reach only during the period of adult emergence, and was driven by earlier emergence of females. Cohort production in the fish-cue reach was ≈20% lower than the reference reach. Our results indicate that certain sublethal predatory effects can reduce secondary production of prey.

Koch, **G**. **R**., FCE-LTER / Florida International University, Miami, USA, gkoch001@fiu.edu
Staehr, P. A., University of Copenhagen, Hillerod, Denmark, pastahr@bio.ku.dk
Gaiser, E. E., Florida International University, Miami, USA, gaisere@fiu.edu
Childers, D. L., Arizona State University, Tempe, USA, dan.childers@asu.edu

SEASONAL HYDROLOGY DRIVES CHANGES IN AQUATIC ECOSYSTEM METABOLISM IN AN OLIGOTROPHIC, SUBTROPICAL ESTUARY

Everglades restoration calls for an increase in water delivery to the major watersheds of Everglades National Park. The responses of the estuarine end-members of these watersheds to hydrologic restoration are not entirely understood. In this project, we investigate how ecosystem metabolism in estuarine Taylor River, an important linkage between Taylor Slough and Florida Bay, is related to existing seasonal changes in hydrology and other environmental drivers. We define seasons in this subtropical estuary based on salinity concentrations rather than traditional rainfall patterns, as salinity is a better indicator of freshwater delivery to the estuary. We derived metabolism rates from high-frequency (10 minute), free-water changes in water column dissolved oxygen. Ecosystem gross primary production (GPP) and respiration (R) rates were greater in magnitude during the dry season than the wet season (GPP: $t=-8.8637$, $p<0.0001$, $df=188$; R: $t=7.0392$, $p<0.0001$, $df=188$), but net ecosystem production (NEP) was not significantly different ($t=-0.6640$, $p=0.5075$, $df=188$). Metabolism rates appear to be driven by seasonal changes in total phosphorus (TP) concentrations, which are in turn dictated by seasonally changing hydrologic patterns in the coastal, southern Everglades.

Kocman, **D**., Institut Jozef Stefan, Ljubljana, Slovenia, david.kocman@ijs.si
Kanduc, T., Institut Jozef Stefan, Ljubljana, Slovenia, tjasa.kanduc@ijs.si
Ogrinc, N., Institut Jozef Stefan, Ljubljana, Slovenia, nives.ogrinc@ijs.si
Horvat, M., Institut Jozef Stefan, Ljubljana, Slovenia, milena.horvat@ijs.si

PHYSICO-CHEMICAL CONTROLS ON MERCURY GEOCHEMISTRY IN A RIVER WATERSHED IMPACTED BY FORMER MERCURY MINING ACTIVITY

Mercury (Hg) distribution and partitioning was studied in the Idrijca River system, draining the area of the former Idrija Hg-mine, Slovenia. Simultaneously, the influence of major physico-chemical parameters (pH, TSS, major ion chemistry, DOC, DO) on its fate was investigated. The partitioning of Hg was mostly controlled by the variable content of suspended solids and complexation with various ligands present in water, among which DOC seems to be the most important. Hg is transported downstream from the mine mainly as finely-suspended material resulting from erosion of contaminated surfaces rather than Hg in the dissolved phase. The released Hg is biologically available, evidenced by the increase of monomethyl Hg (MeHg) concentrations downstream from the mine. However, although very high in terms of total Hg (up to 700 ng/L during extreme hydrological conditions), MeHg concentrations remain relatively low (<0.5 ng/L). We attribute this to the fact that chemical composition of these waters is predominantly influenced by weathering of carbonate bedrocks, waters have high pH (>7.7) and are well aerated. Our data suggest that reduction of Hg(II) prevails in this specific aquatic environment.

Koehl, **M.**, Univ. of California, Berkeley, Berkeley, CA, USA, cnidaria@berkeley.edu

LARVAL SETTLEMENT: HYDRODYNAMICS FROM THE POINT OF VIEW OF A MICROSCOPIC ANIMAL

We use larval settlement into fouling communities to study how swimming behaviors of microscopic organisms interact with ambient water flow to determine their trajectories through the environment. We measured turbulent water flow across fouling communities in the field and recreated it in wave-flumes where we measured on the scale experienced by larvae (mm's, ms's) instantaneous water velocities and concentrations of chemical cues released by the benthos. We determined the temporal pattern of velocities, shears, and cue concentrations encountered by larvae as they swim in the water and land on surfaces at different positions within benthic communities. Although on our human scale, turbulent water flow across a rough substratum is well characterized by boundary shear velocity and dispersal of dissolved substances is modeled as a diffusing cloud, examination of these processes on the scale encountered by microscopic larvae reveal that larvae have rapid on-off encounters with chemical cues while swimming through fine filaments of odor swirling in unscented water, and after they land they experience rapidly-fluctuating hydrodynamic forces with peaks that depend on their location within the fine-scale habitat topography.

Koenig, **L**. **E.**, University of California, Santa Barbara, Santa Barbara, USA, lkoenig@umail.ucsb.edu

Cardinale, B. J., University of California, Santa Barbara, Santa Barbara, USA, cardinale@lifesci.ucsb.edu

DOES DROUGHT ALTER THE RELATIVE IMPORTANCE OF TOP-DOWN VS. BOTTOM-UP CONTROL IN STREAMS?

Climate change models predict that many temperate streams will soon experience greater frequency and duration of droughts. For example, in streams of the Sierra Nevada mountain range, reduced snow pack and earlier spring melts are expected to reduce summer baseflows, leading to extended periods of low or no flow. The impacts that these droughts will have on the structure and function of stream ecosystems are largely unknown. In this study, we examined how increased drought duration impacts the relative importance of two factors known to control the production of algal biomass – herbivores and nutrient supply. We established nutrient diffusing agars (controls and additions) in experimental channels subjected to increasing drought duration (0 to 8 days) with invertebrate herbivores either present or excluded. Effects of herbivory on algal biomass remained constant as the duration of droughts increased. However, bottom-up effects of nutrient supply on biomass diminished as drought duration increased. Our results suggest that top-down controls by consumers may become relatively more important, and bottom-up effects of resources less important, in the face of climate change.

Koester, **M.**, University of Greifswald, Insel Hiddensee, Germany, koesterm@uni-greifswald.de

Paffenhofer, G. A., Skidaway Institute of Oceanography, Savannah, USA, gustav.paffenhofer@skio.usg.edu

ARE FECAL PELLETS TRAPS FOR PROKARYOTES? DOLIOLID VS. COPEPOD PELLET DEGRADATION

Fecal pellets of doliolids and copepods - occurring abundantly in upwelled waters of subtropical shelves – are hotspots of microbial activity. Their nature and fate has been initially investigated by Pomeroy and Deibel in the early 1980's. Those studies addressed mainly time-dependent changes in microbial abundance and growth during pellet degradation. However, questions regarding the origin and physiological state of pellet-attached prokaryotes in the water column remained obscure. We assume that copepod fecal pellet prokaryotes originate mostly from ingested food particles whereas doliolid fecal pellets are inhabited by prokaryotes originating both from food particles and filtered environmental water. Due to the feeding behaviour of doliolids and copepods, their pellets' morphological structure (membraneless vs. peritrophic membrane) differs and affects colonization, degradation activity, and growth of the prokaryotic community. To test our hypotheses we designed an experimental approach simulating pellet degradation at close to in situ conditions. Epifluorescence microscopy combined with image analysis as well as fluorescence-based enzymatic and respirometric assays were applied to follow time-dependent structural and functional changes of pellet-attached and free-living prokaryotes in relation to morphological modifications of the pellets.

Kohler, **S**. **L.**, Western Michigan University, Kalamazoo, MI, USA, steve.kohler@wmich.edu

Timmins-Bertan, J., Western Michigan University, Kalamazoo, MI, USA, Jaime_Timmins-Bertan@URSCorp.com

Ryan, J. A., Western Michigan University, Kalamazoo, MI, USA, julie.ryan@wmich.edu

Sawatzki, P. S., Western Michigan University, Kalamazoo, MI, USA, phillip.s.sawatzki@wmich.edu

EFFECTS OF MICROSPORIDIAN DISEASE ON BENTHIC STREAM COPEPOD POPULATION DYNAMICS

We studied the dynamics of two common benthic copepods, *Eucyclops prionophorus* and *E. elegans*, in a Michigan trout stream over two years. Both species are host to a microsporidian parasite that produces lethal infections in adult males and females. We used the egg ratio method to estimate demographic rates, and conducted laboratory experiments to establish the relationship between development time and water temperature. For both species, disease prevalence was very low from late fall through early spring and increased markedly during the summer. Disease prevalence in *E. prionophorus* ranged between 10-30% throughout the summer. By contrast, disease prevalence in *E. elegans* remained low throughout the summer and increased in early fall following a reduction in *E. prionophorus* population density. During the summer disease epizootic, *E. prionophorus* instantaneous death rate was strongly positively correlated with disease prevalence, suggesting that the disease contributes significantly to *E. prionophorus* population regulation.

Kohler, **T**. **J.**, University of Nebraska, Lincoln, USA, kohler@huskers.unl.edu

Thomas, S. A., University of Nebraska, Lincoln, USA, sthomas5@unlnotes.unl.edu

Flecker, A. S., Cornell University, Ithaca, USA, asf3@cornell.edu

Pringle, C. M., University of Georgia, Athens, USA, cpringle@uga.edu

Zandonà, E., Drexel University, Philadelphia, USA, eugenia.zandona@gmail.com

El-Sabaawi, R., Cornell University, Ithaca, USA, rwe32@cornell.edu

Marshall, M. C., University of Georgia, Athens, USA, trinidad@uga.edu

THE INFLUENCE OF CANOPY COVER, NUTRIENTS, AND SEASON ON STOICHIOMETRIC VARIATION IN EPILITHON OF NEOTROPICAL STREAMS.

Light, nutrients, and seasonality are strong factors in determining the elemental composition of epilithon in temperate stream ecosystems. However, little work has been performed regarding this association in tropical streams. We investigated 1) how epilithon nutrient content varies as a function of canopy cover and nutrient regime and 2) how seasonality influences epilithon standing stocks and stoichiometry. We surveyed 18 Trinidadian streams in 6 watersheds with light and nutrient gradients during the wet and dry seasons. Additionally, we sampled 4 stream reaches bimonthly for 3 years, thinning the canopy of two of the streams to create high light conditions. Epilithon was analyzed for nutrient composition (C:N:P) and biomass, and analyzed using mixed statistical models that were compared using AICc. We found stoichiometry to be influenced by nutrient concentrations and light, though the strength of these relationships differed between systems. Furthermore, we found that seasonality strongly influenced epilithon standing stock and % carbon, suggesting nutritional differences by season and watershed. These finding contribute to studies investigating the Light:Nutrient Hypothesis, as well as the nutrient quality of basal resources in the tropics.

Kominoski, **J**. **S.**, University of British Columbia, Vancouver, Canada, jkominoski@gmail.com

Follstad Shah, J. J., Duke University, Durham, USA, jfs12@duke.edu

FOUNDATION 'SPECIES' AND TERRESTRIAL-AQUATIC LINKAGES: EFFECTS OF SHIFTING PLANT COMPOSITION AT THE AQUATIC-RIPARIAN INTERFACE

Foundation 'species' are abundant primary producers that support biodiversity-ecosystem functioning in terrestrial and aquatic environments. Global environmental changes (climate change, land use, native biodiversity loss) are altering plant composition (including foundation 'species') at regional to continental scales. As aquatic and riparian ecosystems rely on reciprocal energy and nutrient transfer, shifts in plant composition may alter the structure and functioning of these coupled ecosystems. Knowledge of the relative importance

of foundation 'species' in plant communities is needed, in order to understand how these taxa maintain structure and functioning in coupled ecosystems. Patterns of foundation 'species' changes include: global plant cultivation (e.g., *Zea*, *Eucalyptus*), increasing *Alnus* in North and South America, *Tsuga canadensis* loss in North America, *Populus* decline in North America due to *Elaeagnus* and *Tamarix* invasion, *Salix* invasion in Asia and Australia, global invasions of wetlands and grasslands. We will summarize spatial patterns of shifts in foundation 'species', their relative functional role in terrestrial and aquatic ecosystems, drivers of changes in foundation 'species', and the functional implications of these changes on the structure and functioning of aquatic-riparian ecosystems.

Kornis, **M. S.**, University of Wisconsin/Center for Limnology, Madison, USA, kornis@wisc.edu

Carlson, J., University of Wisconsin/Center for Limnology, Madison, USA, jedcarlson3@gmail.com

Nilsson, E., Lund University, Lund, Sweden, Erika.Nilsson@limnol.lu.se

Vander Zanden, M. J., University of Wisconsin/Center for Limnology, Madison, USA, mjvanderzand@facstaff.wisc.edu

STREAM COMMUNITY RESPONSE TO VARYING DENSITIES OF INVASIVE ROUND GOBIES IN A GREAT LAKES TRIBUTARY

Species invasions are considered a major driver of global ecological change, and while presence-absence data are useful for documenting and predicting range expansion, the magnitude of an invader's impact on a given system is dictated by abundance. Here we examine how multiple trophic levels of an invaded stream community respond across an experimentally controlled gradient of invader density. Eighteen 2.25 m^2 in-stream enclosures were stocked with native fish species at natural abundances, while round gobies were stocked at three different densities: 0/m^2 (native condition), 2.7/m^2 (background density at study site), and 10.7/m^2 (density typical of Great Lakes coastal habitats and several tributaries). We examined individual fish growth, invertebrate density and diversity, and periphyton biomass within these three treatments after 50 days in the enclosures. Native fish growth was significantly reduced in the 2.7/m^2 goby treatment, while growth in the 10.7/m^2 treatment mirrored the 0/m^2 treatment. Our counterintuitive results, potentially influenced by high intraspecific competition amongst gobies, suggest a parabolic relationship between round goby abundance and impact and illustrate the complexity of food web interactions across a gradient of invader density.

Kovalenko, **K. E.**, University of Windsor, Windsor, Canada, katya@uwindsor.ca

Ciborowski, J. J., University of Windsor

Daly, C., Suncor Energy Inc.

Dixon, D. G., University of Waterloo

Farwell, A. J., University of Waterloo

Foote, A. L., University of Alberta

Frederick, K. R., University of Alberta

Gardner Costa, J. M., University of Windsor

Hornung, J. P., Suncor Energy Inc.

Liber, K., University of Saskatchewan

CARBON DYNAMICS IN OIL SANDS RECLAIMED WETLANDS

Oil sands mining leaves large boreal areas in need of reclamation and generates considerable quantities of extraction process-affected materials. Community composition of wetlands reclaimed with tailings slowly converges with that of reference wetlands, but ecosystem function trends are unknown. We compared carbon dynamics and depots in 10 reference & oil sands-affected wetlands to evaluate whether a prescribed reclamation strategy, topsoil amendment, accelerates reclaimed wetland development leading to self-sustaining peatlands. We determined carbon fluxes and measured compartment standing stocks for residual hydrocarbons, organic substrate, bacterioplankton, phytoplankton, biofilm, macrophytes, macrophyte litter, zoobenthos and aquatic-terrestrial exports (i.e. aquatic insect emergence). Carbon pathways & budgets were assessed using structural equation modelling. At least some carbon pools differ between reference and oil-sands-affected wetlands. Topsoil supplementation appears to speed convergence for some compartments but not others.
We discuss results in the context of restoration of ecosystem function and optimization of reclamation strategies.

Kraberg, **A. C.**, Alfred Wegener Institute for Polar and Marine Research, Helgoland, Germany, Alexandra.Kraberg@awi.de

Spindler, H., Aquaecology, Oldenburg, Germany, spindler@aquaecology.de

Raabe, T., Aquaecology, Oldenburg, Germany, raabe@aquaecology.de

Wiltshire, K. H., Alfred-Wegener Institute for Polar and Marine Research, Helgoland, Germany, Karen.Wiltshire@awi.de

REGULAR ONLINE ARCHIVAL OF IMAGES AS METADATA FOR PLANKTON TIME SERIES

Plankton long-term data series for phyto-and zooplankton are being generated by institutes around the globe, for both marine and freshwater environments. However, due to taxonomic problems and misidentification or inconsistent identification of difficult taxa, comparison between multiple datasets, and therefore detailed large-scale analyses are often difficult. This could be partly avoided by online database archival of image metadata along with numerical data. An example is PLANKTON*NET (http://planktonnet.awi.de). It contains more than 7000 images of phytoplankton and zooplankton species (including 3D composite images) and additionally illustrated glossaries, taxonomic and biogeographic information and dynamic links to external resources accessible simultaneously via the 'taxon details' generated for each taxon in the database. New, georeferenced, data are entered, by the PLANKTON*NET team but also by remote external users. This facilitates the use of PLANKTON*NET for the archival of metadata for numerical data sets. The Helgoland Roads plankton data series will be presented as an example of a data series whose numerical data are archived online (http://pangaea.de), but annotated with images archived in PLANKTON*NET allowing checks of correct identifications and facilitating comparisons between datasets.

Kraft, **C. E.**, Cornell University, Ithaca, USA, cek7@cornell.edu

Chiotti, J. A., Cornell University, Ithaca, USA, jac544@cornell.edu

Jirka, K. K., Cornell University, Ithaca, USA, kjj23@cornell.edu

Josephson, D. C., Cornell University, Ithaca, USA, dcj3@cornell.edu

Lepak, J. M., Colorado State University, Fort Collins, USA, jmlepak@lamar.colostate.edu

Robinson, J. M., Chesapeake Biological Laboratory, Solomons, USA, jrobin@umces.edu

Weidel, B. C., University of Wisconsin-Madison, Madison, USA, weidel@wisc.edu

zipkin, E. F., USGS Patuxent Wildlife Research Center, Laurel, USA, ezipkin@usgs.gov

LONG-TERM ECOSYSTEM AND POPULATION RESPONSES TO THE LARGE-SCALE REMOVAL OF A DOMINANT NON-NATIVE PISCIVORE FROM LAKE ECOSYSTEMS

A 12-year experiment to restore native communities in Adirondack lakes has involved the intense harvest of a non-native piscivore (smallmouth bass) to improve growth and survival of the native apex predator (lake trout) and increase abundance of native littoral fishes. The ecosystem response has been substantial, as evidenced by: 1) changes in lake trout trophic position, energy sources, growth and mercury bioaccumulation, and 2) increased abundance of native littoral fishes. However, the bass population has not collapsed in response to ongoing and intense harvest. Instead, consistent annual recruitment due to an over-compensatory response in reproduction has regularly occurred since removal was initiated, producing a large population dominated by small bass. This population structure has allowed the positive ecosystem responses to be sustained, while requiring annual harvest to maintain this ecosystem state. A bi-annual oscillation in abundance of remaining smallmouth bass has been observed for the past eight years, consistent with theory predicting this type of population response to intense harvests that are common in freshwater and marine ecosystems throughout the world.

Kranzfelder, **P.**, University of Minnesota, Saint Paul, USA, kranz081@umn.edu

Ferrington, L. C., University of Minnesota, Saint Paul, USA, ferri016@umn.edu

Bouchard, R. W., University of Minnesota, Saint Paul, USA, bouc0048@umn.edu

SURVIVORSHIP AND LONGEVITY OF DIAMESA MENDOTAE MUTTKOWSKI (DIPTERA: CHIRONOMIDAE) BURIED IN SNOW BANKS

Adults of the midge Diamesa mendotae Muttkowski commonly grow and emerge in winter. Previous estimates of longevity for adults collected from snow and maintained in lab at 6°C ranged from 19 days (females) to 17.5 days (males), and both sexes can supercool to less than -20°C. Adults collected in

February from snow banks along groundwater dominated (GWD) sections of the Kinnickinnic River (Wisconsin) were buried in a snow bank, retrieved in batches of 10 males and 10 females at four-day intervals up to 28 days, and then maintained at 6°C. in controlled environmental chambers to determine survivorship and longevity. Specimens were provided access to water to prevent dehydration but were not fed. Average adult longevity (46.2 days) was not substantially different for females (46.8 days) and males (45.6 days) with 50.0% of males and 51.4% of females surviving 51 days or longer. Our results suggest winter-emerging adults may survive under snow cover, with high survivorship and longevity increasing their probability of successful reproduction in small protected areas near GWD streams even in high latitudes were colder air temperatures predominate.

Kraus, **J**. **S**., University of New Mexico and the Museum of Southwestern Biology, Albuquerque, USA, jennk@unm.edu

Burdett, A. S., University of New Mexico and the Museum of Southwestern Biology, Albuquerque, USA, aburdett@unm.edu

Turner, T. F., University of New Mexico and the Museum of Southwestern Biology, Albuquerque, USA, turnert@unm.edu

AQUATIC FOOD WEB STRUCTURE IN DRYING POOLS USING ISOTOPIC DATA FROM A MESOCOSM EXPERIMENT AND SURVEYS IN THE RIO GRANDE, NEW MEXICO

The Rio Grande runs through New Mexico, an arid landscape subject to harsh, dry conditions and seasonal drought. During the dry season, river habitats are reduced to small pools where aquatic food webs are strongly affected by the change in abiotic conditions and biotic interactions (e.g. competition and predation). Surveys were conducted in the main river channel during summer 2006 when the river was subject to extreme drydown. In 2009, 12 mesocosms were used to simulate a drying pool environment, half with fish and half with no fish. Samples were collected over a 6 week period. Algae, detritus, invertebrates, and fishes from the 2006 survey and the mesocosm experiment were processed for stable isotope analysis. Isotopic ratios (δ13C & δ15N) from constituents in the Rio Grande in 2006 and the 2009 mesocosm experiment were used to evaluate temporal dynamics of aquatic interactions in drying pools. Dramatic changes in species richness, abundance, and resource availability occur over very short timescales in drying aquatic habitats. We will discuss the efficacy of isotopic analysis to identify key temporal changes in species interactions.

Kreutzweiser, **D**. **P**., Canadian Forest Service, Natural Resources Canada, Sault Ste Marie, Canada, dave.kreutzweiser@nrcan.gc.ca

Capell, S. S., Canadian Forest Service, Natural Resources Canada, Sault Ste Marie, Canada, scott.capell@nrcan.gc.ca

Holmes, S. B., Canadian Forest Service, Natural Resources Canada, Sault Ste Marie, Canada, steve.holmes@nrcan.gc.ca

Gunn, J. M., Cooperative Freshwater Ecology Unit, Laurentian University, Sudbury, Canada, jgunn@laurentian.ca

FIELD-TESTING A MODEL PREDICTION FOR CLIMATE CHANGE EFFECTS ON LEAF LITTER BREAKDOWN IN BOREAL FOREST STREAMS

We measured leaf pack breakdown and macroinvertebrates in six streams over six years. Summer drought in years 4, 5 and 6 resulted in a 25-40% reduction in summer/fall rainfall and a 20-50% reduction in stream water levels in comparison to years 1, 2 and 3. Average cumulative degree days of water temperature over 80-day periods before fall leaf pack retrieval varied from 1302 to 1498. Year-to-year differences in leaf mass loss (up to 3-fold) were greater than among-stream differences. Mass loss was significantly and positively related to water temperature ($r = 0.483$, $p = 0.004$) but not to invertebrate biomass, Margalef's richness, Shannon diversity, or shredder abundance. Invertebrate assemblages on leaf packs varied significantly from year to year (ANOSIM $p < 0.001$). Interannual assemblage differences were greater in drought years and in drier streams than in wetter years and continuously-flowing streams. Under drought conditions, changes in invertebrate assemblages were primarily driven by reduced chironomids and increased shredder/detritivore abundances. Our results provide empirical support for a published model prediction of increased leaf litter breakdown in warmer years but decreases in drier years.

Krist, **A**. **C**., University of Wyoming, Laramie, USA, krist@uwyo.edu

Tronstad, L. M., University of Wyoming, Laramie, USA, tronstad@uwyo.edu

Julien, H. N., University of Wyoming, Laramie, USA, julienh@uwyo.edu

LIFE-HISTORY SHIFTS IN A COPEPOD: EVIDENCE FOR RAPID EVOLUTION FOLLOWING THE INTRODUCTION OF A NON-NATIVE SPECIES

Evolutionary consequences of invasive species should be widespread because invasive species often alter natural selection on native species. The introduction of non-native lake trout into Yellowstone Lake ~25 years ago greatly reduced cutthroat trout populations, thereby drastically reducing size-selective predation on zooplankton. We studied the consequences of altered selection on the life history of the copepod, *Leptodiaptomus ashlandii* after the invasion of lake trout. Life-history theory predicts that size-selective predation on adults should favor early maturity at a smaller size, smaller offspring and larger brood sizes. We compared brooding status, brood size and egg size between samples collected before the invasion of lake trout and samples collected after lake trout were present. Consistent with life history theory, copepods matured at a smaller size and had smaller eggs before the invasion of lake trout. However brood sizes did not differ between historical and current samples. If these changes resulted from an evolutionary shift in life history traits, these copepods have evolved rapidly in response to an altered selective regime caused by an introduced predator.

Kristjansson, **B**. **K**., Holar University College, Saudarkrokur, Iceland, bjakk@mail.holar.is

Kornobis, E., University of Iceland, Reykjavik, Iceland, etk1@hi.is

Palsson, S., University of Iceland, Reykjavik, Iceland, snaebj@hi.is

Svavarsson, J., University of Iceland, Reykjavik, Iceland, jorundur@hi.is

LIFE UNDER GLACIERS – SUBTERRANEAN AMPHIPODS IN ICELAND.

Two new endemic species of subterranean amphipods were recently discovered in Icelandic springs. Crymostygius thingvallensis represents a new family, the Crymostygiidae. The other species, Crangonyx islandicus falls within the family Crangonyctidae. These findings are remarkable because Iceland was covered repeatedly by glaciers from about 2.6 million BP to about 10,000 BP and is isolated on the mid-Atlantic Ridge. We argue that these species of amphipods have survived the glacial periods in Iceland in sub-glacial refugium. The support for our hypothesis comes from the extent of morphological differences between these species and their closest relatives, their endemism, the low dispersal ability of groundwater amphipods and the geographic isolation of Iceland. We have also found a strong support for this hypothesis by an analysis of mitochondrial genetic variation within Crangonyx islandicus. Our results show that the species is divided into several distinct monophyletic groups, found along the volcanic zone in Iceland, which have been separated by 0.5 to around 5 million years. This presents the first example of a multicellular organisms which have survived glaciations underneath an ice sheet.

Kroeger, **K**. **D**., USGS Woods Hole Science Center, Woods Hole, USA, kkroeger@usgs.gov

Baldwin, S., USGS Woods Hole Science Center, Woods Hole, USA, sbaldwin@usgs.gov

Green, A., USGS Woods Hole Science Center, Woods Hole, USA, adriangreen@usgs.gov

Bratton, J. F., USGS Woods Hole Science Center, Woods Hole, USA, jbratton@usgs.gov

Crusius, J., USGS Woods Hole Science Center, Woods Hole, USA, jcrusius@usgs.gov

SCALING UP SUBMARINE GROUNDWATER DISCHARGE: C, N AND GREENHOUSE GAS FLUXES ON THE U.S. EAST COAST

Coastal groundwater is a poorly constrained source for land/sea fluxes of C (DOC, DIC), N (DIN, DON) and greenhouse gases (GHG; CO2, CH4 and N2O). Terrestrial inputs drive biogeochemical cycling and fluxes of C and GHG in coastal ecosystems, and largely determine their climatic role. Despite evidence of large C and N fluxes due to groundwater discharges, estimates are not available at necessary scales to be considered in budgets or models. We are developing for the first time data-intensive and comprehensive groundwater C, N and GHG flux estimates at the scale of the U.S. east coast. Regional estimates

of discharge rate and chemical concentrations will be derived from compilations of published literature, our own unpublished data and USGS monitoring data from several thousand wells. To determine suitability of the USGS monitoring data as a measure of chemical concentrations delivered to the coast, we are exploring relationships between chemical concentrations 1) in our own sampling directly at the land/sea margin with high-resolution in vertical and horizontal dimensions, and 2) local shallow well data collected within 2 km of the coast.

Kroll, **S. A.**, SUNY-ESF, Syracuse, USA, sakroll@syr.edu
Gomez Alday, J. J., University of Castilla-La Mancha, Albacete, Spain, juanjose.gomez@uclm.es
Moratalla, A., University of Castilla-La Mancha, Albacete, Spain, angel.moratalla@uclm.es
Navarro-Llacer, C., University of Castilla-La Mancha, Albacete, Spain, caliznavarrollacer@hotmail.com
De las Heras, J., University of Castilla-La Mancha, Albacete, Spain, jorge.heras@uclm.es
Ringler, N. H., SUNY-ESF, Syracuse, USA, nhringle@esf.edu

CHANGES IN THE MACROINVERTEBRATE COMMUNITY AS A RESPONSE TO INTER-BASIN WATER TRANSFERS: THE NORTHWESTERN SECTOR OF THE SEGURA RIVER BASIN (SE SPAIN)

In order to determine the effects of flow regulation and the Tajo-Segura Inter-basin Transfer on the ecology of rivers in the Segura Watershed, we sampled water and the macroinvertebrate community in periods of high and low discharge and classified the in-stream habitat and riparian forest. Land use, physicochemical, habitat and biotic variables were analyzed to determine the variables that contributed to an environmental quality gradient. Then, hydrochemical analyses (Piper and Stiff diagrams) were performed to examine the possible effects of these stressors on water quality. Sample points were grouped based on physicochemical and environmental variables as well as macroinvertebrate assemblages. There were highly significant increases in sulphate concentrations and salinity downstream of the Tajo-Segura Transfer. Sulphate levels were also related to similarities in the macroinvertebrate community composition. This study shows the usefulness of combining biomonitoring techniques using macroinvertebrates with classic hydrochemical methods to analyze river ecosystems. Results show that high levels of dissolved sulphate and other ions are a threat to the environmental quality of rivers in the Segura Watershed. Because the study area is located in a semi-arid climate, sulphate, major ion and nutrient concentrations should be monitored to avoid increased impacts to river ecosystems due to contamination and salinization.

Krynak, **E. M.**, Grand Valley State University, Allendale , USA, krynaedw@gvsu.edu
Snyder, E. B., Grand Valley State University, Allendale, USA, snydeeri@gvsu.edu
Davis, J. C., Aquatic Restoration and Research Institute, Talkeetna, USA, arri@mtaonline.net

IMPORTANCE OF MACROPHYTES FOR MACROINVERTEBRATE SECONDARY PRODUCTION AND IMPLICATIONS FOR JUVENILE SALMON FEEDING ECOLOGY

In low gradient Alaskan streams, aquatic macrophytes are often the only stable substrate available. The presence of macrophytes changes water velocity, increases the rate of sedimentation, and alters the composition of sediments creating distinct microhabitats. Macrophyte beds within Wiggle Creek, Matanuska-Susitna borough, Alaska, harbors both invertebrates and juvenile coho salmon (*Oncorhynchus kisutch*). To determine the importance of macrophytes to invertebrates and coho development, secondary production of invertebrates within macrophyte beds will be compared to two other habitats: riffles and submerged near-bank habitats. Coho diet will be assessed using stomach lavage to determine if invertebrates in macrophyte beds contribute to juvenile salmon diet. Juvenile coho are a mobile species and may change their habitat on both small (daily) and large (seasonally) temporal scales. To assess if coho temporal habitat changes correspond with insect production, passive integrated transponder (PIT) tags will be used to track coho movement from May to September 2010. We hope to provide insight into the importance of macrophyte-rich streams to salmon rearing and production in order to inform habitat preservation and restoration efforts.

Kuehn, **K. A.**, The University of Southern Mississippi, Hattiesburg, MS, USA, kevin.kuehn@usm.edu
Steiner, D., Department of Aquatic Ecology, Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland, daniel.steiner@eawag.ch
Buesing, N., Department of Aquatic Ecology, Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland, nanna.buesing@eawag.ch
Gessner, M. O., Department of Aquatic Ecology, Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland, mark.gesner@eawag.ch

CONTRIBUTION OF FUNGI AND BACTERIA TO CARBON FLOWS FROM DECOMPOSING STANDING-DEAD LITTER OF AN EMERGENT WETLAND PLANT

Fungi and bacteria are both important decomposers of plant litter, but their relative importance to decomposition appears to vary across litter types and ecosystems. We estimated carbon flows from standing-dead shoots of *Phragmites australis* to CO_2 and microbial biomass. Estimates were derived from measurements over an annual cycle of fungal and bacterial production, microbial respiration, and standing-dead leaf, sheath and culm litter per m^2. Standing-dead litter mass increased following plant senescence in November and continuously decreased towards September in the following year. Fungal and bacterial production totaled 22±5 and 6±1 $gC/m^2/y$, respectively, and microbial respiration was 54±5 $gC/m^2/y$. A total of 6, 12, and 0.5% of leaf, sheath and culm plant production (632±70 gC/m^2), respectively, was transformed to fungal biomass (bacteria: 2, 3, and 0.2%). CO2 release was equivalent to 12% (leaves), 25% (sheaths) and 3% (culms) of the plant production. These data indicate that while fungi and bacteria both mediate appreciable carbon flows during decomposition of standing-dead *Phragmites* litter, fungi contribute more substantially than bacteria, in stark contrast to the bacterial predominance under submerged conditions in *Phragmites* marshes.

Kumagai, **M.**, Lake Biwa Environmental Research Institute, Otsu, Japan, kumagai-m@lberi.jp
VINCENT, W., Laval University, Quebec City, Canada, Warwick.Vincent@fsg.ulaval.ca

CHARLES R. GOLDMAN IN JAPAN: LIMNOLOGY FROM BOTH SIDES

In ancient China, people believed that the universe consisted of two sides: Yin and Yang. Professor Charles Goldman also has two sides. He was born and educated in the USA, and most of his career has been based at the University of California Davis. Earlier in his life, however, Dr. Goldman stayed at the Misawa US Base in Japan (from 1952 to 1954), where he learned many aspects of Japanese culture, including stories and songs. Since then, he has visited numerous places in the Far East and is at home in both the East and West. His textbook (written with Dr. Alex Horne) 'Limnology' was translated into Japanese, with the title "Rikusuigaku" meaning "Land-Water Science", and was very well received. In 2003, he led a Special Session on Climate Change at the 3rd World Water Forum in Kyoto and Otsu, Japan. As the result of the conference, he was selected as the first president of the World Water and Climate Network (WWCN). Prof. Goldman is active in studying the influence of climate change on the world's lakes including Lake Tahoe, and provides international advice to national and local governments to restore and manage their aquatic environments. Now he plans to issue a new book entitled: "Effects of global warming on freshwater ecosystems of the world: What can be done to reduce negative impacts?" We wish Prof. Goldman ongoing enjoyment of science and culture on both sides of the Pacific.

Kunza, **L. A.**, University of Wyoming, Laramie, USA, lisa@uwyo.edu
Hall, R. O., University of Wyoming, Laramie, USA, bhall@uwyo.edu

NITROGEN FIXATION: THE FATE OF THE N2 FIXED

Rates of N_2 fixation are high in Ditch Creek, WY. The fate of the N_2 is unknown. In marine literature, the difference between the acetylene reduction method and $^{15}N_2$ uptake is explained by the 40-50% release of the N_2 fixed directly into the water as NH_4^+ and DON. We measured N_2 fixation using both $^{15}N_2$ uptake and the acetylene reduction method on four streams and multiple times on Ditch Creek during the summers 2007-2009 in order to examine the theoretical assumed ratio of 3:1 moles ethylene produced to nitrogen fixed. We also used $^{15}N_2$ as a tracer to measure the release of fixed N into the surrounding chamber water as $^{15}N\text{-}NH_4^+$ and ^{15}N-DON during summer 2008 in Ditch Creek. Our empirical measurements were close to the theoretical estimations of 3:1 moles

ethylene produced to nitrogen fixed. Ammonium release accounted for less than 1% of N_2 fixed. The N_2 fixed appears to enter the biofilm and may account for 92% of N accumulation throughout the summer.

Kurt-Mason, **S. J.**, Dept. of Land Resources and Environmental Science, Montana State University, Bozeman, USA, seth_kurt_mason@hotmail.com

McGlynn, B. L., Watershed Hydrology Lab, Dept of Land Resources and Environmental Science, Montana State University, Bozeman, USA, bmcglynn@montana.edu

Poole, G. C., Fluvial Landscape Lab, Dept of Land Resources and Environmental Science, Montana State University, Bozeman, USA, gpoole@montana.edu

ASSESSING HYDROLOGIC RESPONSE TO CHANNEL RECONFIGURATION: SCIENCE TO INFORM THE RESTORATION PROCESS, SILVER BOW CREEK, MONTANA.

Interactions between the physical form of streambeds and the spatiotemporal patterns of surface-water inundation govern water and solute storage and exchange among stream channels, riparian zones, and alluvial aquifers. Despite well-documented linkages among individual channel forms, hydrologic retention, water quality, and in-stream habitat quality, the effects of stream channel reconfiguration on hydrology and solute transport are not well characterized. By conducting conservative tracer experiments prior to and immediately following large-scale channel realignment in Silver Bow Creek, Montana, we are attempting to 1) elucidate changes in hydrologic behavior resulting from channel realignment, 2) identify relationships between measures of hydraulic and topographic complexity, solute transport characteristics and larger spatio-temporal exchanges with groundwater, and 3) identify useful metrics for evaluating the condition of hydrologic behavior and its trajectory toward or away from normative conditions. Such assessment of hydrologic storage and exchange dynamics within an adaptive management framework should improve both the cost effectiveness of restoration approaches and the realized benefits of improving long-term water quality, ecological and economic value of restored streams.

Kuzminov, **F. I.**, Moscow State University, Moscow, Russian Federation, fedor.kouzminov@gmail.com

Gorbunov, M. Y., Rutgers University, New Brunswick, NJ, USA, gorbunov@marine.rutgers.edu

Maximov, E. G., Moscow State University, Moscow, Russian Federation,

Fadeev, V. V., Moscow State University, Moscow, Russian Federation, victor_fadeev@mail.ru

DIAGNOSTICS OF CYANOBACTERIA AND ZOOXANTHELLAE USING NON-LINEAR LASER FLUOROMETRY AND VARIABLE FLUORESCENCE TECHNIQUES

Cyanobacteria and symbiotic dinoflagellates (zooxanthellae) are photosynthetic microorganisms with unique bio-physical properties, which make them potentially good indicators of the state of aquatic ecosystems. Due to the presence of external light-harvesting complexes called phycobilisomes, cyanobacteria exhibit multiple spectrally distinct fluorescence bands that provide additional possibilities for fluorescent monitoring and assessment, including early detection and identification of environmental stresses. Zooxanthelae are endosymbionts that live in various benthic organisms, such as corals and anemonea, and are sensitive to changes in environemntalal conditions (temperature, presence of polutants, etc). Here we examine the potential of two complementary approaches, including variable fluorescence teachnique and non-linear laser fluorometry, for diagnistics of the physiological state of the organisms. Combination of these methods allowed us to determine the photosynthetic characteristics of the cell, as well as the photophysical characteristics of individual pigments. Based on laboratory studies of the impact of natural and anthropogenic stressors (heavy metals, elevated temperature, and excess irradiance), we analyze and discuss the novel possibilities for fluorescent bio-monitoring of aquatic ecosystems.

La Hée, **J. M.**, Florida International University, Miami, USA, jolah76@yahoo.com

Gaiser, E. E., Florida International University, Miami, USA, gaisere@fiu.edu

THE USE OF PERIPHYTON DIATOM COMMUNITIES AS INDICATORS OF WATER QUALITY IN THE EVERGLADES AND THREE TROPICAL KARSTIC WETLAND SYSTEMS

Periphyton diatom communities within the Everglades wetland system respond predictably to changes in water quality and can therefore be effectively used as bioindicators. However, the use of diatoms as indicators in similar karstic wetlands within the Caribbean region has not been investigated. This study therefore aimed to (i) examine the relationship between periphyton total phosphorus (TP) levels and diatom community composition in the Everglades and karstic wetland systems in Belize, Mexico and Jamaica, and (ii) develop predictive models relating diatom community composition to water quality in these wetlands. The four locations shared a distinctive diatom flora, but species richness and diversity were both lower within the Everglades ($p<0.001$). Diatom community composition changed in relation to periphyton TP levels at all locations and "low" and "high" TP communities, as well as indicator species were discerned at each location. Weighted averaging models also predicted mat TP levels from diatom community composition for Everglades ($R^2=0.56$) and Caribbean ($R^2=0.85$) locations. The results of this study demonstrate that diatoms can effectively be used as indicators of water quality in karstic wetlands within the Caribbean region.

Ladd, **H.**, Texas Tech University, Lubbock, USA, hallie.ladd@ttu.edu

Rogowski, D. L., Texas Tech University, Lubbock, USA, david.rogowski@ttu.edu

THE CONSERVATION OF NATIVE SNAILS WITHIN A CHIHUAHUAN DESERT SPRING SYSTEM

We began field investigations in July of 2009 to determine the habitat associations, distribution, and abundance of the native snails and the invasive red-rimmed melania snail (Melanoides tuberculatus) within the Diamond Y spring system located in Pecos County, TX. The potential impact of the invasive red-rimmed melania is of great concern as it has been documented to outcompete and eradicate native snail populations. The invasive red-rimmed melania snail is established at only the main spring within the Diamond Y spring system at densities up to 1575 individuals/m2. Preliminary results show that number of melanoides/m2 are negatively correlated with distance from the Diamond Y spring head ($r2=0.15$, $F1,58=10.25$, $P<0.01$) and melanoides appear to be restricted within the first 300 meters of the spring run. Further investigations and data analysis will be conducted to provide species habitat information that will be useful for the management and conservation of native snails within this system.

Lagrue, **C.**, EcoLab; CNRS, Université de Toulouse, Toulouse, France, lagrue@cict.fr

Lecerf, A., EcoLab; CNRS, Université de Toulouse, Toulouse, France, lecerf@cict.fr

ENVIRONMENTAL CHANGES AND ECOSYSTEM STRUCTURE AND FUNCTIONS: EFFECTS OF DEFORESTATION ON FRESHWATER ECOSYSTEMS

Although stochastic events (hurricanes, fires, floods) occur naturally, catastrophic shifts in ecosystems are increasingly due to human activities. Quantifying and predicting ecosystem vulnerability to anthropogenic perturbations and possibly attenuating their effects is becoming increasingly important in an ever more human-dominated world. Here, we took a whole ecosystem approach in examining multiple effects of riparian deforestation on stream ecosystems. Without physically impacting the aquatic environment, riparian vegetation removal modifies terrestrial influxes to stream ecosystems, usually decreasing carbon input through decaying terrestrial leaf litter but increasing solar radiation and aquatic periphyton production. This study considered all levels of stream ecosystem food webs (leaf litter decomposition, periphyton production, fungal biomass, diversity and density of associated consumers and predators, and parasite abundance). Results indicate that effects of deforestation on stream ecosystems can be highly variable, even between similar aquatic systems, due to shifts occurring at all trophic levels and the disproportionate influence of a few "keystone" species; whether decomposers (Gammarus sp.) and/or predators (odonate larvae). Following riparian deforestation, aquatic ecosystem functioning was affected through both "bottom-up" (primary production) and "top-down" processes (predation).

Laitinen, **N. J.**, Brigham Young University, Provo, USA, ninalaitinen@gmail.com

Shiozawa, D. K., Brigham Young University, Provo, USA, shiozawa@byu.edu

Unmack, P. J., Brigham Young University, Provo, USA, peter.mail2@unmack.net

FISHING FOR SUCKERS: REDEFINING SPECIES BOUNDARIES OF PANTOSTEUS (CATOSTOMUS) BASED ON MITOCHONDRIAL DNA

Pantosteus, a subgenus of Catostomus, is an understudied fish that warrants further phylogenetic analysis in order to determine species boundaries. Mitochondrial DNA (cytochrome b, ATPase) collected from mountain suckers (Catostomus platyrhyncus), bluehead suckers (C. discobolus), desert suckers (C. discobolus), Rio Grande sucker (C. plebeius), and bridgelip suckers (C. columbianus) indicate that Pantosteus is more genetically diverse than previously suggested. Mountain suckers in the northern Bonneville Basin were genetically very distinct from mountain suckers in the southern region of the basin. Similar patterns have been documented in other fish species of the Bonneville Basin. Furthermore, mountain suckers from the Lahontan Basin of Nevada and Missouri drainage basin were basal to Bonneville Basin mountain suckers, bluehead suckers, and desert suckers leading to interesting phylogeographic questions about the origin of their current distribution. Lahontan Basin suckers also formed two clades, the Truckee River and East Walker River. Two distinct clades of bluehead suckers formed in the upper snake and Colorado drainage basins. The Rio Grande sucker and Nazas sucker were basal to mountain suckers, bluehead suckers, and desert suckers. Based on this study, Pantosteus is not monophyletic and classification systems of Pantosteus need to be revised.

Landom, **K**., Utah State University, Ecology Center, Department of Watershed Sciences, Logan, USA, kevinlandom@gmail.com

Crowl, T. A., Utah State University, Ecology Center, Department of Watershed Sciences, Logan, USA,

Budy, P., Utah State University, USGS Utah Cooperative Fish and Wildlife Research Unit, WATS Department, Logan, USA,

Thiede, G. P., Utah State University, Department of Watershed Sciences, Logan, USA,

Luecke, C., Utah State University, Department of Watershed Sciences, Logan, USA,

BIOMANIPULATION AND FISH CONSERVATION IN THE SHALLOW, EUTROPHIC, UTAH LAKE: A COMBINED BOTTOM-UP AND TOP-DOWN FOOD WEB MODELING APPROACH

We used a combination of food web models to evaluate three questions concerning biomanipulation and fish conservation in a shallow lake ecosystem: 1) how will the food web respond to large-scale fish removal (biomanipulation); 2) what is the top-down impact of nonnative piscivores; 3) would the re-establishment of native forage fish species buffer predation on existing native fishes? Our bottom-up food web model suggests, based on the effects of water temperature, resource availability, and competition, combined removal of both benthivore and piscivore fish biomass would be most beneficial to lake restoration and native fish conservation. Our top-down food web model suggests the annual consumption of young native fish is millions of individuals, but could potentially reach numbers as high as hundreds of millions. Based on our size-dependent vulnerability model, we suggest native forage species are not capable of reaching a size-refuge fast enough to sustain populations. Results from this study will aid in guiding monitoring and experimental design that will improve existing food web models, facilitate adaptive management during biomanipulation, and address existing impediments to native fish conservation.

Lane, **C**. **S**., Memorial University of Newfoundland, St. John's, Canada, chad.lane@mun.ca

Lyon, D. R., University of Arkansas, Fayeteville, USA,

Ziegler, S., Memorial University of Newfoundland, St. John's, Canada, sziegler@mun.ca

THE IMPACT OF NUTRIENT ENRICHMENT ON THE USE OF 13C-LABELED SUBSTRATES BY EPILITHIC BIOFILMS IN HEADWATER STREAMS

Carbon and nutrient cycling within epilithic biofilm communities of four Arkansas Ozark streams representing a gradient of nutrient concentrations was investigated within mesocosms containing benthic substrate and streamwater. 13C-labeled glucose and vanillin were added to mesocosms and incubated in situ without light to assess the impact of substrate additions on heterotrophic processes. Substrate-C respired, determined from 13C content of the dissolved inorganic carbon, increased with nutrient enrichment and to a greater degree with glucose relative vanillin. Net ammonium uptake doubled with either substrate but only in the most nutrient-rich stream while nitrate uptake was stimulated by glucose in all but the most nutrient-rich stream. The added substrates also stimulated net phosphate uptake which increased with stream P availability. Results suggest that labile C stimulates heterotrophic activity, however both stream nutrient status and substrate form greatly impacted these effects on nutrient and C cycling in these biofilms. Further, results of 13C labeling of phospholipid fatty acids will enable us to link these effects to substrate use efficiency and variation in the activity of groups of microbes in these biofilms.

Lange, **K**., University of Otago, Dunedin, New Zealand, katha.lange@googlemail.com

Liess, A., Umeå University, Umeå, New Zealand, antonia.liess@ebc.uu.se

Townsend, C. R., University of Otago, Dunedin, New Zealand, colin.townsend@otago.ac.nz

Matthaei, C. D., University of Otago, Dunedin, New Zealand, christoph.matthaei@otago.ac.nz

LIGHT, NUTRIENTS AND GRAZING INTERACT TO DETERMINE STREAM DIATOM COMMUNITY COMPOSITION

Benthic algal communities are shaped by the availability of nutrients and light and by herbivore consumption. Studies that simultaneously address the roles of all three factors are rare. We investigated the effects of nutrients (four levels, ambient to highly enriched), snail grazing pressure (four levels, no grazing to high) and light (two levels, unshaded and shaded) on benthic stream algae in 128 streamside channels in a full-factorial design. The algal community was dominated by diatoms, which were determined to species level using acid-cleaned samples and assigned to functional groups according to their physiognomic growth form. Light treatments had the strongest influence on diatom community composition, while nutrient enrichment had an intermediate and grazing a fairly weak effect. Diatom functional groups also responded strongly to the three stressors: 'low profile' taxa dominated at low resource levels, whereas 'high profile' and 'motile' taxa became more prevalent at higher resource levels. Interactions between the three factors were common. Our findings highlight the considerable potential of functional algal groups as indicators of changing environmental conditions to complement the traditional taxonomic approach.

Langhans, **S**. **D**., Eawag, Duebendorf, Switzerland, simone.langhans@eawag.ch

Lienert, J., Eawag, Duebendorf, Switzerland, judit.lienert@eawag.ch

Reichert, P., Eawag, Duebendorf, Switzerland, peter.reichert@eawag.ch

A DECISION THEORETICAL APPROACH TO ECOLOGICAL STREAM ASSESSMENT - A CASE STUDY FOR HYDRO-MORPHOLOGY

Stream assessment and management is a challenge to scientists and practitioners alike. Streams, being highly complex ecosystems, are difficult to characterize with adequate indicators. Furthermore, stream management decisions are made by many stakeholders with potentially diverging interests, and predictions about the outcome of management interventions are difficult as they are affected by uncertainty. Although different approaches to stream assessment and management exist, there is a need for an integral strategy that accounts for the mentioned difficulties in both assessment and management. We identified decision theory to provide appropriate techniques and discuss here, using the example of hydro-morphology, how decision theoretical elements can be employed for designing an integrated stream assessment procedure. The key elements of the suggested procedure involve (i) the elicitation of value functions either by interviewing experts or converting existing assessments, (ii) the hierarchical, multiplicative aggregation of sub-objectives' value functions, and (iii) flexibility in terms of considered attributes. The further development of this procedure will lead to a flexible concept which can be applied to observed attributes or state assessment and to predicted attributes to support management decisions.

LaPilusa, **T**. **L**., SUNY Oneonta, Oneonta, USA, LAPITL67@ONEONTA.EDU

Heilveil, J. S., SUNY Oneonta, Oneonta, USA, heilvejs@oneonta.edu

POPULATION STRUCTURE OF CARDISOMA GUANHUMI LATREILLE (CRUSTACEA: DECAPODA) SUSTAINABLE MANAGEMENT IMPLICATIONS OF A COMMODITY SPECIES ON ANDROS ISLAND, BAHAMAS

Monitoring of aquatic resources in developing countries has become crucial due to habitat fragmentation and increased harvesting pressure to improve economic growth. These issues create an inherent danger to population stability of commodity species. *Cardisoma guanhumi* Latreille, the blue land crab, is a commodity species functioning as a crucial part of the economy on Andros

Island, Bahamas. Anecdotal reports indicate a marked decline in population size of blue land crabs over the last decade. This project used mitochondrial d-loop sequence analysis to identify the discrete populations of *Cardisoma guanhumi* and quantify the extent of its genetic diversity on Andros Island. Analysis of preliminary d-loop sequences has revealed a great deal of genetic diversity between populations in the less-settled portions of Andros. Knowing the extent of the populations and amount of genetic diversity in each will allow scientific data to be used to create sound management plans aiding in the sustainability of blue land crab on Andros Island, Bahamas.

Larned, **S. T.**, National Institute of Water & Atmospheric Research, Christchurch, New Zealand, s.larned@niwa.co.nz
Plew, D. R., National Institute of Water & Atmospheric Research, Christchurch, New Zealand, d.plew@niwa.co.nz
Packman, A. I., Northwestern University, Evanston, USA, a-packman@northwestern.ed
Vopel, K. C., Auckland University of Technology, Auckland, New Zealand, kay.vopel@aut.ac.nz

THE DIDYMO STRATEGY: HOW DO BIG ALGAL MATS PERSIST IN SWIFT, OLIGOTROPHIC RIVERS?

To balance the conflicting requirements of minimal drag (to reduce detachment) and maximal exposure to turbulent flow (to increase nutrient acquisition), autotrophs in oligotrophic rivers adapt to and modify their hydrodynamic environments. We explored these interactions using Didymosphenia geminata (didymo). We reconstructed cobble riverbeds with attached didymo in a flume for hydrodynamic measurements. We repeated the measurements after removing didymo from the cobble bed, and used differences in the presence and absence of didymo to infer the hydrodynamic effects of didymo on near-bed flow. Didymo reduced flow separation and form drag relative to bare cobble beds. However, didymo surfaces also introduced roughness at scales that were not present on bare cobbles. Didymo roughness increased turbulent shear stress, but displaced maximum shear stress away from the bed. The effect of increased turbulence from biological roughness exceeded that of decreased form drag. These observations suggest that didymo resists detachment by displacing turbulent energy, not by smoothing rough beds. Low permeability within didymo mats leads to diffusive transport, which may retain solutes in the upper layers of mats where living didymo cells occur.

Larrañaga, **S.**, University of British Columbia, Vancouver, Canada, xanti.larranaga@gmail.com
Kominoski, J. S., University of British Columbia, Vancouver, Canada, jkominoski@gmail.com
Richardson, J. S., University of British Columbia, Vancouver, Canada, john.richardson@ubc.ca

DOES RIPARIAN FOREST COMPOSITION INFLUENCE RESOURCE-CONSUMER STOICHIOMETRY DYNAMICS AND FUNCTIONING IN STREAM ECOSYSTEMS?

Different types of organic matter and its selection by consumers can affect the transfer rates of energy through food webs. To test the effects of changes in riparian inputs on stream ecosystem structure and functioning, we measured stoichiometry (C:N:P) and 13C and 15N isotopes of leaf litter resources and invertebrates and emergence in streams with different riparian forest composition (deciduous, coniferous, mixed) and performed a laboratory invertebrate feeding preference experiment. Initial and incubated Alnus rubra litter had lower C:N:P and 13C, and higher 15N than Tsuga heterophylla among all streams. Background levels of consumer tissue stoichiometry did not vary among taxa or riparian forest type. However, 13C and 15N isotope values for invertebrates were more enriched from mixed and coniferous than deciduous streams, and for predator than shredder taxa. Individual consumption rates of A. rubra incubated in streams with different forest types were affected by the composition of mixtures, and individual Tsuga heterophylla consumption rates were affected by forest type identity. Invertebrate emergence was highest from deciduous streams. Riparian forest composition can affect structural and functional aspects of stream ecosystems.

Larsen, **L. G.**, U.S. Geological Survey, Reston, USA, lglarsen@usgs.gov
Harvey, J. W., U.S. Geological Survey, Reston, USA, jwharvey@usgs.gov
McPhillips, L. E., U.S. Geological Survey, Reston, USA, lmcphillips@usgs.gov
Maglio, M., U.S. Geological Survey, Reston, USA, mfranklin@usgs.gov

CONTROLS ON ECOSYSTEM METABOLISM IN RESTORED AND UNRESTORED SUBURBAN STREAMS: ROLES OF FLOW, GEOMORPHOLOGY, AND FINE SEDIMENT DYNAMICS

Stream restoration changes the geomorphic template upon which biogeochemical reactions occur, altering flow patterns and sediment and nutrient transport. How these changes impact ecosystem functioning is poorly understood. Here we describe results of a 1-yr field study that elucidate controls on community respiration and primary production in different geomorphic units within adjacent 200-m reaches of restored and unrestored Piedmont streams. Local measurements of sediment oxygen demand and chlorophyll-a were paired with measurements of sediment physical and chemical properties, local hydraulic characteristics, and continuous hydrologic and water-quality monitoring and modeled statistically. In the restored stream, substrate characteristics were the prime control on metabolism, with respiration dominating in storage zones with fine sediment and primary production dominating in main channel sites with coarser sediment. In the unrestored stream, primary production and respiration co-varied spatially, with photosynthetically active radiation (PAR) the dominant control. Thunderstorm-induced flooding caused substantial declines in primary production and respiration in both streams, the magnitude of which depended on local geomorphology. During recovery, factors controlling spatial variation in metabolism differed from pre-flood, with flow velocity and PAR becoming increasingly important.

Larson, **E. R.**, University of Washington School of Aquatic and Fishery Sciences, Seattle, USA, lars9570@u.washington.edu
Olden, J. D., University of Washington School of Aquatic and Fishery Sciences, Seattle, USA, olden@uw.edu
Usio, N., Niigata University Center for Transdisciplinary Research, Niigata, Japan, usio.n@cc.niigata-u.ac.jp

NICHE CONSERVATISM BY SIGNAL CRAYFISH *PACIFASTACUS LENIUSCULUS* BETWEEN NATIVE AND INVADED LAKES

The study of aquatic invasive species has historically neglected comparisons of functional roles between native and invaded ranges. Such reciprocal comparisons of species function may provide insights into issues of niche shifts and conservatism and the predictability of invasive species impacts across broad spatial scales. We compared the trophic niche of the signal crayfish *Pacifastacus leniusculus* between five lakes in its invaded range in Hokkaido, Japan, and four lakes in its native range in Washington State, United States, using stable isotopes of carbon and nitrogen. Our results indicate enormous plasticity in trophic position (primary consumer to predator) and niche breadth (reliance on autochthonous or allochthonous energy sources dependent on lake size and morphometry) between individual lakes regardless of range. Univariate and multivariate analyses demonstrate that the overall trophic niche of *P. leniusculus* was conserved between Washington and Hokkaido. The plasticity of *P. leniusculus*' trophic niche, conserved across ranges, demonstrates the dangers inherent in the introduction of invasive arthropod generalists, which may have unpredictable, context-dependent ecological impacts in response to resource availability and biotic interactions.

Lash, **F. P.**, Texas State University, San Marcos, USA, fl1022@txstate.edu
Zhang, Y., Texas State University, San Marcos, USA, yz11@txstate.edu
Nowlin, W. H., Texas State University, San Marcos, USA, wnowlin@txstate.edu
Bonner, T. H., Texas State University, San Marcos, USA, Tbonner@txstate.edu

IMPACT OF LAND USE IN THE LOWER BRAZOS RIVER ON THE BENTHIC MACROINVERTEBRATE DIVERSITY

Riverine ecosystem structure and function are determined by watershed characteristics. Land use pattern, such as developed urban areas and agriculture land, influence the stream ecosystem processes and impact the biotic invertebrate community through a variety of mechanisms. This study investigated macroinvertebrate community assemblage from 33 sites within six catchments with differing land use from the tributaries of the Lower Brazos River. Eight land use categories were measured at both local and catchment scales using GIS overlays of land cover. The land use data were compared in each catchment group. Quantitative benthic macroinvertebrate samples were collected and a variety of habitat physicochemical characteristics were measured at each site over three seasons. 184,000 invertebrate individuals were identified, which represented 185 taxa. Collector-gatherers and predators had the greatest species richness and the greatest relative abundance. The results indicated that macroinvertebrate

assemblages showed differences in species richness and abundance due to both different land use in watersheds and natural local habitat variation. This study supports the general prediction that macroinvertebrate diversity of streams and rivers is influenced by land use pattern within the watershed.

Lassus, **J.**, Department of Zoology, Miami University, Oxford, OH, USA, lassusj@muohio.edu

Asher, A., Environmental Sciences Program, Arkansas State University, State University, AR, USA,

Monroe, E. M., Department of Zoology, Miami University, Oxford, OH, USA,

Christian, A. D., Department of Biology, University of Massachussetts, Boston, MA, USA,

Berg, D. J., Department of Zoology, Miami University, Hamilton, OH, USA,

COMPARATIVE ANALYSIS OF POPULATION GENETICS OF TWO FRESHWATER MUSSEL SPECIES IN THE SPRING RIVER, AR

Freshwater mussels of the families Unionidae and Margaritiferidae are among the most endangered groups of benthic invertebrates. We surveyed microsatellite variation to determine genetic structure of two unionids, the Arkansas Brokenray (*Lampsilis reeviana*) and the Rainbow mussel, (*Villosa iris*) from the Spring River, AR. *Lampsilis reeviana* is a threatened species and has a limited range, while *V. iris* does not have any conservation status and is a much more widespread species across the United States than *L. reeviana*. It was found that both species have high within population variation, and low among population variation, suggesting that there is strong gene flow among the populations. Furthermore, there is no relationship between geographic distance and genetic distance between populations, suggesting no isolation-by-distance at this spatial scale. Three out of seven *V. iris* loci deviated from Hardy-Weinberg equilibrium with mostly heterozygote deficiencies, while 3 out of 8 of *L. reeviana* deviated from H-W equilibrium with similar heterozygote deficiencies. These results show similar findings from previous scientific studies and suggest that both limited-range and widespread unionids show similar trends in their population genetics.

Laurion, **I.**, Institut national de la recherche scientifique, Centre Eau Terre Environnement, Quebec, Canada, isabelle.laurion@ete.inrs.ca

Mladenov, N., University of Colorado, Boulder, USA, Natalie.Mladenov@Colorado.EDU

DISSOLVED ORGANIC MATTER PHOTOLYSIS IN CANADIAN ARCTIC THAW PONDS

The accelerated warming and increased precipitation in polar regions degrade permafrost and increase carbon inputs to aquatic systems from both old (peat) and new sources (plant and cyanobacterial mat growth). Warming also leads to increased thermal stratification, while decreasing seasonal ice cover influences overall seasonal irradiance. These changes result in increasing photochemical and microbial processes that liberate part of this carbon to the atmosphere as greenhouse gases, generating a positive feedback for global warming. A series of arctic thaw ponds on Bylot Island (73degN) are being studied to investigate their role as carbon reactors. Part of the study was to measure DOM photolysis by following changes in absorption, spectral slopes, synchronous fluorescence and EEMs over 12 days. Preliminary results indicate that photolysis is rapid in these light exposed and stratified systems (exponential change from 0.16 to 0.38 day-1, depending on indicator), with larger relative losses in DOM color and reduction in DOM molecule size in the most exposed pond. However, DOC concentration changes were not significant, possibly indicating a transformation between molecule size pools rather than DOM photochemical mineralization.

Lavoie, **C. R.**, Towson University, Towson, USA, clavoi1@students.towson.edu

Gresens, S. E., Towson University, Towson, USA, sgresens@towson.edu

USE OF CHIRONOMIDAE (DIPTERA) PUPAL EXUVIAE TO DISTINGUISH GRADIENTS OF IMPACT FROM AGRICULTURAL VERSUS URBAN LAND USES

Chironomid pupal exuviae and environmental data were collected in 27 low-order streams in Baltimore County, Maryland, USA. Sites were selected to encompass gradients of agricultural and urban catchment land use, and were compared to streams from primarily forested catchments. Agricultural streams were characterized by the highest amount of fine sediments, highest phosphorus concentrations, highest algal abundance, and lowest canopy cover. Urban streams exhibited the highest conductivity, elevated sediment-bound lead and zinc concentrations, and decreased fine sediments. Agricultural, urban, and forested streams differed significantly in composition of chironomid genera (MRPP, t = -4.7077, p = 0.0007). Forested streams were colonized by many genera not found consistently in agricultural and urban streams, such as Parametriocnemus and Stempellinella, and had more indicator taxa (7) than urban (1) and agricultural (1) streams combined. The abundances of Tanytarsus spp. and Cricotopus spp. were consistently higher in agricultural streams than in forested and urban streams. Urban streams were dominated by Orthocladius species, and showed a large decrease in diversity and richness compared to forested and agricultural streams.

Lavoie, **I.**, Institut national de la recherche scientifique (INRS), Quebec City, Canada, ilavoie.bio@gmail.com

Hamilton, P. H., Canadian Museum of Nature, Ottawa, Canada, PHAMILTON@mus-nature.ca

Poulin, M., Canadian Museum of Nature, Ottawa, Canada,

STUDYING A TEMPERATE LOWLAND RIVER FROM HEAD TO TOE: LINKING SPATIOTEMPORAL VARIABILITY IN PHYSICO-CHEMICAL PROPERTIES AND PHYTOPLANKTON COMMUNITIES

The Rideau River, as the oldest river/canal system with uninterrupted operation in North America, is recognized as a UNESCO historic site with well documented anthropogenic disturbances. As part of a multidisciplinary project, the Canadian Museum of Nature undertook a three-year study examining spatial, seasonal and annual variability in physical, chemical, and biological characteristics of the Rideau River. More specifically, factors controlling phytoplankton communities on a fine spatiotemporal sampling scale were investigated, with bi-monthly sampling of sites less than 10 km apart. The results from this study showed that phytoplankton chlorophyll-a was not related to nutrient concentrations, but that the presence of the invasive zebra mussel, dams and waterfalls along the river had a marked effect on algal standing stock within selected reaches. No single factor controlled the phytoplankton standing stock. Phytoplankton data expressed as community structure revealed that the Rideau Canal/River was controlled by different environmental variables temporally and spatially. On a bimonthly sampling scale, nutrients clearly influenced the structure of the phytoplankton communities in selected reaches, while this link was not observed when only chlorophyll-a data were examined.

Law, **R.**, Lancaster Environment Centre, Lancaster, United Kingdom, roslaw@ceh.ac.uk

Elliott, J. A., Centre for Ecology and Hydrology, Lancaster, United Kingdom, alexe@ceh.ac.uk

Page, T., Lancaster Environment Centre, Lancaster, United Kingdom, t.page@lancaster.ac.uk

THE INFLUENCE OF GRAZING AND VELOCITY ON PHYTOBENTHIC COMMUNITIES IN AN OLIGOTROPHIC RIVER

Phytobenthic biomass and community composition were studied in an oligotrophic river in the UK to investigate the influence of invertebrate grazers and flow velocity. Overall algal biomass per sample was measured twice weekly and the taxa present were identified. Comparisons of samples showed that, contrary to some previous studies, a higher velocity habitat reduced algal biomass in this oligotrophic system. Also comparisons of protected and unprotected samples showed that grazers negatively impacted upon phytobenthic biomass. Community composition was influenced by the differing velocity habitats with most taxa reflecting biomass changes and surviving better in the low velocity habitat. The community composition, however, showed that grazers were not selective in the algal taxa consumed. Diversity indices did not alter considerably throughout this study suggesting that diversity was a robust measure uninfluenced by grazers or moderate velocity differences.

Lawrence, **D. J.**, University of Washington, Seattle, USA, djlaw@u.washington.edu

Olden, J. D., University of Washington, Seattle, USA, olden@u.washington.edu

CONSERVATION PLANNING FOR FRESHWATERS: DO NATIONAL PARKS SERVE AS PROTECTED AREAS FOR FISH DIVERSITY?

Protected areas have been suggested as one conservation tool to reduce the plethora of human-related threats that endanger freshwater fishes. However, no national study to date has evaluated whether current protected areas (although not specifically designed for the protection of freshwater resources) may serve as conservation units of freshwater biodiversity. Thus, we evaluated the potential

for U.S. National Parks (NPs), one of the preeminent conservation systems of the country, to serve as protected areas for fish diversity. To accomplish this task we, 1) assessed the extent to which NPs represent native fish diversity in major ecoregions and the U.S. as a whole, 2) identified those NPs that are critical in providing a representative network of freshwater conservation areas, 3) quantified the present and future threats to NPs that may impede their usefulness as conservation units, and 4) identified under-represented watersheds on the landscape whose future protection could enhance fish diversity protection in the U.S.

Lawrence, **J**. **E**., Department of Environmental Science, Policy, and Management, University of California, Berkeley, Berkeley, CA, USA, jlawrence@berkeley.edu

Lunde, K. B., Department of Environmental Science, Policy, and Management, University of California, Berkeley, Berkeley, CA, USA, klunde@berkeley.edu

Mazor, R. D., Department of Environmental Science, Policy, and Management, University of California, Berkeley, Berkeley, CA, USA, raphaelm@sccwrp.org

Bêche, L. A., Department of Environmental Science, Policy, and Management, University of California, Berkeley, Berkeley, CA, USA, leah.beche@gmail.com

McElravy, E. P., Department of Environmental Science, Policy, and Management, University of California, Berkeley, Berkeley, CA, USA, mcelr@sbcglobal.net

Resh, V. H., Department of Environmental Science, Policy, and Management, University of California, Berkeley, Berkeley, CA, USA, resh@berkeley.edu

LONG-TERM MACROINVERTEBRATE RESPONSES TO CLIMATE CHANGE: IMPLICATIONS FOR BIOLOGICAL ASSESSMENT IN MEDITERRANEAN-CLIMATE STREAMS

Climate change is expected to have strong effects on mediterranean climate-regions worldwide, which could have important implications for biological assessment programs. We examined potential climate-change effects using a consistently collected, 20-y benthic macroinvertebrate dataset from 4 sites along 2 small Northern California streams. We found that the index of biotic integrity (B-IBI) developed for Northern California streams and other common indices and metrics were not influenced by temperature or precipitation extremes. To monitor climate-change effects, we developed local temperature- and precipitation-change indicators composed of the presence-absence of 9 invertebrate taxa. These indicators were successful in detecting significant differences between cool and warm years, and wet and dry years. Also, 2 biological traits found in large, long-lived organisms decreased with increasing temperature and decreasing precipitation at the most intermittent site, which indicates that climate change may selectively affect taxa with certain traits. The robustness of the B-IBI and other common benthic metrics to climate variability demonstrates their continued applicability for examining water quality, but also suggests that they will not likely be good indicators for detecting climate-change effects. The use of indicators based on specific taxa, coupled with biological trait information, may detect impacts of climate change within existing biological assessment programs.

Leandre, **M**. **Y**., Hampton University, Hampton, USA, mlean001@odu.edu

Gibson, D. M., Hampton University, Hampton, USA, deidre.gibson@hamptonu.edu

Frischer, M. E., Skidaway Institute of Oceanography, Savannah, USA, marc.frischer@skio.usg.edu

Paffenhöfer, G. A., Skidaway Institute of Oceanography, Savannah, USA,

Wills, W. D., Hampton University, Hampton, USA,

Bickel, S., Virginia Institute of Marine Science, Gloucester, USA,

PHYTOPLANKTON AND BACTERIOPLANTON PROFILING OF SUBTROPICAL CONTINENTAL SHELF INTRUSION WATERS

Understanding the natural food web requires consideration of the trophic interactions linking species. Currently the ecological role of Dolioletta gegenbauri is being studied to determine what these pelagic tunicates are consuming in-situ. The organisms were presented with intrusion waters from along the South Atlantic Bight during cruises in June, July and August 2009. A profile of their molecular gut content is being compiled using a PNA-PCR-based gut content assay. In conjunction, phyto- and bacterioplankton communities were analyzed to compare abundances in the subtropical continental shelf intrusion waters. Thus far, the dominant species found included Nitzchia, Guinardia, Rhizosolenia, Pseudo-Nitzchia, and Dinoflagellates. We noticed a shift in species composition as the bloom aged from June to August and this data will be discussed.

Leavitt, **P**. **R**., University of Regina, Regina, Canada, Peter.Leavitt@uregina.ca

Bunting, L., University of Regina, Regina, Canada, Lynda.Bunting@uregina.ca

Mathie, E., University of Regina, Regina, Canada, Mathie@uregina.ca

Schindler , D. E., University of Washington, Seattle, USA, deschindl@uw.edu

Chapman Climate Conference Synthesis Group,

THE ENERGY-MASS (EM) FLUX FRAMEWORK: AN ECTOSYSTEM APPROACH TO QUANTIFY EFFECTS OF CLIMATE, HUMANS, AND BIOTA ON LAKES.

The energy-mass (Em) flux framework proposes that climate, humans and other biota regulate lake ecosystems by altering the influx of energy (E) and mass (m) through diverse direct and indirect pathways. In this view, lakes are open ecosystems that retain E and m by production of particles that are deposited as sediments, have limited capability of accessing sequestered materials, and are dependant on a continuous influx of E and m from the ectosystem, the region surrounding the lake. Physical models of the environmental forcing of lakes reveal that neither E nor m pathways are intrinsically paramount, and instead predict that the magnitude of effect of individual inputs depends on the ratio of influx to lake content. This hypothesis was tested by quantifying changes in whole-lake production arising from reciprocal transfer of fish biomass (no net change in influx), introduction of a top predator (pulsed input), and migration of anadromous semelparous salmon (continuous influx). Paleolimnological analyses confirm that ecosystem forcing by fish is a linear function of the importance of E and m subsidies relative to lake content.

Lee, **S**., University of Florida, Gainesville, USA, slee@ufl.edu

Brown, M. T., University of Florida, Gainesville, USA,

DISTURBANCE AND COMMUNITY METABOLISM OF FRESHWATER ECOSYSTEMS: A MICROCOSM STUDY USING PH-ALKALINITY METHOD

The effect of water motion disturbance on the productivity of freshwater ecosystems was investigated using open-top laboratory microcosms. Water samples were collected from nearby lakes, and the productivity of the microcosm communities was measured and calculated from the pH-alkalinity method under the different water motion disturbance regimes. Since the only energy source for the microcosm is artificial light that promotes primary production and subsequent secondary production, the gross primary productivity (GPP) calculated from dissolved inorganic carbon patterns indicates energy capturing capability of each microcosm community under disturbance. The average GPP was increased by high-intensity disturbance but decreased by low intensity. The highest level of intensity lowered GPP. Also, an intermediate level of disturbance frequency was more effective than a continuous disturbance for increase in GPP under the same total amount of disturbance energy. This study has shown that the energy capturing capability of a freshwater ecosystem may be maximized under an intermediate level of disturbance intensity and frequency. This microcosm study is expected to provide insight into the relationship between natural disturbance and community metabolism.

Leech, **D**. **M**., DePauw University, Greencastle, USA, dinaleech@depauw.edu

Ensign, S. H., UNC Institute of Marine Sciences, Morehead City, USA, ensign@email.unc.edu

Piehler, M. F., UNC Institute of Marine Sciences, Morehead City, , mpiehler@email.unc.edu

A MISSING LINK: ZOOPLANKTON COMMUNITY DYNAMICS IN THE ABSENCE OF RIVER HERRING IN A COASTAL, BLACKWATER RIVER, NORTH CAROLINA, USA

The Chowan River Basin historically had one of the largest spawning migrations of river herring (*Alosa aestivalis* and *Alosa pseudoharengus*) in the southeastern US. Overfishing and poor water quality has subsequently led to dramatic declines, resulting in a moratorium on harvests. Resource managers identified food availability as a potential impediment to river herring recovery efforts. Zooplankton prey abundance was last assessed in the 1980s and was generally low (<2 individuals/L). Consequently, we sampled zooplankton within the main stem and tributaries of the Chowan Basin over the last two years. We also measured water quality, including chlorophyll-*a* and nutrient concentrations, dissolved oxygen, and organic matter loading. While zooplankton composition is similar to the 1980s (primarily small-bodied cladocerans and copepods), abundance is much higher. Zooplankton were greatest in the spring and summer during spawning migration and juvenile development, ranging from 35/L to 400/L. Zooplankton abundance was negatively correlated with discharge and positively correlated with chlorophyll-*a* concentration. Decreases in river herring, increases in zooplankton,

and decreases in chlorophyll-*a* suggest a tightly coupled food chain in which river herring indirectly influence ecosystem productivity.

Lehman, **P. W.**, CA Department of Water Resources, West Sacramento, USA, plehman@water.ca.gov

Liu, L., CA Department of Water Resources, West Sacramento, , Lliu@water.ca.gov

Tang, A., CA Department of Water Resources, West Sacramento, , atang@water.ca.gov

Mayr, S. D., CA Department of Water Resources, West Sacramento, , sdmayr@water.ca.gov

HYDRAULICALLY ISOLATED PONDS CONTRIBUTE MOST OF THE ORGANIC CARBON PRODUCED IN THE FRESHWATER TIDAL WETLAND, LIBERTY ISLAND, CA

The production and export of inorganic and organic material from the freshwater tidal wetland Liberty Island are thought to be important to fishery production in San Francisco Estuary but the mechanisms controlling material flux and production are unknown. The relative contribution of vegetated and open water ponds to material flux of the wetland was determined from discrete samples of organic and inorganic materials including nutrients, salt, total and dissolved organic carbon, chlorophyll a concentration and phytoplankton species carbon collected every 1.5 hr over the tidal day combined with continuous measurements of flow. Concentrations of inorganic and organic materials were greater in the vegetated ponds. A shallow vegetated pond in the interior of the wetland contributed 20-50% of the inorganic material and 50-60% of the organic carbon exported by the wetland. Carbon accumulation in this pond was facilitated by the greater tidal asymmetry and small-scale topography in the interior of the wetland that increased residence time. This study suggests the importance of ponds in the interior of the wetland to inorganic and organic material flux of freshwater tidal wetlands.

Leibowitz, **S. G.**, US Environmental Protection Agency, Corvallis, USA, leibowitz.scott@epa.gov

Wigington, P. J., US Environmental Protection Agency, Corvallis, USA, wigington.jim@epa.gov

Comeleo, R. L., US Environmental Protection Agency, Corvallis, USA, comeleo.randy@epa.gov

Ebersole, J. L., US Environmental Protection Agency, Corvallis, USA, ebersole.joe@epa.gov

HEADWATER EFFECTS ON DOWNSTREAM WATERS: LEGAL PERSPECTIVES, SCIENCE NEEDS, AND ASSESSMENT APPROACHES

Headwater streams make up at least 53% of total stream length in the US. Although these systems are of interest for their own sake, there has recently been significant focus on how headwater streams contribute to downstream waters. This has resulted in part from recent legal opinions regarding the Clean Water Act, but also because of interest in hydrologic connectivity between stream network elements. In this talk, we consider headwater effects on downstream waters from legal, scientific, and assessment perspectives. First, we review the US Supreme Court's ruling in *Rapanos*, including legal opinions concerning permanence of flow and significant nexus. We then consider science needs resulting from this case, and challenges with addressing these needs. Finally, we discuss several approaches that we have developed that can be used to assess the downstream effects of headwaters. These include use of Hydrologic Landscape Regions, assessments of stream duration, and modeling of hydrologic connectivity.

Leichtfried, **M.**, Institute for Limnology, Austrian Academy of Sciences, Mondsee, Austria, maria.leichtfried@oeaw.ac.at

WALPOLA, H., University of Innsbruck, Institute for Ecology, Innsbruck, Austria, hiranthiwalpola123@yahoo.com

AMARASINGHE, M., University of Kelaniya, Institute for Botany, Kelaniya, Sri Lanka, mala@kln.ac.lk

FUEREDER, L., University of Innsbruck, Institute for Ecology, Innsbruck, Austria, leopold.fuereder@uibk.ac.at

THREE TROPICAL RIPARIAN VEGETATION PLANTS: HOW DO THEIR LEAVES DECOMPOSE IN A SRI LANKAN STREAM? WHO ARE THE IMPORTANT PLAYERS IN THIS PROCESS?

Within the framework of the cooperative project IRESA (Initiative of River Ecology in Sri Lanka: from Science to Application), first decomposition study was carried out on a low order stream in wet climatic zone of Sri Lanka. Highest decomposition rates were found for Alstonia with very fine; middle for rubber; and lowest for bamboo with very tough tissue. Macroinvertebrates colonization started shortly after the exposition of litterbags. Two temporal patterns were recognized: a) rubber leaves were fast colonized to maximum and left soon; b) bamboo leaves were slow colonized slow a plateau, animals stayed for whole remaining process time. Nutrients and potential respiration analysis of fresh fallen and conditioned leaves showed higher food quality of conditioned leaves, documenting biofilm development and explaining colonization patterns. Diptera dominated taxonomic composition; its functional feeding analysis showed dominance of only gathering collectors. Colonizing fauna with biofilms provide for more effective leaf decomposition. Structure and toughness of leaves are more important than their origin. Therefore, the introduction of leaves may not only affect terrestrial vegetation but also the functional organization of river ecosystems.

Leigh, **C.**, Australian Rivers Institute, Griffith University, Brisbane, Australia, c.leigh@griffith.edu.au

Burford, M. A., Australian Rivers Institute, Griffith University, Brisbane, Australia, m.burford@griffith.edu.au

Roberts, D. T., Seqwater, Brisbane, Australia, dtroberts@seqwater.com.au

A NEW INDEX TO PREDICT VULNERABILITY OF RESERVOIRS TO CYANOBACTERIAL BLOOMS

Cyanobacterial blooms in water reservoirs present a major ecosystem functioning and human health issue. The ability to predict reservoir vulnerability to these blooms would assist in decision making, future management and prevention. We developed an index of vulnerability based on simple measures of reservoir and catchment characteristics, and tested its predictive capacity using water quality data collected over a number of seasons and years from 15 reservoirs in subtropical Australia. The index correlated significantly and strongly with nutrient concentrations, algal cell densities, including potentially toxic cyanobacteria, and proportions of cyanobacteria in summer months. The index also performed better than any component parameter alone. Our index is the first to encapsulate the physical characteristics of subtropical reservoirs and their catchments into an effective indicator of the likelihood of summer blooms. More broadly, the index offers greater understanding into the links between cyanobacteria and the physical environment of dammed rivers. With climate change, continued river impoundment and the growing demand for potable water, our index has potential decision making benefits when planning future reservoirs to reduce the likelihood of cyanobacterial blooms.

Leigh, M. N., Western State College of Colorado, Gunnison, USA, mandi.leigh@western.edu

Alexander, **K. D.**, Western State College of Colorado, Gunnison, USA, kalexander@western.edu

BENTHIC MACROINVERTEBRATE COMMUNITY RESPONSE TO SEASONAL LEAF INPUTS FROM ALPINE TUNDRA IN THE SOUTHERN ROCKY MOUNTAINS (HINSDALE COUNTY, COLORADO, USA).

Nellie Creek, a first order stream, originates in alpine tundra on Uncompahgre Peak in the San Juan Mountains of Hinsdale County, CO, USA. Aquatic macroinvertebrates were sampled in Nellie Creek biweekly from July to September, 2008, along an elevational gradient from alpine tundra down to subalpine forest. Nearly 5,000 individuals were identified to 22 taxa and categorized into functional feeding groups. Our data indicates seasonal species and functional feeding group shifts responding to the changing terrestrial nutrient and energy inputs from alpine tundra leaf fall. With a truncated growing season and the unavailability of other allocthonous inputs in Nellie Creek, the seasonal changes in the benthic macroinvertebrate community including the timing of shredder life cycles mimics lower elevation streams that originate in deciduous forests. These results indicate that tundra vegetation, though small in physical stature, fills the same functional role of supplying course allocthonous inputs as in streams draining deciduous forests.

Lencioni, **V**., MUSEO TRIDENTINO DI SCIENZE NATURALI, TRENTO, Italy, lencioni@mtsn.tn.it
MARZIALI, L., MUSEO TRIDENTINO DI SCIENZE NATURALI, TRENTO, Italy,
ROSSARO, B., UNIVERSITY OF MILAN, MILAN, Italy,

A DIVERSITY-BASED MODEL FOR CHIRONOMIDS IN ALPINE AND PRE-ALPINE SPRINGS IN RELATION TO ENVIRONMENTAL FACTORS

Diversity and distribution of Chironomids (Diptera, Chironomidae) from 124 springs (helo-, limno- and rheo-crene) in the Italian Prealps and Alps (62-2792 m a.s.l.) were studied in relation to environmental variables (e.g., lithology, altitude, substrate composition, temperature, water chemistry) and human impacts (e.g., water abstraction, pasture). More than 32,000 specimens and 90 taxa were collected, of which more than half are present in <10% of sites. Orthocladiinae accounted for a large part of specimens (>80%), among which many cold stenothermal and rheophilous species. Highest richness and diversity were recorded in rheo-helocrene springs at intermediate altitude. An unsupervised neural network (self-organizing map) emphasised differences between spring types and different anthropogenic pressures. Canonical Correlation Analysis outlined the environmental variables which contributed most along with Chironomid taxa to site ordination: altitude, conductivity, water temperature, discharge, substrate granulometry, silica. A supervised neural network (multilayer perceptron) generated a model able to predict Shannon Diversity Index based on Chironomid taxa according to 37 environmental variables. The role of different predictors (water velocity, conductivity, granulometry etc.) in determining the biodiversity value (diversity index) was emphasized.

Lennon, **J. T**., Michigan State University, W.K. Kellogg Biological Station, Hickory Corners, USA, lennonja@msu.edu
Jones, S. E., Michigan State University, W.K. Kellogg Biological Station, Hickory Corners, USA, stujones@msu.edu

DO TERRESTRIAL CARBON SUBSIDIES STABILIZE AQUATIC ECOSYSTEM FUNCTIONING?: EVIDENCE FROM WHOLE-ECOSYSTEM EXPERIMENTS

Terrestrial ecosystems export large quantities of dissolved organic carbon (DOC) to nearby aquatic ecosystems. Food web and ecosystem theory predict that such donor-controlled resource inputs should influence the stability of recipient ecosystems. We tested these predictions by manipulating terrestrial DOC loading to a series of ponds. As expected, our ponds became increasingly heterotrophic with increasing DOC loading, owing in part to light limitation of gross primary productivity. Using dynamic linear models, we identified a strong non-linear relationship between P uptake dynamics and DOC supply rate. Specifically, phosphorus uptake was much more rapid in ponds with low DOC loading than ponds with high DOC loading. Using a combination of simulation modeling and reciprocal transplant experiments, we conclude that terrestrial DOC inputs reduce ecosystem stability via light limitation of phytoplankton. Although terrestrial DOC inputs subsidized heterotrophic bacteria to some degree, microbes remained carbon limited and were thus incapable of compensating for episodic increases in phosphorus availability. Our results suggest that lakes may become less resilient to nutrient perturbations in the future given the observed trends of increasing DOC around the globe.

Lento, **J**., University of Ottawa, Ottawa, Canada, jlento@gmail.com
Morin, A., University of Ottawa, Ottawa, Canada, Antoine.Morin@uottawa.ca

HABITAT SPACE AND ENERGY AVAILABILITY AS DETERMINANTS OF SIZE DISTRIBUTIONS OF LOTIC ASSEMBLAGES

Size spectra in aquatic systems have shown a strong consistency of shape across a range of environmental conditions and among different groups of organisms, with higher normalized biomass of small organisms than large. This research was intended to test the relative effects of energy and space availability on the shape of stream size spectra. We collected macroinvertebrates, crayfish, and fish from 17 streams varying in nutrient levels and habitat complexity. Habitat space was estimated from digital photographs of stream substrates. Stable isotopes were used to estimate trophic position and approximate energy availability. Both energy and space availability affected the normalized biomass of organisms in our study sites, although energy availability explained more of the variation in normalized biomass. There was a strong negative linear relationship between normalized biomass and $\delta^{15}N$, which suggested that energy availability contributed to primary structuring of size spectra. However, the average slope of the spectra did not match what was expected if energy alone mediated spectrum shape. The weaker effect of space availability may have contributed to secondary structuring of size spectra, controlling deviations from linearity.

LeRoy, **C. J**., Evergreen State College, Olympia, USA, LeRoyC@evergreen.edu
Fischer, D. G., Evergreen State College, Olympia, USA, FischerD@evergreen.edu
Barlow, C. H., Evergreen State College, Olympia, USA, BarlowC@evergreen.edu
Andrews, W. M., Evergreen State College, Olympia, USA,
Belleveau, L., Evergreen State College, Olympia, USA,
Muck, A., Evergreen State College, Olympia, USA,
Andre, Z., Evergreen State College, Olympia, USA,
Kallestad, J., Washington State University, Puyallup, USA,

GENETIC VARIATION IN FOUNDATION TREE SPECIES INTERACTS WITH SALMON CARCASS PRESENCE IN STREAMS

Riparian zones are often dominated by foundation tree species, making it important to understand how intraspecific genetic variation can influence the allochthonous inputs streams receive. Building on recent *Populus* genes-to-ecosystems work, we determined the influence of genotype on both phytochemistry and litter decomposition for *Populus trichocarpa*. In addition, we examined the interaction between litter and allochthonous salmon carcass inputs. We found that salmon carcass presence overwhelmed genetic variation and altered non-additive effects in litter mixtures. Genotypes of *P. trichocarpa* differed significantly in initial litter % condensed tannin, N, P, and lignin. These phytochemical differences led to significant differences in litter decomposition at harvest day 14 and 28 in the absence of salmon, but only on day 28 in the presence of salmon. Additionally, the presence of salmon led to significantly more synergistic responses of decomposition to litter mixing. These findings have important implications because restoration projects often use carcass "tosses" and/or the replanting of foundation tree species to improve riparian and stream habitats, while interactions between these restoration actions and the influence of genetic variation in foundation species are understudied.

Lessard, **J. L**., National Institute of Water and Atmospheric Research, Christchurch, New Zealand, j.lessard@niwa.co.nz
Larned, S. T., National Institute of Water and Atmospheric Research, Christchurch, New Zealand, s.larned@niwa.co.nz
Meriano, M., National Institute of Water and Atmospheric Research, Christchurch, New Zealand, m.meriano@niwa.co.nz
Plew, D. R., National Institute of Water and Atmospheric Research, Christchurch, New Zealand, d.plew@niwa.co.nz

LOOKING FOR LINKAGES BETWEEN HYDROLOGY AND ECOLOGY IN GROUNDWATER DOMINATED LOWLAND STREAMS, CANTERBURY, NEW ZEALAND

The Lake Ellesmere Tributary Research Area (LETRA) is a new, joint initiative of NIWA's Flagship Program,Water Allocation Program, and Lincoln Venture's Groundwater Allocation Program. LETRA, located in the Canterbury Plains on New Zealand's South Island, contains many small, low gradient, groundwater dominated streams, with abundant macrophyte growth. The hydrological dynamics and ecological functioning of these systems is poorly understood. Studies initiated this year are attempting to quantify surface water groundwater interactions in these systems as well as evaluating macrophyte-flow interactions and their ecological effects. Linkages between recharge, discharge, and water quality are revealed using groundwater tracers. Salt releases were used to relate reach-scale macrophyte coverage to solute dispersal and storage. Preliminary analyses show differences in water chemistry, wetted channel dimensions and flow-macrophyte interactions across streams and seasons. Differences may be due to changes in groundwater flow, water use, and local land-use. Reach-scale hydraulic resistance varies seasonally with changes in macrophyte coverage and species. Continuing LETRA research will include benthic macroinvertebrate studies, experimental macrophyte removals, nutrient additions, as well as more detailed groundwater monitoring.

Levesque, **D**., Université de Montréal, Montreal, Canada, David.Levesque@umontreal.ca
Cattaneo, A., Université de Montréal, Montreal, Canada, Antonia.cattaneo@umontreal.ca
Hudon, C., Environnement Canada, Montreal, Canada, Christiane.Hudon@EC.GC.CA

THE CYANOBACTERIUM *LYNGBYA WOLLEI* IN THE ST. LAWRENCE RIVER

The benthic filamentous cyanobacterium *Lyngbya wollei* forms extensive mats on the bottom of the St.Lawrence River. It produces low-toxicity neurotoxins and volatile organic compounds affecting drinking water taste and odor. Since *L. wollei* was found over a 100-km stretch of the St. Lawrence River, we wanted to determine the physical and chemical variables controlling its abundance and distribution over an annual cycle. For this, we surveyed 11 sites located along a transect perpendicular to the north shore of lake Saint-Louis (Quebec), a large fluvial lake of the St. Lawrence River where water masses originating from the Great Lakes and the Ottawa River flow side by side. Sampling was carried out at weekly to monthly interval between spring 2009 and spring 2010. At each site, we measured physical and chemical variables and the biomass of *L. wollei*, other filamentous algae, and macrophytes. *L. wollei* biomass was highest near shore, in the coloured water mass from the Ottawa River and steadily increased from May to December. This information will be used to model the spatial and temporal patterns of this obnoxious cyanobacterium.

Levi, **P. S.**, University of Notre Dame, Notre Dame, USA, plevi@nd.edu
Tank, J. L., University of Notre Dame, Notre Dame, USA, jtank@nd.edu
Janetski, D. J., University of Notre Dame, Notre Dame, USA, djanetsk@nd.edu

THE ROLE OF INTRODUCED PACIFIC SALMON ON ECOSYSTEM FUNCTION IN MIDWESTERN STREAMS

Pacific salmon (*Oncorhynchus* spp.) play multiple roles in their native stream ecosystems, where they provide both a resource subsidy and benthic disturbance during spawning. The role of introduced salmon in sandy-bottomed Midwestern streams may shift towards disturbance as a result of substrate instability. We measured water chemistry, physical characteristics, gross primary production (GPP), and community respiration (CR) in two tributaries to Lake Michigan before, during, and after the salmon run in 2009. The streams had significantly different ambient nutrient concentrations and only Pine Creek showed a nutrient increase during the salmon run. Also, salmon biomass and large wood volume differed between the streams, which have been shown to influence the role of salmon in the Pacific Northwest. During the run, GPP increased in Pine Creek from 0.03 to 0.1 gO_2/m^2/day, whereas in Thompson Creek, GPP decreased from 2.1 to 1.0 gO_2/m^2/day. In contrast, salmon increased CR almost 3-fold in both streams. In their native and introduced ranges, salmon may enhance or depress GPP and nutrients depending on environmental factors, which has implications for stream trophic interactions and community structure.

Levine, **S. N.**, University of Vermont, Burlington, VT, USA, slevine@uvm.edu
Lini, A., University of Vermontu, Burlington, VT, USA, alini@uvm.edu
Ostrofsky, M. L., Allegheny College, Meadville, PA, USA, mostrofs@allegheny.edu
Bunting, L., University of Regina, Regina, SK, Canada, Lynda.Bunting@uregina.ca
Burgess, H. D., University of Vermont, Burlington, VT, USA, hburgess@uvm.edu
Leavitt, P., University of Regina, Regina, SK, Canada, Peter.Leavitt@uregina.cca
Dahlen, D., Paul Smiths College, Paul Smiths, NY, USA,
Lami, A., CNR-Istituto per lo Studio degli Ecosistemi, Pallanza-Verbania, Italy,
Guilizzoni, P., CNR-Istituto per lo Studio degli Ecosistemi, Pallanza-Verbania, Italy,

PALEORECONSTRUCTION OF THE TROPHIC HISTORY OF LAKE CHAMPLAIN: THE NORTHEAST ARM

Missisquoi and St. Albans Bays in the Northeast Arm of Lake Champlain are known for their toxic cyanobacterial blooms, but have short monitoring histories (since 1992) that impede restoration planning. To extend knowledge of the eutrophication process in the Northeast Arm, we collected sediment cores from four sub-regions and analyzed them for proxies of nutrient availability and productivity. All cores showed pre-settlement oligotrophy only marginally altered by 18th and 19th century land clearing, traditional agriculture, and commerce. Eutrophication began in late 19th century as urban centers industrialized and directed effluents into the lake and agriculture refocused on valley-based dairy production. Suburban growth in the 1960s accelerated eutrophication throughout the Arm except in semi-isolated Missisquoi Bay, where mesotrophy was maintained until agroindustry expanded in the 1980s. Ongoing lake remediation through P input reduction has stabilized algal biomass in St. Albans Bay at 1970s levels, but eutrophication continues elsewhere. Although the Arm's main basin is less productive than its bays, its sediment is richer in P, N, organic C and algal pigments due to less dilution of autochthonous with allochthonous materials.

Lewandowska, **A.**, Leibniz Institute of Marine Sciences IFM-GEOMAR , Kiel, Germany, alewandowska@ifm-geomar.de
Hillebrand, H., Institute for Chemistry and Biology of the Marine Environment - University Oldenburg, Wilhemshaven, Germany, helmut.hillebrand@uni-oldenburg.de
Sommer, U., Leibniz Institute of Marine Sciences IFM-GEOMAR , Kiel, Germany, usommer@ifm-geomar.de

IMPACT OF CLIMATE WARMING ON COMMUNITY INTERACTIONS IN PELAGIC ECOSYSTEM – THE KIEL MESOCOSM EXPERIMENT.

Climate warming can led to dramatic changes in marine pelagic communities. Most of the recent ecological studies focus on impact of warming on a limited number of species, ignoring species coexistence and food web interactions. Our indoor mesocosms experiments with natural plankton community from Kiel Bight, Baltic Sea clearly show how plankton composition and interaction between phyto- and zooplankton can change with warming. We manipulated temperature in combination with other factor (light or grazing pressure) and observed decrease of phytoplankton biomass, changes in phenology, species composition and community dominance structure with warming. We show the importance of indirect temperature effects like grazing affecting development of spring phytoplankton bloom and present an example how food web interactions in pelagic ecosystem might change with climate warming.

Lewis, **G. D.**, University of Auckland, Auckland City, New Zealand, gd.lewis@auckland.ac.nz
Lear, G., University of Auckland, Auckland City, New Zealand, g.lear@auckland.ac.nz
Neale, M., Auckland Regional Council, Auckland City, New Zealand,
Washington, V., University of Auckland, Auckland City, New Zealand,
Fan, V., University of Auckland, Auckland City, New Zealand,

A BIOFILM BASED BACTERIAL COMMUNITY INDEX TO TRACK CHANGES IN STREAM ECOSYSTEM HEALTH

Bacteria form a significant part of stream communities with important roles in nutrient cycling, contaminant processing, and the fixation, cycling and transfer of energy in aquatic food webs. The bacterial composition of resident biofilm communities is responsive to external conditions including temperature, pH, water chemistry, nutrient supply and contaminants. This study describes the development and broad scale testing of a bacterial community index, based on the bacterial composition of stream biofilms, as a tool for tracking and comparing stream ecosystem health. A PCR based DNA community fingerprinting approach is used to record the presence and frequency of occurrence of bacteria within a biofilm sample. The relative occurrence of a range of peaks in the fingerprint is used to calculate the bacterial community index. Extensive evaluation is underway encompassing 1500 samples from 300 sites throughout New Zealand, including urban, rural, intensive agriculture and forested catchments. The responsive nature of the bacterial community to change suggests that such an index will become an important tool for water managers to detect ecosystem threats before significant damage occurs to macro-organism communities.

Li, **J. J.**, University of Maryland Baltimore County, Baltimore, USA, jli2@umbc.edu
Swan, C. M., University of Maryland Baltimore County, Baltimore, USA, cmswan@umbc.edu

NITROGEN SOURCE DYNAMICS INTERACT WITH DETRITIVORE FEEDING ACTIVITY AND MICROBIAL RESPIRATION TO ALTER LEAF LITTER DECOMPOSITION IN AQUATIC MICROCOSMS

Nutrient pollution can enrich waterways and also riparian vegetation via assimilation and transformation into new biomass. Since leaf litter is the primary energy source to shaded streams and microbial immobilization of nutrients within the water column can increase its "quality", such alterations could change ecosystem processing of detritus. Our goal was to understand the relative importance of these nutrient sources to decomposition and the interactive role of a common leaf shredding invertebrate. Experimentally N enriched Reed Canary Grass (*Phalaris arundinacea*) was compared to field-collected tissue of lower C:N in a microcosm study under three water enrichment regimes in the presence/absence of the leaf shredding isopod, *Caecidotea communis*. Field-collected tissue decomposed faster in the absence of *Caecidotea* than compared to enriched grasses, while microbial respiration was significantly higher with enriched grasses in its presence. Significant interactions between grass/water treatments both in the presence and absence of macroinvertebrates

were found. Our results suggest that strong interactions between nitrogen source and shredder feeding influence decomposition and microbial respiration. Understanding these complex interactions will be critical to understanding how heavily polluted streams process detritus.

Li, **J**. **L**., Oregon State University, Corvallis, USA, judyli@comcast.net
Gerth, W., Oregon State University, Corvallis, USA, william.gerth@oregonstate.edu
VanDriesche, R., Oregon State University, Corvallis, USA, richvd@yahoo.com
Sobota, J., Oregon State University, Corvallis, USA, Janel.Banks@oregonstate.edu
Bateman, D., Oregon State University, Corvallis, USA, doug_bateman@usgs.gov

MACROINVERTEBRATE RESPONSES TO TIMBER HARVEST AND A DAM-BREAK FLOOD IN HINKLE CREEK OREGON

We examined aquatic macroinvertebrate responses to sequential timber harvests adjacent to headwater and mainstem reaches of Hinkle Creek in southwestern Oregon, USA by comparing harvested to unharvested sites, before and after logging. Invertebrates were collected at a network of 24 sites for 2 years pre-harvest (2004-2005), 4 years post-headwater harvest (2006-2009), and 1 year post-mainstem harvest (2009). Longitudinal gradients in composition and differences between seasons persisted after harvests. Local effects at fishless headwater sites were detected as higher insect emergence, lower numbers of benthic taxa, higher benthic densities, and higher proportions of chironomids. In fish-bearing tributaries and mainstem sites downstream of harvested headwaters, there were no detectable changes in benthic invertebrates or emerging insects. Smaller cutthroat trout ate less and larger fish consumed more than at control sites the year after headwater harvest, but this effect disappeared the following year. After harvest along mainstem sites and a dam-break flood in early 2009, local effects at downstream sites were similar to previous responses at headwater sites (ie. lower taxa richness, fewer EPT taxa, higher emergence, greater percent chironomids).

Li, **Y**., Department of Environment Science and Engineering, Hohai University, Nanjing, China, yipinglihhu@gmail.com
Acharya, K., Desert Research Institute, Las Vegas, USA, Kumud.Acharya@dri.edu

AN ATTEMPT TO FLUSH OUT LAKE TAIHU ALGAE:IS YANGTZE RIVER WATER DIVERSION PROJECT WORKING?

To improve water quality and alleviate eutrophication problem for Lake Taihu, the third largest shallow lake in China, water transfer project from Yangtze River was initiated in 2002. This study investigates the impacts of Yangtze River water transfer on the lake's eutrophication. Water age was used to describe complex hydrodynamics using a three-dimensional numerical model. In general, water ages in Lake Taihu were highly spatially and temporally heterogeneous, depending on hydrodynamic conditions induced by wind and inflow/outflow tributaries. The best conditions for water transfer to lower nutrient concentrations in Meiliang and Zhushan Bays, the most polluted regions in the lake, are during the summer with dominant southeasterly wind. The most efficient flow rate of transferred water is approximately 100 m3/s (the flow rates have ranged from 50-220 m3/s in the past). Increased flow rates would not necessarily provide better exchanges. Finally, Water transfer may preferentially influence some parts of the lake more than others. Unless nutrient concentrations in the transferred water are lowered to reasonable levels, dilution effects are going to be minimal. Keywords: eutrophication; water age; EFDC; shallow lake; numerical model

Liblik, **T**., Marine Systems Institute at Tallinn University of Technology, Tallinn, Estonia, taavi.liblik@phys.sea.ee
Lips, U., Marine Systems Institute at Tallinn University of Technology, Tallinn, Estonia, urmas.lips@phys.sea.ee
Lips, I., Marine Systems Institute at Tallinn University of Technology, Tallinn, Estonia, inga@sea.ee
Kikas, V., Marine Systems Institute at Tallinn University of Technology, Tallinn, Estonia, villu.kikas@phys.sea.ee
Altoja, K., Marine Systems Institute at Tallinn University of Technology, Tallinn, Estonia, kristi09.05@gmail.com

HIGH-RESOLUTION OBSERVATIONS OF VERTICAL STRUCTURE AND VARIABILITY OF HYDROPHYSICAL FIELDS AND RELATED CHANGES IN PHYTOPLANKTON COMMUNITY AND BEHAVIOR

The water column in the deeper areas of the Gulf of Finland (Baltic Sea) reveals a three-layer vertical structure in summer when two pycnoclines – the seasonal thermocline (usually at the depths of 10-20 m) and the permanent halocline (60-70 m) occur. Due to the variable wind forcing and the width of the Gulf, well larger than internal Rossby radius, the meso-scale processes (including coastal upwelling events) and related changes in vertical thermohaline structure are dominant dynamical features. We present an analysis of observations in the Gulf including a moored water column profiler (vertical profiling of temperature, salinity and Chl a fluorescence was carried out in July-August 2009 with a time step of 3 hours), an ADCP, sampling on board a research vessel and a ship-of-opportunity. The distinct periods when certain features/processes prevailed – passage of a filament originated from a coastal upwelling, deepening of the seasonal thermocline (downwelling) and building up a secondary stratification in the upper layer – are revealed. We relate the observed high variability in vertical distribution and migration pattern of phytoplankton to these key processes of various scales.

Liebowitz, **D**. **M**., University of Florida, Gainesville, USA, dinalieb@ufl.edu
Cohen, M. J., University of Florida, Gainesville, USA, mjc@ufl.edu
Heffernan, J. B., International University, Miami, USA, jheffer@fiu.edu
Frazer, T. K., University of Florida, Gainesville, USA, frazer@ufl.edu

TOP-DOWN CONTROL OF ALGAL PROLIFERATION IN FLORIDA'S CHANGING SPRINGS

Many of Florida's 700+ springs are demonstrating dramatic shifts from states dominated by submerged aquatic vegetation (SAV) to states dominated by benthic algae, yet the drivers of these changes remain ambiguous. While nitrogen enrichment has been implicated and is the center of management attention, regional data examining the role of nutrients remain equivocal. Therefore we examine an inclusive suite of interacting factors, focusing on the hypothesis that aquatic macroinvertebrate grazers are key contributors to patterns of algal proliferation in Florida's springs (predicting a negative relationship between macroinvertebrates and algae), and that declining dissolved oxygen (DO) levels lead to grazer exclusion and subsequent release of algal control. We conducted hierarchically nested surveys in eight springs representing contemporary gradients in nitrogen, algae, and DO, collecting quantitative measures of algal biomass, macroinvertebrate biomass, and physical and chemical metrics to determine the existence of systematic relationships in the field. We present the analyses of these surveys, which support the hypothesis of macroinvertebrates as significant factors in controlling algal proliferation, and discuss preliminary in situ experimental verification of causal mechanisms and potential biomass thresholds.

Liess, **A**., Umeå University, Umeå, Sweden, antonia.liess@emg.umu.se
Le Gros, A., University of Otago, Dunedin, New Zealand, ariane.le_gros@agroparistech.fr
Wagenhoff, A., University of Otago, Dunedin, New Zealand, wagan104@student.otago.ac.nz
Matthaei, C. D., University of Otago, Dunedin, New Zealand, christoph.matthaei@gmail.com
Townsend, C. R., University of Otago, Dunedin, New Zealand, colin.townsend.otago@gmail.com

EVIDENCE FOR NITROGEN LIMITATION OF PRIMARY AND SECONDARY PRODUCTION IN STREAMS

Anthropogenic amplification of the nitrogen (N) cycle and the resulting shifts in the supply ratio of N to phosphorus (P) can shift nutrient limitation of aquatic ecosystems from N to P. Here we focus on how stream communities change along gradients of N and P supply, caused by differences in land-use intensity and soil type. We asked (I) whether changes in N or P availability affect periphyton biomass, nutrient content and taxon richness and (II) whether changes in periphyton biomass and nutrient content affect benthic invertebrate abundance, nutrient limitation and taxon richness. We selected 41 southern New Zealand tributaries along a gradient of catchment land use and soil type. We measured stream water nutrient state, periphyton nutrient ratios and biomass, benthic algal taxon richness and invertebrate abundance, taxonomic composition and richness. Enhanced N availability increased periphyton nutrient content and biomass to a larger extent than did P availability, while neither affected algal taxon richness. Lower periphyton C:N ratios but not C:P or N:P ratios were associated with higher invertebrate abundance; comparisons between grazer and periphyton nutrient ratios also indicated that P does not limit grazer growth. Increased N availabilities in the water column and in the periphyton were negatively correlated with invertebrate taxon richness. We conclude that primary and secondary production in these southern New Zealand streams is mainly N rather than P limited.

Liess, **M**., UFZ - Helmholtz Centre for Environmental Research, Leipzig, Germany, matthias.liess@ufz.de

CONSIDERING ECOLOGICAL PROCESSES TO ADVANCE ECOLOGICAL RISK ASSESSMENT OF TOXICANTS

Predicting effect of toxicants on the ecosystem level relies mainly on extrapolating results from single species laboratory tests and sometimes mesocosm studies. Validation of predictions through field monitoring studies are widely absent. However, the few available studies raise the concern that sensitive species need a more careful evaluation of effects and recovery as their (1) sensitivity towards PPP's is higher and (2) recovery is slower than predicted when considering the ecological context. The presentation shows trait-based approaches on how to include more realistic estimations of effect and recovery in the risk assessment framework. These enable informed decision on the management of sensitive species.

Limm, **M**. **P**., University of Minnesota, Minneapolis, USA, mlimm@tc.umn.edu
Hondzo, M., University of Minnesota, Minneapolis, USA, mhondzo@umn.edu
Power, M. E., University of California, Berkeley, Berkeley, USA, mepower@berkeley.edu
Dietrich, W. E., University of California, Berkeley, Berkeley, USA, bill@eps.berkeley.edu
Bode, C., University of California, Berkeley, Berkeley, USA, collin@berkeley.edu
Finnegan, N. J., University of California, Santa Cruz, Santa Cruz, USA, nfinnega@ucsc.edu

ONTOGENIC SHIFT IN HABITAT USE AND CRITICAL FLOW THRESHOLD BY THE CADDISFLY *DICOSMOECUS GILVIPES*.

A species vulnerability to disturbance can vary with organism ontogeny. We investigated whether flood timing would have a differential impact on *Dicosmoecus gilvipes* populations. Specifically, we measured whether critical flow thresholds and habitat use vary with *Dicosmoecus* larval size. Based on field experiments the critical flow velocity, Weber number, and Sheilds stress increased with larval size, as did larval flow velocity preference. The results suggest early flood events will have a greater impact on *Dicosmoecus* populations than later flood events of similar magnitude. During low flow periods, the local scale influence of flow velocity on *Dicosmoecus* distribution, periphyton composition, and periphyton productivity may significantly impact ecosystem processes at larger scales.

Lin, **L**. **H**., Virginia Tech, Blacksburg, USA, laurenl@vt.edu
Webster, J. R., Virginia Tech, Blacksburg, USA, jwebster@vt.edu

SENSITIVITY ANALYSIS OF THE PULSE RELEASE METHOD FOR ESTIMATING NUTRIENT UPTAKE IN STREAMS

The constant nutrient enrichment method has been used extensively to measure nutrient uptake in streams. However, this method is impractical for large streams and the pulse nutrient enrichment method was suggested as an alternative. We developed a computer model to simulate nutrient uptake with initial parameters based on a study of the Snake River. We then simulated a pulse nitrogen addition and measured the downstream response as if it were a field experiment. We then determined the sensitivity of the technique to stream characteristics. There was always an overestimation of uptake length and under-estimation of areal uptake. The error was high when the half-saturation constant for uptake was low or velocity was high and there was little dispersion, either in the water column or from transient storage. We suggest that the pulse addition method has limited value as it has been previously applied. However, it may be possible to use a pulse addition to quantify a fully dynamic model and obtain useful information about stream nutrient dynamics in a large river.

Linke, **S**., Griffith University, Brisbane, Australia, simon.linke@gmail.com

KEEPING IT REAL: DO IMPACT SIMULATIONS REFLECT ACTUAL DISTURBANCES (AND DOES IT MATTER)?

Over the last nine years - after the first workshop on simulated impacts- a few publications have appeared in the scientific literature. While this is significant progress, some questions main unresolved. 1.Realistic trajectories of impact: Depending on the nature of the simulated impact, different methods can increase realism. Methods include taxa-based impacts, individual-based impacts or random impacts 2.Stochasticity: Despite widely available datasets and better predictive models, stochastic fluctuations in the ecological assemblages are still the largest hurdle to successful bioassessment. Despite the importance of realistic levels of stochasticity, achieving this can be tricky. 3.The circular nature of simulations: Usually, simulations are either based on random impacts or rules about the sensitivity of certain taxa. This, however will influence the outcome of a methods comparison. Random impacts will automatically favour generalised methods, while targeted impacts will favour specific metrics. In this paper, I will highlight these limitations and suggest possible solutions based on published and new examples.

Linke, **S**., Australian Rivers Institute,Griffith University, Nathan, Australia, simon.linke@gmail.com
Turak, E., NSW Department of Environment & Climate Change, Sydney South, Australia,
Nel, J., CSIR, Stellenbosch, South Africa,
Olley, J. M., Australian Rivers Institute,Griffith University, Nathan, Australia,

A SYSTEMATIC APPROACH FOR ENVIRONMENTAL WATER ALLOCATIONS

Systematic approaches have been used for conservation and restoration planning activities worldwide, including in high profile projects such as the Cape Floristic Region Conservation plan and the rezoning of the Great Barrier Reef Marine Park. The key principle behind these approaches is to state clear objectives at the beginning and then find a plan that fulfils the objectives in the most effective way, thus reducing social and economic impact on other stakeholders. In this paper, we discuss a novel way in which these planning principles can be utilised for allocating environmental water allocations. By considering the dendritic network structure of rivers upstream, water can be optimally allocated to environmental assets. Hereby water delivered to an asset downstream can provide environmental services on its way through the system, achieving synchroneous benefits at multiple locations. While the proposed systematic framework optimises spatial allocations, future work will have to address temporal considerations, for example when repeated flows are needed to sustain populations. Another key consideration for effective allocations is uncertainty in both allocation availability and success in maintaining biological attributes.

Liu, **Y**., Brooklyn College of The City University of New York, Brooklyn, USA, yliu@brooklyn.cuny.edu
Cheng, Z., Brooklyn College of The City University of New York, Brooklyn, USA, ZCheng@brooklyn.cuny.edu
Branco, B., Brooklyn College of The City University of New York, Brooklyn, USA, BBranco@brooklyn.cuny.edu
Marra, J. F., Brooklyn College of The City University of New York, Brooklyn, USA, jfm7780@brooklyn.cuny.edu

PHOSPHORUS DYNAMICS IN PROSPECT PARK PONDS, NEW YORK CITY

The man-made water system in Prospect Park in Brooklyn (New York) is composed of a series of shallow freshwater ponds. Since mid-1990's, the ponds have been fed predominantly by municipal water, which contains 2 mg/L of P added to control drinking water Pb concentrations. The added phosphorus may have contributed to hypereutrophic conditions over the past decade. However, uncertainty remains as to the relative importance of soluble orthophosphate additions from municipal water and internal loading of phosphorus from sediments. Seasonal monitoring of P throughout the water course suggests overwhelming internal loading in the summer seasons in several of the ponds. This observation is also substantiated by increases in the release from sediments of other metals that are commonly mobilized under anoxic or low pH conditions. Remediation alternatives have been proposed including filtering to remove P from input municipal water, switching to a groundwater source (low-P, high-N), or dredging, in addition to the current practice of algae harvesting every two weeks in the summer. The potential effectiveness of each remediation alternative needs to be evaluated to help guide the resource managers.

Loadman, **N**. **L**., University of Winnipeg, Winnipeg, Canada, n.loadman@uwinnipeg.ca
Huebner, J. D., University of Winnipeg, Winnipeg, Canada, j.huebner@uwinnipeg.ca
Palitsky, D. J., University of Winnipeg, Winnipeg, Canada, danielpalitsky@gmail.com
Wiegand, M. D., University of Winnipeg, Winnipeg, Canada, m.wiegand@uwinnipeg.ca
Husarewycz, W. H., University of Winnipeg, Winnipeg, Canada, willhusarewycz@hotmail.com
Young, D. L., University of Winnipeg, Winnipeg, Canada, d.young@uwinnipeg.ca

EFFECTS OF CHRONIC ULTRAVIOLET-B RADIATION AT THREE TEMPERATURES ON SURVIVAL AND REPRODUCTION OF *DAPHNIA MAGNA*

We have been investigating abiotic influences on survival and reproductive output of *Daphnia magna*. In this study we investigated the combined effects of temperature variation and chronic exposure to ultraviolet-B radiation (UV-B) on survival and reproduction, including clutch size in *Daphnia*. At 20 degrees C, survival was much lower in UV-B exposed *Daphnia* than in controls. Similarly, UV-B exposed *Daphnia* produced fewer offspring (F1) than did controls. F2 offspring production was affected by both P and F1 treatment, with minimal F2 production by UV-B exposed F1s whose parents were also exposed to UV-B. At 24 degrees, UV-B treatment also reduced survival. F1 production was significantly reduced by UV-B exposure in 1 of 2 experiments at 24 degrees. At 30 degrees, UV-B reduced maternal survival. Consistent with previous observations, reproduction was impaired in both UV-B exposed and control animals at the high temperature. Both UV-B radiation and elevated environmental temperature are deleterious to our population of *Daphnia magna*. The combined effects of these two abiotic stressors on freshwater zooplankton merit further investigation due to anticipated effects of climate change.

Lomonaco, **J**. **D**., Appalachian State University, Boone, USA, joshlomonaco@hotmail.com
Creed, R. P., Appalachian State University, Boone, USA, creedrp@appstate.edu

THE CRAYFISH-BRANCHIOBDELLID MUTUALISM: THE WORM'S PERSPECTIVE

Recent research has suggested that the crayfish (Cambarus chasmodactylus) and their branchiobdellid (Annelida) symbionts (Cambarincola ingens) are engaged in a cleaning symbiosis mutualism. While some experiments have evaluated the effect of the worms on the crayfish the benefits that the worms derive from the association has not been examined experimentally. One important aspect of the mutualism for the worms involves egg deposition: worms are reported to only lay eggs on a live crayfish host. We conducted an experiment to test this hypothesis. Worms were removed from crayfish and then put into one of three treatments: 1) they were placed back on to a live crayfish, 2) they were placed on the carapace from a dead crayfish and 3) they were placed in glass dishes. Worms had access to food in all treatments. Worms only laid eggs on the live crayfish. No eggs were found in the other two treatments. Egg distribution on the crayfish was non-random; most eggs were laid on the ventral surfaces of abdominal segments 1 and 2. Egg hatching time was approximately 2.5 weeks and time to maturity was approximately 1 month. Our results confirm that the association between C. chasmodactylus and C. ingens is a mutualism.

Lottig, **N**. **R**., University of Wisconsin Center for Limnology, Boulder Junction, USA, nrlottig@wisc.edu
Stanley, E. H., University of Wisconsin Center for Limnology, Madison, USA, ehstanley@wisc.edu
Hanson, P. C., University of Wisconsin Center for Limnology, Madison, USA, pchanson@wisc.edu
Kratz, T. K., University of Wisconsin Center for Limnology, Boulder Junction, USA, tkkratz@wisc.edu

INTEGRATING LAKES AND STREAMS TO UNDERSTAND BIOGEOCHEMICAL PATTERNS AND DRIVERS OF A NORTHERN WISCONSIN AQUATIC LANDSCAPE

Water-rich landscapes are often comprised of a complex arrangement of lakes, streams and wetlands. We analyzed two datasets that represent the regional distributions of 16 biogeochemical constituents in lakes and streams in northern Wisconsin to ask: 1) how does the chemistry of streams and lakes compare to one another, and 2) what can we learn about regional drivers of aquatic biogeochemistry if we compare lakes and streams at large spatial scales? Regional lake and stream chemistry differed significantly ($p = 0.01$); largest differences were observed in constituents that characterize groundwater inputs (e.g., calcium and magnesium). Concentrations of these ions were always lower ($p < 0.01$) in lakes than streams, indicating greater dilution by precipitation in lakes relative to streams. Conversely, constituents influenced by wetlands (e.g., dissolved organic carbon, $p = 0.66$) did not differ between lakes and streams. Multivariate analysis suggests that ~67% of the variance in lake and stream biogeochemistry was explained by groundwater input and wetland extent. These results demonstrate the necessity of integrating lake and stream chemistry to understand the broad biogeochemical characteristics of aquatic landscapes.

Lucas, **D**. **R**., St. Olaf College, Northfield, USA, lucas@stolaf.edu
LaRoy, J. R., St. Olaf College, Northfield, USA, laroy@stolaf.edu
Bahagry, S. A., St. Olaf College, Northfield, USA, bahagry@stolaf.edu
Waldron, C. E., St. Olaf College, Northfield, USA, waldron@stolaf.edu
Schmidt, S. N., St. Olaf College, Northfield, USA, schmidts@stolaf.edu

ECOSYSTEM LINKAGES BETWEEN RESTORED WETLANDS AND RESTORED PRAIRIES IN SOUTHEASTERN MINNESOTA

With the understanding that no system is truly isolated, there has been increasing interest to study ecological connections across ecosystem boundaries. Until recently, however, few studies have examined the effects of aquatic production on surrounding terrestrial ecosystems. Our study focused on the impact of aquatic invertebrates emerging from two small restored wetland pond in Southern Minnesota on surrounding C:N in soil and plants and nutrient content (NH_4 and NO_3) of soil in restored prairies. We hypothesized that there would be a decrease in nutrient content at increasing distances from the water's edge. Preliminary analysis indicates a significant relationship between distance and NH_4 levels for two of the four transects, whereby NH_4 decreases with distance from the pond. There also appears to be a marginally significant correlation between distance and NO_3. Further analyses, such as stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$) of soil and plants, will help resolve these patterns. These findings imply that these restored aquatic ecosystems may have a substantial effect on the nutrient levels of surrounding soil and vegetation.

Luecke, **C**., Utah State University, Logan, USA, chris.luecke@gmail.com

FISH IMPACT ZOOPLANKTON BUT FEED MOSTLY ON BENTHOS: DECIPHERING THE PARADOX?

The biomass of zooplankton in fishless ponds in arctic Alaska is greater than in ponds and lakes with fish. Seminal research by John O'Brien indicated that planktivory by arctic fishes structured zooplankton communities resulting in large-bodied, highly visible cladocerans present in fishless ponds and small-bodied, cryptic zooplankton present in lakes with these fish. An apparent paradox arises in that the stomach contents indicated that the fish in these arctic lakes fed almost entirely on benthic invertebrates. Analyses of the migratory patterns and associated feeding habits of arctic grayling in the ponds and lakes near the Toolik Field help to resolve this paradox. Some shallow ponds that contain large-bodied zooplankton serve as summer habitat for migratory grayling. These shallow ponds nearly freeze solid during winter and so do not contain fish throughout the year. Stomach contents of grayling captured in these small ponds were dominated by the large-bodied *Daphnia*, in spite of an abundance of benthic invertebrates. Grayling that remained in deeper lakes that provide winter habitat fed almost entirely on benthic invertebrates and surface insects. The feeding habits of grayling in summer residence lakes demonstrate diet preference for large cladocerans compared to benthic invertebrates. This strong feeding preference for *Daphnia* allows these fish to eliminate them from lakes with residence fish.

Luedersdumont, **J**. **A**., Idaho State University, Pocatello, ID, USA, talkstodiatoms@gmail.com
Bellmore, R. J., Idaho State University, Pocatello, ID, USA, belljame@isu.edu
Baxter, C. V., Idaho State University, Pocatello, ID, USA, coldenbaxter@gmail.com

FLOODPLAIN HABITAT HETEROGENEITY AND BENTHIC INVERTEBRATE COMMUNITIES: A COMPARISON OF MAIN CHANNEL AND SIDE CHANNEL HABITATS IN THE METHOW RIVER, WA

Intact floodplains contain a high diversity of off-channel or side channel aquatic habitats that vary in their degree of hydrologic connectivity to the main channel, thereby providing a range of environments for organisms like

benthic macroinvertebrates. In a montane floodplain segment of the Methow River (Washington), we compared the composition and diversity of benthic macroinvertebrates in the main channel versus five side channels that varied in surface water connectivity to the main stem. We hypothesized that side channels with greater connectivity would have invertebrate assemblages that more closely resembled the main channel. We observed that macroinvertebrate composition in highly connected channels was indeed similar to that in main channel habitats. In contrast, side channels with low connectivity had lower diversity than main channel habitats, and starkly different assemblages dominated by more lentic taxa, such as *Gammarus sp.*, burrowing mayflies (*Paraleptophlebia sp.*), and hemipterans not found in the main stem. Our results suggest heterogeneity in hydrologic connectivity affects invertebrate distributions in floodplains and are consistent with the tenet that maintaining and restoring such habitat complexity may help conserve biodiversity.

Luek, **A.**, Laurentian University, Sudbury, Canada, andreas.luek@gmail.com
Morgan, G. E., Cooperative Freshwater Ecology Unit, Sudbury, Canada, gmorgan@laurentian.ca
Gunn, J., Laurentian University, Sudbury, Canada, jgunn@laurentian.ca
Ramcharan, C. W., Laurentian University, Sudbury, Canada, cramcharan@laurentian.ca

CHALLENGES IN RECOVERING AQUATIC FOOD WEBS: RESOURCE LIMITATION AND PREDATOR-PREY INTERACTIONS

Industrially damaged lakes allow the opportunity to study food web dynamics on simplified systems. We studied how benthic pathways can influence the biological recovery of a whole lake food web. We hypothesized that an impaired benthic invertebrate community affects yellow perch foraging. Perch are omnivorous predators and often the sole fish species present. After an intensive quantitative benthic invertebrate survey, we increased food web complexity in three lakes by adding smallmouth bass following a full BACI design. We studied the effects of the added trophic level, hypothesizing a cascading response, involving habitat as well as diet shifts of yellow perch. A higher reliance on benthic invertebrates should be associated with increased use of littoral refugia. We monitored density, habitat use and diet changes in the fish community plus benthic invertebrate biomass. Results showed a low biomass of especially larger benthic invertebrates. Perch faced the problem of increased reliance on littoral food plus limited access to pelagic food. In these damaged lakes the subsidizing effect of benthic communities is hampered, if not reversed, as a pelagic subsidy for littoral feeding fish.

Luhar, **M. K.**, Massachusetts Institute of Technology, Cambridge, USA, mluhar@mit.edu
Nepf, H. M., Massachusetts Institute of Technology, Cambridge, USA, hmnepf@mit.edu

SEAGRASS BLADE POSTURE AND MOTION OVER A WAVE CYCLE

Seagrasses are important primary producers in coastal environments; they also stabilize the seabed and provide nutrient cycling services. By controlling light availability, blade posture could play a key role in dictating seagrass ecosystem health. Blade motion also sets relative velocities between the vegetation and the water. Relative velocities control both the thickness of the diffusive boundary layer around the blades, which can limit nutrient uptake, and the hydrodynamic drag force, which can damage or dislodge plants. Via laboratory experiments, we study the motion of model seagrass blades, spanning the natural range of seagrass buoyancy and rigidity, under wave forcing. Blade motion depends on the ratio of the moments exerted by the drag force and the restoring force due to blade rigidity or buoyancy. When the drag force dominates, the blades remain depressed in a streamwise posture for the majority of the wave cycle. When the restoring force is greater than the drag force, the blades remain upright, resembling a cantilever.

Luilo, **G. B.**, University of New Mexico, Albuquerque, USA, kazimoto@unm.edu
Cabaniss, S. E., University of New Mexico, ALbuquerque, USA, cabaniss@unm.edu

A QSPR FOR PREDICTING CHLORINE DEMAND IN DRINKING WATER TREATMENT USING NATURAL ORGANIC MATTER MODEL COMPOUNDS

In this study we report a Quantitative Structure-Property Relationship (QSPR) for predicting chlorine demand using 201 organic model compounds from literature data. Eight constitutional descriptors were selected using linear regression (Minitab), followed by dividing the data into calibration (109), cross validation (N = 59) and external validation datasets (N = 42). The QSPR has eight constitutional descriptors with R2 = 0.86 and StdE = 1.24 mole/mole. Predictive power was assessed by Leave-Many-Out validation (q2 = 0.85; RMSE = 1.22 mole/mole) and external validation (q2 = 0.88; RMSE = 1.17 mole/mole). These statistics are close to each other, and both meet criteria of model predictive power, indicating a robust model. Model Applicability domain evaluation showed that 7 out 42 compounds in external data were over-extrapolated ($h \geq 2.5$). The QSPR is being interfaced with the AlphaStep model of natural organic matter to predict chlorine demand for surface waters.

Lunau, **M.**, The Ecosystems Center, MBL, Woods Hole, USA, mlunau@mbl.edu
Erickson, M., The Ecosystems Center, MBL, Woods Hole, USA, merickson@mbl.edu
Waldron, M., The Ecosystems Center, MBL, Woods Hole, , mwaldronmbl.edu
Ducklow, H. W., The Ecosystems Center, MBL, Woods Hole, , hducklow@mbl.edu

SHIPBOARD, NEAR-REAL-TIME ENUMERATION OF LIVING PHYTOPLANKTON AND BACTERIA ALONG THE WEST ANTARCTIC PENINSULA.

Flow Cytometry (FC) has become a powerful tool in microbial ecology. However, the application is still not widespread in oceanography due to high cost and technical requirements typically limiting use to the laboratory environment. Nevertheless, prompt, direct counting of live microplankton in the field could provide valuable ecological information in near-real time. Moreover, shipboard FC saves time and costs and prevents artifacts by making the preservation, shipping and storage of samples obsolete. In this study we used the Accuri C6 FC on board ship during a research cruise along the West-Antarctic Peninsula in the austral summer 2010. The C6 is an affordable, dual laser FC which allowed excellent identification of pigmented procaryotes, pico- and nano eucaryotes, and DNA-labeled bacteria. The data presented here provide detailed information about the microphytoplankton distribution, their size and granularity, as well as bacterial abundance and membrane activity measurements along a north/south and onshore/offshore gradient from high resolution depth profiles using CTD casts and pump sampling. The decreasing size and increasing resolving power of FCs suggests installation and deployment on moorings, gliders and other autonomous platforms.

Lunau, **M.**, The Ecosystems Center, MBL, Woods Hole, USA, mlunau@mbl.edu
Erickson, M., The Ecosystems Center, MBL, Woods Hole, USA, merickson@mbl.edu
Voss, M., Institute for Baltic Research, Rostock, Germany, maren.voss@io-warnemuende.de
Engel, A., Alfred-Wegener-Institute, Bremerhaven, Germany, aengel@awi.de
Ducklow, H. W., The Ecosystems Center, MBL, Woods Hole, USA, hducklow@mbl.edu

IMPACT OF UNBALANCED NITRATE INPUTS ON THE MICROBIAL TRANSFORMATION OF NITROGEN: A STABLE ISOTOPE AND SORTING FLOW CYTOMETRIC STUDY.

The anthropogenic perturbation of the global nitrogen cycle profoundly affects the ecology of coastal environments. Increasing riverine inputs of nitrate into coastal areas due to intensified use of fertilizers can lead to eutrophication, to changes in the community composition and to anoxia in stream beds and coastal sediments. However, mechanistic (short-term) studies on the impact of unbalanced nitrate supply on the transformation of inorganic nitrogen by both autotrophic and heterotrophic microplankton are still rare. Here we used a 15N stable isotope tracer approach in combination with cell sorting by flow cytometry to study the cycling of reactive nitrogen within the lower food web (phytoplankton and bacteria) in a coastal ecosystem (Waquoit Bay, MA, USA). Our data indicate that excess nitrate supply with respect to Redfield ratios of C:N:P:Si induced preferential uptake of ammonium over nitrate by microplankton. This findings point to a potential decrease in buffer capacity of coastal environments for increasing nitrate concentrations. Our finding has implications for the extension of eutrophication from coastal areas towards the more open ocean.

Lunde, **K. B.**, University of California Berkeley, Berkeley, USA, klunde@berkely.edu
Resh, V. H., University of California Berkeley, Berkeley, USA, resh@berkeley.edu

MACROINVERTEBRATE RESPONSE TO BIOTIC AND ABIOTIC STRESSES IN FRESHWATER WETLANDS OF THE SAN FRANCISCO BAY AREA

Many of California's ponds and depressional wetlands, although anthropogenic in origin, are situated on protected lands with stewards who want to inventory and maximize their ecological value and biological diversity. Thus, our goal was to examine which abiotic and biotic factors influenced aquatic macroinvertebrate community structure and build a multimetric index (MMI) to evaluate overall wetland condition. We sampled aquatic macroinvertebrates within the littoral zone of 43 depressional wetlands from 2007-2009, totaling 63 sample events. Sites were a priori defined as reference (16), urban impaired (21), or impaired by invasive fish (6). Non-metric Multidimensional Scaling (NMS) ordination along with subsequent Multi-Response Permutation Procedures (MRPP) was used to investigate differences in community structure. Urbanization was correlated with strong shifts in community structure, increasing conductivity, and reduced pond vegetation. In contrast, invasive fish had a marginal effect on the overall community. MMI scores were higher for ponds with mild cattle grazing and those managed for wildlife. These data show that in-pond characteristics and management play an important role in wetland conservation science.

Luria, **C. M.**, Virginia Commonwealth University, Richmond, USA, cmluria@gmail.com
Franklin, R. B., Virginia Commonwealth University, Richmond, USA, rbfranklin@vcu.edu
Bukaveckas, P. A., Virginia Commonwealth University, Richmond, USA, pabukaveckas@vcu.edu

BACTERIAL COMMUNITY RESPONSE TO EXPERIMENTAL MANIPULATIONS OF AND NATURAL GRADIENTS IN ORGANIC MATTER AND NUTRIENTS IN THE TIDAL-FRESHWATER JAMES RIVER

Bacterial communities in aquatic environments are often characterized by large proportions of dormant individuals. A relatively small proportion of the community may be responsible for the bulk of material and energy cycles that dictate ecosystem processes. In order to examine factors that regulate activity state, water samples were collected from the tidal-freshwater James River during the summer of 2009 for characterization of microbial communities using microscopy and molecular techniques. Additionally, laboratory experiments were performed wherein labile organic matter (OM) was provided directly (as glucose) or indirectly (via phytoplankton exudates) by manipulating light and nutrient conditions. Activity states were assessed through differential fluorochrome staining. Preliminary results indicate that nutrients alone had greater effect on bacterial growth rates than manipulations of labile OM. Surprisingly, there was little change in the proportion of active bacteria even in cultures with most favorable growing conditions. T-RFLP was used to examine changes in assemblage structure in response to variable conditions. Work currently underway will compare community RNA and DNA profiles in order to assess changes in activity state within individual taxa.

Lusk, **J. D.**, U.S. Fish and Wildlife Service, Albuquerque, USA, joel_lusk@fws.gov
Davis, A. P., , Albuquerque, USA, a.davis@comcast.net

WATER QUALITY AND FISH CONTAMINANT BURDENS IN RELATION TO HEALTH OBSERVATIONS OF RIO GRANDE SILVERY MINNOW (HYBOGNATHUS AMARUS) FROM THE RIO GRANDE, NEW MEXICO

It is widely known that the health of fish can be adversely affected by exposure to water pollution. Working with others, the U.S. Fish and Wildlife Service conducted the Rio Grande Silvery Minnow Health Study from July 2006 to July 2008. Adult and juvenile Rio Grande silvery minnow were collected nearly every 3 months from 6 sites in the Rio Grande from Bernalillo to San Antonio, New Mexico. Whole fish were chemically analyzed for a variety of metals, organochlorine compounds, and fire retardant residues. Additional water quality (e.g., dissolved oxygen, temperature, pH and conductivity) and physical measures were taken and related to whole stream metabolism. These results and the results of the chemical analysis of water and sediment that were conducted contemporaneously by others were compared to the fish health observations conducted on Rio Grande silvery minnow from the Middle Rio Grande.

Lutz, **B. D.**, Duke University, Durham, USA, Brian.Lutz@duke.edu
Bernhardt, E. S., Duke University, Durham, USA, ebernhar@duke.edu
Roberts, B. J., Louisiana Universities Marine Consortium, Chauvin, USA, broberts@lumcon.edu
Mulholland, P. J., Oak Ridge National Laboratory, Oak Ridge, USA, mulhollandpj@ornl.gov

WHAT CAN A STREAM STAND TO LOSE? A NEW METHOD FOR INVESTIGATING DOM BIOGEOCHEMISTRY

Nutrient spiraling theory (NST) has been invaluable for understanding nutrient dynamics in streams, but cannot be readily applied to dissolved organic matter (DOM) because we cannot enrich or label this pool. This is a major limitation given the importance of DOM in governing stream energy and trophic structure. We propose a new adaptation of NST to indirectly assess in-stream DOM dynamics. We attempt to displace different fractions of DOM consumed as either sources of carbon (C) or nitrogen (N) for stream biota through conducting a series of short (<2hr), sequential, progressive, kinetic enrichments of each N (as nitrate) and labile C (as acetate) in Walker Branch. For both N and C, we demonstrate high initial demand, which is saturated at the highest enrichment levels. Sensitive fluorescence measures indicate that DOM composition changes with enrichment level and differentially with C vs N addition, even though dissolved organic N and C concentrations show little response. Asking what a stream can stand to lose, rather than what it can consume, may prove to be a useful approach for investigating DOM dynamics.

Lynch, **J. S.**, GEI Consultants, Inc., Denver, USA, jlynch@geiconsultants.com
Canton, S. P., GEI Consultants, Inc., Denver, USA, scanton@geiconsultants.com
Bergstedt, L. C., GEI Consultants, Inc., Denver, USA, lbergstedt@geiconsultants.com
Conklin, D. J., GEI Consultants, Inc., Denver, USA, dconklin@geiconsultants.com
DeJong, G. D., GEI Consultants, Inc., Denver, USA, gdejong@geiconsultants.com

AN ANALYSIS OF THE POTENTIAL IMPACTS OF MINING ACTIVITIES IN THOMPSON CREEK, IDAHO ON MACROINVERTEBRATE POPULATIONS USING LONG-TERM DATA

The Thompson Creek Metals Company operates a molybdenum mine in the Thompson Creek watershed in Idaho. Biological monitoring of the macroinvertebrate populations in Thompson Creek, a tributary to the Salmon River, began in 1980, and has continued annually through 2008, with 29 consecutive years of data available for one site upstream and one site downstream of mining activities. The presence of healthy, diverse benthic invertebrate communities from 1980 through 2008 at both sites indicates that mining activities do not appear to be adversely affecting the invertebrate populations in this stream. Long-term data indicate that macroinvertebrate density and number of taxa have exhibited increasing trends over time at both sites in Thompson Creek, and there are no statistically significant differences in mean density and number of taxa between sites upstream and downstream of the mining activity. Substantial annual variability in macroinvertebrate parameters has been observed at both sites over the course of the study. Analysis of the long-term data suggests a weak relationship between density and flow, but other factors also appear to be associated with the high variability.

Lytle, **D. A.**, Oregon State University, Corvallis, USA, lytleda@oregonstate.edu
Martínez-Muñoz, G., Oregon State University, Corvallis, USA, martinez@eecs.oregonstate.edu
Zhang, W., Oregon State University, Corvallis, USA, zhangwe@eecs.oregonstate.edu
Larios, N., University of Washington, Seattle, USA, nlarios@u.washington.edu
Shapiro, L., University of Washington, Seattle, USA, shapiro@cs.washington.edu
Paasch, R., Oregon State University, Corvallis, USA, paasch@engr.orst.edu
Moldenke, A., Oregon State University, Corvallis, USA, moldenka@science.oregonstate.edu
Mortensen, E. N., Oregon State University, Corvallis, USA, enm@eecs.oregonstate.edu
Todorovic, S., Oregon State University, Corvallis, USA, sinisa@eecs.oregonstate.edu
Dietterich, T. G., Oregon State University, Corvallis, USA, tgd@oregonstate.edu

BUG.I.D.: AUTOMATED PROCESSING AND IDENTIFICATION OF BENTHIC INVERTEBRATE SAMPLES

Identification and counting of larval invertebrate samples is a rate-limiting step in many benthic ecology projects. The BugID system automates image capture,

processing, and classification with minimal user input. Images are processed with computer vision methods that identify informative pattern features, and this information is used to train a classifier algorithm. Machine learning is then used to classify the specimen as a known taxon (included in the training set) or reject it as an unknown "distractor" taxon that hasn't been incorporated into the training set. When tested on images from 9 larval stonefly taxa representing 7 families, BugID correctly identified 94.5% of specimens, even though small or damaged specimens were included. When distractors (10 common invertebrates not present in the training set) were included to make classification more challenging, accuracy decreased but was generally close to 90%. BugID is the first system of its kind that allows users to select thresholds for rejection. Rejected images of distractor taxa or hard-to-identify specimens can later be examined by a taxonomic expert, and new taxa can ultimately be incorporated into the training set.

Maberly, **S**. **C**., Centre for Ecology & Hydrology, Lancaster, United Kingdom, scm@ceh.ac.uk

Jones, I. D., Centre for Ecology & Hydrology, Lancaster, United Kingdom, ianj@ceh.ac.uk

Thackeray, S. J., Centre for Ecology & Hydrology, Lancaster, United Kingdom, sjtr@ceh.ac.uk

Winfield, I. J., Centre for Ecology & Hydrology, Lancaster, , ijw@ceh.ac.uk

ECHOES IN THE ECOSYSTEM: MULTIPLE STRESSORS AND LAKE RESPONSE

Lakes are subjected to numerous environmental stresses that operate at different scales, can act sequentially or in parallel and can affect 'bottom-up' or 'top-down' processes. This study analysed long-term records, of over 50 years, from Windermere, UK. Historically, the main external stressors on Windermere have mainly been bottom-up processes that affect nutrient availability and lake productivity via local nutrient enrichment from within the catchment. This led to attendant knock-on effects of eutrophication such as high summer pH and oxygen depletion at depth. Recently, a combination of climate change and invasion of a non-native fish, probably linked to climate change, has altered the response of the lakes to nutrient load. This appears to have taken place via a top-down trophic cascade caused by a greater grazing pressure by fish, reduced summer zooplankton and increased summer phytoplankton despite phosphate removal from inflowing sewage works. The study should serve as a warning to lake regulators: clear deterioration in water quality can occur even when loads of limiting nutrients are reduced because of interactions within a lake, in this case driven by climate change.

Macdonald, **K**. **S**., New Mexico State University, Las Cruces, USA, tripp@nmsu.edu

Sallenave, R., New Mexico State University, Las Cruces, USA, rsallena@nmsu.edu

Cowley, D. E., New Mexico State University, Las Cruces, USA, cowley@nmsu.edu

MORPHOLOGICAL AND GENETIC VARIATION IN *TRIOPS* (BRANCHIOPODA: NOTOSTRACA) FROM EPHEMERAL WATERS OF THE NORTHERN CHIHUAHUAN DESERT OF NORTH AMERICA

Tadpole shrimp are one of the more important animals structuring diversity in ephemeral arid wetlands. In the northern Chihuahuan Desert, this fauna is composed of a species complex in the genus *Triops*, composed of three morphological forms that have variously been referred to as species, subspecies, and intraspecific variation. We sampled and measured *Triops* spp. from 15 natural playas and man-made flood retention ponds. We also sequenced portions of the mitochondrial COI and ND1 genes for 30 collected shrimp. The three forms are morphologically different for multiple characters. Molecular analyses strongly support the monophyly of each of the three groups, both in DNA sequence and in the presence of multiple unique amino acid changes in each form. Finally, the three morphs appear to exhibit different reproductive systems, with populations one form thought to be gonochoric (equal sex ratios and obligate outcrossing), one form having only self-fertilizing hermaphrodites, and the final form being androdioecious, having both self-fertilizing hermaphrodites and males. We propose that these three groups are sufficiently distinct in morphology, mitochondrial DNA, and reproductive life history to warrant elevation to species level.

Machado, **A**. **L**., CESAM/Universidade de Aveiro, Aveiro, Portugal, luisamachado@ua.pt

Monaghan, K., CESAM/Universidade de Aveiro, AVEIRO, Portugal, kamonaghan@ua.pt

Soares, A., CESAM/Universidade de Aveiro, Aveiro, Portugal, asoares@ua.pt

"THE EFFECTS OF FOREST-FIRE ON LOTIC MACROINVERTEBRATE COMMUNITIES IN PORTUGAL: A CHRONOSEQUENCE STUDY"

Portugal is one of the European countries with the largest forest area damaged by fire (1990-2007) but information on the effects of wild fire on lotic freshwater communities is very scarce. To document the impact of wild fires in the lotic macroinvertebrate communities, we selected 17 catchments (100% burnt) that provided a time-series of fire impacted sites between 1990 and 2007. Macroinvertebrates were collected by kick sampling and a detailed description of stream habitat was made. Recently impacted sites had a reduced diversity and abundance of macroinvertebrates compared to sites burnt longer ago. The community organization of the recently impacted sites was characterized by the absent of several families of Ephemeroptera (Leptophlebiidae), Odonata (Aeshnidae, Gomphidae, Calopterygidae), and Trichoptera (Calamoceratidae, Polycentropodidae, Rhyacophilidae), common in the other catchments analysed. Sites that burnt more than 3 years before sampling presented no apparent ecological differences between them, in relation to the time since fire impact. The data provided by this chronosequence study indicate that the recovery of the macroinvertebrate community in Portuguese upland streams happen relatively fast.

Macias, **N**., Sacramento State University, Sacramento, USA, nm539@saclink.csus.edu

Wallace, J. R., Millersville University, Millersville, USA, john.wallace@millersville.edu

EFFECTS OF AN INVASIVE PLANT DIET ON NATIVE AND NON-INDIGENOUS CRAYFISH GROWTH, SURVIVORSHIP AND BEHAVIOR

Rusty crayfish, *Orconectes rusticus* native to the Midwest and *Ailanthus altissima,* (Tree of Heaven), a native tree to Asia were introduced to southcentral PA in the last twenty years. *Ailanthus altissima* produces a phytotoxin with herbicidal qualities and some herbicides have been found to have endocrine disrupting effects on *O. rusticus* crayfish thereby reducing aggression. The purpose of this study was to understand the impact of an invasive plant diet on native (*Cambarus bartonii* and non-indigenous crayfish growth rates, survivorship and behavior. Crayfish life history metrics were measured in the field using microcosms and diets of *A. altissima* and native tree, *Lireodendron tulipifera* (control). Aggression status and dominance was assayed using a crayfish ethogram. Both crayfish species grew significantly larger on the invasive plant diet. *Orconectes rusticus* grew significantly more than *Cambarus bartonii* on *A. altissima* leaves compared the control leaf diet. Prior to feeding on *Ailanthus* leaves, *O. rusticus* were significantly more aggressive than *C. bartonii*. Post-feeding, we found *C. bartonii* to be significantly more aggressive on a diet of *A. altissima*.

MacKenzie, **R**. **A**., USDA Forest Service Institute of Pacific Islands Forestry, Hilo, USA, rmackenzie@fs.fed.us

Holitzki, T., University of Hawaii at Hilo, Hilo, USA, holitzki@hawaii.edu

Kryss, C. L., USDA Forest Service Institute of Pacific Islands Forestry, Hilo, USA, ckryss@fs.fed.us

IMPACTS OF EXOTIC SPECIES TO FOOD WEB STRUCTURE OF PACIFIC ISLAND STREAMS

The insular nature of Pacific Islands has resulted in unique assemblages of stream fauna that have evolved into specialized organisms with narrow niche requirements. Thus, Pacific island stream fauna are expected to be vulnerable to invasion of streams by generalist exotic species. Stable isotopes (δD, $\delta^{13}C$, $\delta^{15}N$) were used to compare food web structure between Hawaiian streams with and without exotic poeciliids. Preliminary results revealed no significant differences between streams. However, poeciliids were utilizing similar food resources as the endemic goby, *Lentipes concolor*. Benthic algae and leaf litter contributed equal amounts to the basal resources of poeciliid and goby diets, primarily through the consumption of exotic caddisfly larvae (*Cheumatopsyche analis*). Results revealed that significantly lower densities of native gobies in poeciliid invaded streams may be due to competition for food resources with abundant poeciliids. Results also revealed that the invasion of Hawaiian streams by *C. analis* may have created a novel trophic link between native fish and leaf litter, a food resource that may not have historically been a major food resource for Pacific island stream fauna.

MacLennan, **M**. **M**., University of Alberta, Edmonton, Canada, mmmaclen@ualberta.ca

Vinebrooke, R. D., University of Alberta, Edmonton, Canada, rolf@ualberta.ca

INTERACTIVE EFFECTS OF SIZE-SELECTIVE PREDATION AND CLIMATE WARMING ON PLANKTONIC METACOMMUNITIES IN ALPINE LAKES

Alpine lake communities are particularly sensitive to climate warming but their responses to increased temperatures will depend on interactions with other stressors and the potential establishment of tolerant species. Large zooplankton often dominate naturally fishless alpine lakes; however, predation by introduced fish selects for smaller zooplankton, which may be more tolerant of warming. Therefore, we hypothesized that 1) size-selective predation antagonistically suppresses negative effects of warming on zooplankton diversity and production and 2) that the regional species pool buffers local alpine communities against these environmental stressors. These hypotheses were tested using a three-factor mesocosm experiment [(fish absence vs simulated predation) × (ambient temperature vs warmed) × (local vs local + regional species)] performed with four replicate lake communities. Preliminary results show size-selective predation caused warming to reduce total zooplankton abundance and size, increasing phytoplankton biomass. In contrast, warming in the absence of size-selective predation reduced juvenile zooplankton abundance but was compensated by larger adults, decreasing phytoplankton biomass. These findings suggest that size-selective predation causes climate warming to impair secondary production but enhance primary production in alpine lakes.

Macneale, **K**. **H**., NOAA Fisheries - Northwest Fisheries Science Center, Seattle, WA, USA, Kate.Macneale@noaa.gov

Spromberg, J. A., NOAA Fisheries - Northwest Fisheries Science Center, Seattle, WA, USA, Julann.Spromberg@noaa.gov

Damm, S., US Fish & Wildlife Service, Lacey, WA, , Steve_Damm@fws.gov

Davis, J., US Fish & Wildlife Service, Lacey, WA, USA, jay_davis@fws.gov

Scholz, N. L., NOAA Fisheries - Northwest Fisheries Science Center, Seattle, WA, USA, Nathaniel.Scholz@noaa.gov

CONTAMINATED STORMWATER RUNOFF: EFFECTS ON INVERTEBRATE DRIFT AND SURVIVAL AND IMPLICATIONS FOR ENDANGERED SALMONIDS

Numerous studies have documented declines in the diversity and abundance of macroinvertebrate communities in urban watersheds. However, the extent to which these declines are caused by non-point source pollution as opposed to physical habitat factors remains unclear. We examined the effects of contaminants in urban stormwater on macroinvertebrate communities, specifically whether exposure to contaminants alters invertebrate drift behavior and survival. Using a custom built filtration system and experimental stream channels on a stream in Seattle, WA, we exposed diverse macroinvertebrate communities to either filtered ("clean") or unfiltered (ambient) stream water for several three-week experiments. Analysis of chemistry samples indicated there were differences between treatments (e.g. reduction of polycyclic aromatic hydrocarbons and metals in filtered treatments relative to unfiltered treatments), and we observed differences in the drift behavior and survival for some sensitive macroinvertebrate taxa. Such reductions in sensitive invertebrates may help explain why communities in chronically-exposed urban watersheds are depauperate, and why species that rely on invertebrate production, such as endangered salmonids may be at risk as well.

Madden, **C**. **J**., SFWMD- Everglades Research Division, W Palm Beach, FL, USA, cmadden@sfwmd.gov

McDonald, A. A., SFWMD- Everglades Research Division, W Palm Beach, FL, USA,

INTEGRATED SIMULATION MODELING STUDY OF FLORIDA BAY ECOSYSTEM RESPONSE TO CHANGING SALINITY, WATER AND NUTRIENT REGIMES

Florida Bay has been altered by diminished freshwater inflow and reduced circulation, resulting in seagrass die-off, species declines and algal blooms. The Comprehensive Everglades Restoration Plan for restoring the estuary will increase freshwater discharge to Florida Bay. A numerical model of Florida Bay, the Seagrass Ecosystem Assessment and Community Organization Model (SEACOM) supports development of restoration strategies and simulates coupled benthic-water column regimes, integrating physics, geochemistry and biology. The Everglades Landscape Model (ELM) simulates watershed phosphorus loadings to the estuary; a hydrologic transport mass-balance model (FATHOM) links to SEACOM to create a landscape framework for calculating flushing rates and salinity distributions. SEACOM simulates seagrass biomass, production and community structure and phytoplankton functional groups. The integrated models test hypotheses about drivers and stressors in the ecosystem. Changes in nutrient and freshwater delivery, N:P ratios, and substrate type can influence light, salinity and nutrient regimes, and affect productivity and species composition. SEACOM provides analysis of flushing rates and nutrient cycling to assess thresholds and shifts in benthic-pelagic dominance. The integrated upstream-downstream model framework enables forecasting of community response to watershed management.

Madenjian, **C**. **P**., USGS Great Lakes Science Center, Ann Arbor, USA, cmadenjian@usgs.gov

Stapanian, M. A., USGS Great Lakes Science Center, Sandusky, USA, mstapanian@usgs.gov

Witzel, L. D., Ontario Ministry of Natural Resources, Port Dover, Canada, larry.witzel@ontario.ca

Einhouse, D. W., New York Department of Environmental Conservation, Dunkirk, USA, dweinhou@gw.dec.state.ny.us

Pothoven, S. A., NOAA Great Lakes Environmental Research Laboratory, Muskgeon, USA, steve.pothoven@noaa.gov

Whitford, H. L., Ontario Ministry of Natural Resources, Port Dover, USA, heather.whitford@ontario.ca

EVIDENCE FOR PREDATORY CONTROL OF THE INVASIVE ROUND GOBY

We coupled bioenergetics modeling with bottom trawl survey results to evaluate the capacity of piscivorous fish in eastern Lake Erie to exert predatory control of the invading population of round goby Neogobius melanostomus. Burbot Lota lota is a native top predator in eastern Lake Erie. The round goby invaded eastern Lake Erie during the late 1990s. According to annual bottom trawl survey results, round goby abundance in offshore waters peaked in 2004, but then declined during 2004-2008. Coincidentally, round gobies became an important component of burbot diet beginning in 2003. We estimated adult burbot abundance and age structure in eastern Lake Erie during 2007. Diet composition and energy density of eastern Lake Erie burbot were also determined during 2007. This information, along with estimates of burbot growth, burbot mortality, burbot water temperature regime, and prey fish energy densities, were incorporated into a bioenergetics model. Results indicated that the adult burbot population in eastern Lake Erie annually consumed 1,361 metric tons of round gobies. Based on the results of bottom trawling, we estimated the biomass of round gobies in offshore waters eastern Lake Erie during 2007-2008 to be 2,232 metric tons. Thus, the adult burbot population was feeding on round gobies at an annual rate equal to 61% of the estimated round goby standing stock. We concluded that the burbot population had high potential to exert predatory control on round gobies.

Magoulick, **D**. **D**., USGS, Arkansas Coop Research Unit, University of Arkansas, Fayetteville, USA, danmag@uark.edu

DiStefano, R. J., Missouri Department of Conservation, Columbia, USA, Bob.DiStefano@mdc.mo.gov

Westhoff, J. T., University of Missouri, Columbia, USA, jacobwesthoff@hotmail.com

Rabeni, C. F., University of Missouri, Columbia, USA, RabeniC@missouri.edu

IS INTERSPECIFIC COMPETITION A MECHANISM OF DISPLACEMENT OF IMPERILED BIG CREEK CRAYFISH BY INVASIVE WOODLAND CRAYFISH?

The invasive woodland crayfish Orconectes hylas has apparently displaced the state and globally imperiled Big Creek crayfish Orconectes peruncus from parts of its former range in Missouri Ozark streams. The potential for extirpation or extinction of O. peruncus requires urgent action to evaluate potential causes which may lead to management actions. We conducted a field experiment to examine interspecific competition between the species as a potential mechanism of displacement. We determined intraspecific and interspecific competition on native O. peruncus survival and growth in two stream sites where O. peruncus has been extirpated and O. hylas has invaded. The experiment was carried out from July through September, a period that incorporates the majority of the growing season. Enclosures were conditioned for three weeks prior to initiation of the experiment to permit accumulation of natural crayfish foods. Results will be used in conjunction with results from other completed and ongoing

research to determine the mechanism(s) responsible for the disappearance of the imperiled O. peruncus from St. Francis River drainage streams, and to identify conservation/management alternatives.

Mahabir, **S.**, Midwestern State University, Wichita Falls, USA, mahabirs@msu.edu
Vogtsberger, R. C., Midwestern State University, Wichita Falls, USA, roy.vogtsberger@mwsu.edu

PRELIMINARY RESULTS OF AN AQUATIC INSECT BIODIVERSITY STUDY IN THE CHIHUAHUAN DESERT OF WEST TEXAS

Biodiversity of desert streams was assessed by the sampling of aquatic insects residing in the south fork of the Alamo de Cesario Creek in the Chihuahuan Desert of West Texas. The primary objective was to develop an accurate inventory of aquatic insects inhabiting permanent and temporary streams in this locality. Available water sources were sampled along the canyon floor which once held flowing waters of a relictual river. This ancient riverbed has become known as the Alamo de Cesario and is currently represented by two remnant permanent streams fed by underground springs. Ephemeral streams occurring between the permanent sites had surface flow periodically at low points along the canyon floor. Using a D-frame aquatic net, six-inch kitchen tea strainer (approx. 1 mm mesh), long-handled dipper cup, and white enamel pan, samples were collected on a monthly basis from October 9, 2008 to January 16, 2010. The aquatic insect faunas of the permanent and intermittent streams were compared using Sorensen's similarity index. A total of 7 orders and 27 families have been identified thus far.

Maiolini, **B.**, IASMA Research and Innovation Centre, S. Michele all'Adige, Italy, bruno.maiolini@iasma.it
Carolli, M., IASMA Research and Innovation Centre, S. Michele all'Adige, Italy, mauro.carolli@iasma.it
Bruno, M. C., IASMA Research and Innovation Centre, S. Michele all'Adige, Italy, cristina.bruno@iasma.it
Silveri, L., IASMA Research and Innovation Centre, S. Michele all'Adige, Italy, luana.silveri@iasma.it

WATER TEMPERATURE REGIMES IN AN HYDROPOWER IMPACTED ALPINE CATCHMENT

The temperature regime of a river is a main driver for physical, chemical, and biological processes in aquatic ecosystems. Besides the foreseen consequences of climate change, most Alpine river systems are also affected by changes in their natural temperature regimes by hydropower production. Different effects on water temperature occur during the phases of production, i. e. water abstraction, stocking in reservoirs and release of turbinated waters. While constant changes, and their ecological effects, due to the first two phases, have been well quantified by several studies, less attention has been paid to intermittent changes (thermopeaking) associated to hydropeaking. In this research we aim to: 1) quantify and analyse changes in the temperature regime below two representative Alpine power plants, with different distance from source, elevation and mean discharge. Water temperature was recorded at ten minutes intervals for one year above and below the power plants. 2) evaluate the response of the benthic community to thermopeaking events, separated from hydropeaking by using open air artificial flumes. In these we induced two "warm" winter and two "cold" summer thermopeaking events.

Maki, **R**. **P.**, Voyageurs National Park, Grand Rapids, USA, ryan_maki@nps.gov
Christensen, V. G., United States Geological Survey, Mounds View, USA, vglenn@usgs.gov

NUTRIENT CYCLING AND RELATION TO CHANGES IN WATER LEVELS FOR KABETOGAMA LAKE, VOYAGEURS NATIONAL PARK, NORTHERN MINNESOTA, 2008-09

Water and sediment samples were collected to assess internal and external nutrient loading to Kabetogama Lake. Kabetogama Lake develops annual cyanobacterial blooms, some of which have produced a hepatotoxin, microcystin. The lake exhibits polymictic circulation, suggesting a possible link between frequent recirculation and internal recycling of phosphorus. Water was sampled from the lake surface, the sediment-water interface, inflows, and outflows. Preliminary results indicate that average total phosphorus concentrations are similar between inflows and lake-surface samples (22.3 and 26.3 micrograms per liter, respectively) while samples collected at the sediment-water interface yielded concentrations up to 727 micrograms per liter. Concentrations near the sediment-water interface were highly variable among sites, indicating that significant amounts of phosphorus may have been released from the sediments at only a subset of the lake sites. The International Joint Commission, which set new rules governing dam operation on this system in 2000, will decide whether to maintain or revise these rules in 2015 based, in part, on whether the rules appear to have benefited the aquatic ecosystem. This study will provide significant information for that assessment.

Mallin, **M**. **A.**, University of North Carolina Wilmington, Wilmington, USA, mallinm@uncw.edu
Johnson, V. L., University of North Carolina Wilmington, Wilmington, USA,
Ensign, S. H., University of North Carolina Chapel Hill, Morehead city, USA, ensign@email.unc.edu

HOW THE LANDSCAPE IMPACTS WATER QUALITY OF THREE OLIGOHALINE TIDAL CREEKS

A series of physical, chemical and biological samples were taken at 12 sites within three oligohaline tidal creeks of differing human development, during both dry and wet weather. The most urbanized stream yielded the highest BOD, orthophosphate, chlorophyll a, total suspended solids (TSS) and surfactant concentrations, while the most rural stream yielded the highest total organic carbon concentrations. Percent watershed development and percent impervious surface coverage were positively correlated with BOD, orthophosphate, and surfactant concentrations, but negatively with total organic carbon. BOD was strongly correlated with chlorophyll a for all sites combined. Fecal coliform bacteria, TSS, turbidity, orthophosphate, total phosphorus and BOD were significantly higher during rain events compared to non-rain periods. Rainfall preceding sampling was positively correlated with turbidity, TSS, BOD, TP and fecal coliform bacteria concentrations. Turbidity and TSS were positively correlated with phosphorus, fecal coliform bacteria, BOD and chlorophyll a. Hypoxia occurs at several of these sites, likely a function of both algal bloom decomposition and stormwater-driven runoff of BOD-inducing materials into the creeks. That, plus the strong relationship between TSS and pollutant parameters argues for better sedimentation controls under all landscape types.

Maloney, **K**. **O.**, Smithsonian Environmental Research Center, Edgewater, USA, maloneyk@si.edu
Weller, D. E., Smithsonian Environmental Research Center, Edgewater, USA, wellerd@si.edu

STRUCTURAL EQUATION MODELING REVEALS THAT PAST AND PRESENT LAND USE AFFECT STREAM ECOSYSTEMS VIA MULTIPLE PATHWAYS

To support stream ecosystem restoration and conservation, we need better knowledge of the indirect and lasting effects of land use. We constructed a structural equation model (SEM) to evaluate the relative strengths of direct and indirect effects of historical (1952) and contemporary (2002) land uses on 190 streams in Maryland, USA. Additional variables included spatial position, system size, riparian condition, habitat quality, NO3-N, and measures of benthic macroinvertebrate taxonomic and functional diversity and integrity. The SEM fit well and explained 63% of variation in NO3-N and 15%, 22%, and 66% of variation in taxonomic richness, functional richness, and integrity, respectively. Direct effects showed that NO3-N increased with development and agriculture from both times, and that taxonomic richness decreased with both historical land uses but increased with contemporary agriculture. Contemporary agriculture had no significant direct effect on integrity but significant indirect effects on integrity mediated through NO3-N, riffle quality, and the measures of richness. Contemporary developed and both historical land uses had indirect effects on present day stream components. Spatial position indirectly influenced streams through system size and land uses.

Marcarelli, **A**. **M.**, Michigan Technological University, Houghton, MI, USA, ammarcar@mtu.edu
Baxter, C. V., Idaho State University, Pocatello, ID, USA, baxtcold@isu.edu
Murakami, M., Chiba University, Chiba, Japan, muramasa@faculty.chiba-u.jp

QUANTITY AND QUALITY: THE ROLE OF TERRESTRIAL SUBSIDIES IN FOOD WEB PATHWAYS AND ECOSYSTEM METABOLISM IN HORONAI STREAM

High-quality subsidies may be low magnitude fluxes, but have disproportionate effects in food webs (e.g., terrestrial invertebrate prey for fish). Alternately, low-

quality subsidies may be large fluxes but have weak food web effects (e.g., leaf litter and DOC). We asked, what is the relative role of different terrestrial subsidies (leaf litter vs. terrestrial invertebrates) for organic matter flow through the food web of forested Horonai Stream (Hokkaido, Japan)? The annual flux of terrestrial invertebrate biomass into this stream is equal to only 5% of the flux of leaf litter biomass, yet terrestrial invertebrates contribute 44% to the energy budget of the fish assemblage. In contrast, measures of open-water primary production and respiration suggest that leaf litter inputs drive metabolism of the ecosystem. We compiled data on algal, invertebrate and fish production and trophic connections between these organisms to determine what proportion of animal production is derived from terrestrial inputs directly via consumption and indirectly via food web linkages. Comparisons like this will shed light on how subsidies of different quality and to different trophic levels compare in aquatic food webs.

Mariash, **H. L.**, University of Jyväskylä, Jyväskylä, Finland, heather.mariash@jyu.fi
Kainz, M. J., WasserCluster – Biologische Station, Lunz, Austria, martin.kainz@donau-uni.ac.at
Rautio, M. L., University of Jyväskylä, Jyväskylä, Finland, milla.rautio@uqac.ca

OVERWINTERING DAPHNIA: FAT AND REPRODUCING

Mostly considered to overwinter in a resting stage, we present field evidence that *Daphnia* not only survive but thrive under the ice of Arctic lakes and ponds. The objective of this cross continent study was to explore the link between lipids and winter survival of this key herbivore. We hypothesized that *Daphnia*'s ability to actively overwinter, surviving more than 9 months of ice cover, was related to their structural fatty acids composition and examined the role of polyunsaturated fatty acids (PUFA) in *Daphnia*'s cold stress response. Samples were collected in the autumn and winter from southern Quebec, Canada, northern Finland, and pre-alpine Austria (2008-2009). Preliminary results indicate *Daphnia* that actively overwinter contained higher concentrations of omega-3 PUFA compared to *Daphnia* that did not overwinter.

Marotta, **H.**, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, humbertomarotta@gmail.com
Pinho, L., Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, luanaqp@yahoo.com.br
Gudasz, C., Uppsala University , Uppsala, Sweden, cristian.gudasz@ebc.uu.se
Bastviken, D., Linköping University, Linköping , Sweden, david.bastviken@liu.se
Tranvik, L., Uppsala University , Uppsala, Sweden, Lars.Tranvik@ebc.uu.se
Enrich-Prast, A., Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, aenrichprast@gmail.com

TEMPERATURE SENSITIVITY OF ANAEROBIC CH_4 AND CO_2 PRODUCTION IN SEDIMENTS – ARE TROPICAL AND BOREAL LAKES DIFFERENT?

Lakes are well-recognized recipient ecosystems for carbon from areas in the watershed, and sediment can play an important role as global stock of carbon. An important question is to what extent the organic carbon stored in sediment can be mineralized to greenhouse gases as a feedback of global warming in different biomes. We assessed experimentally the effect of warming on anaerobic CH_4 and CO_2 production in Amazon and Boreal lake sediments. Amazon and Boreal lake sediments showed a similar range of increase in CH_4 and CO_2 production following the same gradient from colder and warmer temperatures (4 to 40 ºC). Our results suggest that in spite predictions of lower temperature changes at tropical compared to boreal latitudes, the future increase in anaerobic CH_4 and CO_2 production might be higher on an areal basis in tropical sediments, as compared to boreal ones. Therefore tropical stocks of carbon in aquatic ecosystems might be more sensitive to global warming than anticipated.

Marsh, **M. D.**, Coastal Carolina University, Conway, USA, mdmarsh@coastal.edu
Gulis, V., Coastal Carolina University, Conway, USA, vgulis@coastal.edu
Koepfler, E., Coastal Carolina University, Conway, USA, eric@coastal.edu

MICROBIAL ACTIVITY AND DIVERSITY ASSOCIATED WITH DECOMPOSING *SPARTINA* WRACK IN COASTAL ECOSYSTEMS

Spartina wrack has not been studied extensively despite considerable accumulation of material in salt marshes. In this study, we addressed: (1) decomposition rates of *Spartina alterniflora* wrack along the salt marsh elevational gradient; (2) the relative importance of fungi vs. bacteria on *Spartina* wrack; (3) the differences in fungal community structure between standing dead *Spartina* and *Spartina* wrack. Four study sites in the salt marsh at Baruch Marine Field Lab in North Inlet, SC were used; each had 4 sampling stations (treatments) along the elevational gradient: subtidal, intertidal, high marsh and terrestrial. Decomposition rates of *Spartina* in litter bags, associated microbial respiration, fungal and bacterial biomass (from ergosterol and epifluorescence microscopy, respectively) were followed over ten months (March-December 2009). Fungal community structure was assessed by DGGE. We found a decrease in wrack decomposition rate along the elevational gradient (low to high marsh) and considerably higher fungal than bacterial biomass in all treatments. Patterns of microbial biomass and respiration through time differed among treatments. Fungal communities on *Spartina* wrack were surprisingly diverse, with more than 20 phylotypes per sample routinely detected.

Marshall, **M. C.**, University of Georgia, Athens, USA, fibrtrinidad@gmail.com
Lopez-Sepulcre, A., University of California, Riverside, USA, andresls@ucr.edu
Thomas, S. A., University of Nebraska, Lincoln, USA, sthomas5@unl.edu
El-Sabaawi, R. W., Cornell University, Ithaca, USA, rana@uvic.ca
Flecker, A. S., Cornell University, Ithaca, USA, asf3@cornell.edu
Reznick, D. N., University of California, Riverside, USA, gupy@ucr.edu
Pringle, C. M., University of Georgia, Athens, USA, cpringle@uga.edu

DOES LIGHT AVAILABILITY AFFECT GUPPY *POECILIA RETICULATA* CONTRIBUTIONS TO NUTRIENT RECYCLING IN TRINIDADIAN HEADWATER STREAMS?

As part of the NSF FIBR Guppy Evolution project, we used a whole-stream experimental approach to assess effects of light on guppy ammonium (NH_4) excretion rates and associated consequences on benthic nutrient cycling in Trinidadian streams. We measured rates of benthic NH_4 uptake and excretion of predation-adapted guppies introduced into predator-free reaches of two headwater streams, one naturally shaded and the other with an experimentally thinned canopy. Light availability approximately doubled and enhanced algal standing crop by 22% and area-specific uptake by 5-fold relative to our shaded stream. Guppy population size and mass-specific excretion rates were significantly greater in the canopy-thinned than the shaded stream. Resulting population-level excretion rate in the canopy-thinned stream was 2X the shaded stream and accounted for 57% of benthic NH_4 demand compared to 16% in the shaded stream. Our findings suggest that light availability drives food web structure, altering the magnitude of nutrient recycling from higher trophic levels. Ongoing research is examining how mass-specific excretion rates change as the guppies adapt to a predator-free environment and how these changes feedback on ecosystem structure and function.

Martin, **E. C.**, Kansas State University, Manhattan, USA, erikam86@ksu.edu
Gido, K. B., Kansas State University, Manhattan, USA, kgido@ksu.edu

DENSITY-DEPENDENT GROWTH OF JUVENILE CENTRAL STONEROLLER (CAMPOSTOMA ANOMALUM) WITHIN AND AMONG COHORTS

Changes in population density in intermittent prairie streams often result from influences of abiotic and biotic factors. Stream drying decreases inhabitable area and exacerbates density-dependent factors. Increased intraspecific competition within size classes of fish can increase as streams dry, but interactions between different size classes may be alleviated if there are ontogenetic shifts in resource use. The main objective of this study was to test effects of intraspecific competition on condition of juvenile central stonerollers (Campostoma anomalum) using experimental streams located on Konza Prairie Biological Station. Juvenile stonerollers were stocked with increasing densities of other juveniles as well as adults to assess differences among size classes. We found that condition of juveniles was 16% higher in low versus high juvenile density treatments, and 12% higher in the absence of adults than with adults at high density. Long-term data on mean lengths of stonerollers at three sites in a natural stream supported these findings. We observed a negative relationship between density and length at the headwater (r2 = 0.52) and mainstem (r2 = 0.61) sites. Our data suggest density dependent factors might be important in structuring populations in this system.

Martin, **G. M.**, University of Waterloo, Waterloo, Canada, gmmartin@scimail.uwaterloo.ca
Taylor, W. D., University of Waterloo, Waterloo, Canada, wdtaylor@uwaterloo.ca

EVIDENCE FOR THE IMPORTANCE OF ALLOCHTHONOUS SOURCES AND DREISSENID MUSSELS IN SUPPLYING PHOSPHATE FOR *CLADOPHORA* GROWTH IN LAKE ONTARIO

Despite the success of phosphorus loading controls in remediating eutrophication problems in the Great Lakes during the 1960's and 1970's, nuisance *Cladophora* returned to shorelines in the 1990's. In an attempt to quantify the degree to which local inputs and internal cycling by dreissenid mussels contribute to phosphate (PO_4^{3-}) concentrations that permit *Cladophora* growth, intense sampling for soluble reactive phosphorus (SRP) was carried out from May to October, 2009, in a nearshore segment of Lake Ontario near Pickering, Ontario. As the standard SRP assay is known to overestimate PO_4^{3-} in phosphorus-limited waters, alternative methods were also used, including dialysis tubing in lieu of filtration and a steady-state radiobioassay. SRP concentrations ranged from 0.3-6.2 µg/L, with the lowest concentrations occurring in August and the highest in October. The results suggest higher SRP in the nearshore compared to offshore waters, near point source and non-point sources, and above mussel beds. SRP concentrations yielded with dialysis were comparable to those obtained with filtration, while estimates of PO_4^{3-} from the steady-state radiobioassay were orders of magnitude lower than those measured with the SRP assay.

Martin, **J. B.**, University of Florida, Gainesville, USA, jbmartin@ufl.edu
Roy, M., University of Florida, Gainesville, USA, Moutusi@ufl.edu
Moore, P. J., University of Florida, Gainesville, USA, gratefulrambler@gmail.com
Cable, J. E., Louisiana State University, Baton Rouge, USA, jcable@lsu.edu
Smith, C. G., USGS, St. Petersburg, USA, cgsmith@usgs.gov
Cherrier, J., Florida A&M University, Tallahassee, USA, jennifercherrier@gmail.com
Dorsett, A. M., Florida A&M University, Tallahassee, USA, amanda.m.dorsett@gmail.com

IRON AND CARBONATE MINERAL DIAGENESIS IN THE SUBTERRANEAN ESTUARY

Groundwater discharge from subterranean estuaries consists of both fresh and marine waters and their mixing modifies redox conditions and reduces the solubility of carbonate minerals. Redox conditions control which terminal electron acceptor is primarily involved in the remineralization of organic carbon. Iron oxides can be particularly important where there is consumption of oxygen and NO_3. Carbonate mineral solubility appears to be controlled more by elevated pCO_2 from organic carbon remineralization and the associated decrease in pH than lowering of saturation state caused by mixing of fresh and marine waters. Dissolved Fe concentrations in pore waters of the subterranean estuary can be used to assess the magnitude of organic carbon remineralization, changes in pCO_2, and the impact on carbonate dissolution. Development of flank margin caves, which commonly form in the subterranean estuary (i.e., the seaward end of fresh water lens) of carbonate islands, may be linked to variations in redox conditions caused by submarine groundwater discharge. These diagenetic reactions, and subsequent alteration of subterranean porewater compositions, may be important for controlling mass flux to the oceans.

Martinez, **J. L.**, University of Texas at El Paso, El Paso , USA, jlmartinez14@miners.utep.edu
Legarda, N. M., University of Texas at El Paso, El Paso, , nmlegarda@miners.utep.edu
Walsh, E. J., University of Texas at El Paso, El Paso, USA, ewalsh@utep.edu

AFFECTS OF WASTEWATER RELEASE ON BENTHIC MACROINVERTEBRATES IN RIO BOSQUE, A RECONSTRUCTED WETLANDS IN EL PASO, TX

Rio Bosque Wetlands Park was constructed to re-establish habitats characteristic of the Rio Grande River. The wetland receives treated effluent from an adjacent wastewater treatment plant. Using wastewater to fill the wetlands is a concern due to the unknown effects of un-remediated compounds, such as Pharmaceuticals and Personal Care Products (PPCPs) to benthic macroinvertebrates. Water and sediment samples from three sites were collected from September 2009 - April 2010. General water chemistry parameters (pH, conductivity, nutrients, etc.) were monitored and additional samples were retained for detection of PPCPs. Sediment samples were collected to analyze benthic macroinvertebrate diversity, and PPCPs. As the wetland developed, from September 2009 – December 2009, the inorganic nitrogen increased throughout the wetland. In January, all levels of these compounds were elevated. All other water chemistry parameters tested for were similar throughout the wetland. Benthic macroinvertebrates were initially low, consisting of primarily Chironomidae and Nematoda. Thus far the dominant taxa are Chironomidae at all sites. Future work will include exposing chironomids to relevant PPCPs to test for effects on emergence time and sex ratios.

Martinez, **J. A.**, NOAA, Honolulu, USA, jonathan.martinez@noaa.gov
Wolanski, E., James Cook University, Townsville, Australia, eric.wolanski@jcu.edu.au
Richmond, R. H., University of Hawaii at Manoa, Honolulu, USA, richmond@hawaii.edu

THE EFFECTS OF AN ALIEN INVASIVE ALGA ON SEDIMENT RETENTION AND RESUSPENSION IN COASTAL HAWAIIAN WATERS AND THE INFLUENCE OF COMMUNITY BASED RESTORATION

Avrainvillea amadelpha is an alien invasive alga that has become established in Hawaiian coastal regions, especially in soft bottom habitats where it competes with seagrass and other coral reef organisms for habitat and resources. The presence of A. amadelpha at Paiko Lagoon Peninsula (PLP) at Maunalua Bay is suspected to contribute to sediment retention on this reef. Community based organizations along with several partners have identified PLP as the first location of an ambitious attempt to restore Maunalua Bay. Volunteers have manually cleared A. amadelpha from an experimental plot near PLP in hopes of freeing trapped sediment with the goal of clearing the carbonate reef. The goal was to assess the role of A. amadelpha in sediment retention and resuspension and to investigate the efficacy of manual clearing in eliminating sediment. A sediment resuspender was used to suspend sediment on the surface of and between algal thalli as well as areas that have been cleared of algae and suspended sediment was measured with a turbidity meter. Areas of reef with A. amadelpha had over 2x more resuspendable sediment than the cleared plot, areas naturally clear of algae and areas inhabited with native seagrass. We found manual removal of algae was effective in freeing up and reducing sediment retention. Over an order of magnitude more of accumulated resuspendable sediment was trapped between algal holdfasts and not on the algal thalli.

Martinez, **N. D.**, Pacific Ecoinformatics and Computational Ecology Lab, Berkeley, USA, neo@PEaCElab.net
Baure, B., Potsdam University, Potsdam, Germany, b_baver@yahoo.de

NETWORKS GONE WILD! OR SHOULD THEY? COMPARING INDUSTRIAL AND NATURAL PREDATION IN HUMAN-NATURAL SYSTEMS

Size selection is one of the most prominent features of predation and fishing in aquatic ecosystems where predators often cull smaller members of prey populations (e.g., juveniles). Fisheries do the opposite by stripping the world's oceans of their large bodied fishes. Body size is also one of the most important factors affecting the stability in complex ecological networks where large predator-prey body-size ratios greatly increase the number of species that are able to dynamically persist. This presentation will illustrate how size selection during exploitation by humans and consumption by predators affect the structure, dynamics, and function of complex ecosystems both with and without economic extraction of species' biomass. The methodology of using network science to merge natural (ecology) and social (economics) science will be also introduced. Our simulations of nonlinear models of coupled human-natural systems suggest that a change in management towards selecting for small rather than large individuals could greatly increase ecosystem health and biomass as well as economic profit.

Alvarez, M., Universidade e Vigo, Vigo, Spain, maruxa@uvigo.es
Peckarsky, B., University of Wisconsin , Madison, USA, peckarsky@wisc.edu
Penton, M. USA, malgaep@gmail.com

FOOD, REFUGE OR BOTH? THE POTENTIAL ROLE OF MOSS IN SHAPING GRAZER ASSEMBLAGES OF HIGH ALTITUDE STREAMS

If bryophytes serve as refuge for grazing invertebrates, then predator-prey interactions may be buffered in streams dominated by moss. To ascertain the mechanisms explaining observed differences in community composition between high-altitude streams dominated by moss (where armored caddisflies are more abundant) and those dominated by diatom-covered rocks (dominated by disturbance-resistant mayflies), we performed a microcosm experiment comparing the response of these two types of grazers to predation risk. Algal accrual and growth rates of the grazers were estimated in circular flow-through chambers with different substrates (artificial moss vs. tiles) and predation risk (trout chemical cues present vs. absent). Although moss substrates provided more food (epiphytic diatoms), only the mayflies took advantage of the increased algae, and grew faster compared to those feeding on diatom-covered tiles. The non-consumptive effect of the predator did not alter mayfly growth; but algal accrual was higher where mayflies were exposed to predation risk, consistent

with a behavioral trophic cascade. The trade-offs between food, habitat stability and predator avoidance could explain differences in the grazer communities among these streams.

Marvin-DiPasquale, **M. C.**, US Geological Survey, Menlo Park, USA, mmarvin@usgs.gov
Agee, J. L., US Geological Survey, Menlo Park, USA, jlagee@usgs.gov
Kakouros, E., US Geological Survey, Menlo Park, USA, kakouros@usgs.gov
Kieu, L. H., US Geological Survey, Menlo Park, USA, lkieu@usgs.gov

METHYLMERCURY PRODUCTION IN HEADWATER CATCHMENTS: COMPARING STREAMBED AND OUT-OF-CHANNEL CONTROLS

Previous research has suggested that much of the methylmercury (MeHg) measured in the surface water of rivers may originate in the upstream headwater regions. This study focused on two such headwater areas, one in the Upper Hudson River basin in the Adirondacks Region of north central New York state and the other in the Edisto River basin in the Atlantic Coastal Plain of South Carolina. An initial comparison of in-channel streambed sediment and adjacent out-of-channel flood plain zones indicated that the latter habitat type exhibited higher MeHg concentrations and production rates. This trend was at least partially due to higher concentrations of bioavailable inorganic Hg(II) in the out-of-channel sites. Total mercury was also positively correlated with sediment organic content, which was also generally higher in out-of-channel sites. Subsequent field experiments focused on comparing MeHg production dynamics in the sediment zones above and below the water table surface in out-of-channel sites in both watersheds. Controls on MeHg production in these headwater catchment areas will be discussed in terms of overall microbial activity, Hg(II) availability, sediment organic content and iron and sulfur speciation.

Mas-Martí, **E.**, University of Barcelona, Barcelona, Spain, emasmarti@ub.edu
Muñoz, I., University of Barcelona, Barcelona, Spain, imunoz@ub.edu

EFFECTS OF SEASONAL DROUGHT ON FOOD WEB STOICHIOMETRY IN A MEDITERRANEAN STREAM

Mediterranean streams are characterised by strong variations in stream flow and water temperature throughout the year, drying out mostly during the summer. An increase in the intensity and frequency of droughts is expected from climate change, thus extending temporality from Mediterranean ecosystems to other temperate river systems. Therefore, understanding the effects of drought on the stream biota is essential for predicting and mitigating potential effects of increasing flow temporality. The goal of this study was to characterise the changes in food web structure in a Mediterranean stream. Benthic macroinvertebrates, amphibian larvae and available resources were sampled from March to December 2009 in a temporal stream. Food web structure was established through stable isotope analyses. Changes in elemental composition (CNP content) of consumers and basal resources were also studied. Preliminary results showed that changes in resource availability allowed higher trophic diversity among consumers during summer pool disconnection. Predatory taxa also increased in summer pools. Temporal variation in consumers' nutrient content was observed for both the different taxa and functional feeding groups. An increase in P content occurred following stream disconnection in collectors, shredders and amphibian larvae.

Matson, **E. A.**, Univ. of Guam Marine Lab, Mangilao, USA, eamatson@uguam.uog.edu

DIVERSITY OF AQUIFER DISCHARGE MECHANISMS TO A TIDALLY-FLUSHED COASTAL LAGOON OF GUAM: HYDRO- AND BIO-GEOCHEMISTRY

Guam's Ghyben-Herzberg aquifer discharges ca. 5 m3/ m shoreline/day throughout the entire periphery of the northern Guam Lens Aquifer. Within one lagoon (Tumon Bay), the freshwater accounts for ~15% of bay volume/day and, due to its high nutrient content, competes biochemically with the average 70% tidal prism. Were it not for flood turbulence through 2 restricted reef troughs, mixing would be insufficient to preclude thorough lagoonal mixing and possible development of algal blooms and retainment of polluted surface runoff. The lagoon resembles a chemostat, with subtidal seepage up through sediments that is augmented with both intertidal seepage and many 200-800 L/min direct aquifer flow through relict Pleistocene carbonate macropores. This rather unique hydrodynamic situation is a useful model for the study of density stratification, upside-down sedimentary redox profiles, non-tidal density mixing, as well as microalgal production, coral nutrient uptake, and flushing of coastal pollutants.

Mattar, **M.**, University of Massachusetts, Amherst, USA, mmattar@cs.umass.edu
Murtagh, S., University of Massachusetts, Amherst, USA, smurtagh@cs.umass.edu
Hanson, A., University of Massachusetts, Amherst, USA, hanson@cs.umass.edu

PICT AND PAS: SENSOR AGNOSTIC TOOLS FOR PLANKTON IMAGE CLASSIFICATION

There are many sensors available for producing images of plankton, both in situ and in a laboratory. Most of the tools available for processing and classifying images are tied to a particular sensor. We will be presenting two tools: PICT and PAS. PICT is both a stand-alone tool and part of PAS which is designed to improve the labeling process. PICT makes predicions about images while an expert labels them, so the expert only needs to correct incorrect predictions, drastically reducing the amount of time to produce a high-quality labeled dataset. PAS is an image analysis framework that covers the entire classification process from processing images to producing classifiers for use on future images. It intergrates two open source packages, ImageJ and WEKA, which are actively supported by the computer vision and machine learning communities, allowing state of the art agorithms to be easily added to PAS. PAS also provides tools for exploring experimental results and a standardized experimental setup, so that experimental results can be shared with other researchers, who can produce identical results with the same experiment parameters.

Matthaei, **C. D.**, University of Otago, Dunedin, New Zealand, christoph.matthaei@otago.ac.nz
Townsend, C. R., University of Otago, Dunedin, New Zealand, colin.townsend@otago.ac.nz
Magbanua, F. S., University of Otago, Dunedin, New Zealand, fsmagbanua@gmail.com
Piggott, J. J., University of Otago, Dunedin, New Zealand, jeremy.piggott@otago.ac.nz

AGRICULTURE, INVADERS AND MULTIPLE STRESSORS IN AQUATIC ECOSYSTEMS

Many aquatic ecosystems worldwide are affected by inputs of nutrients, fine sediment and pesticides, raised water temperatures, reduced water exchange rates due to abstraction, and introduced invaders. While these stressors are known to exert individual effects on aquatic communities and ecosystem functioning, their combined impacts are poorly understood. In a series of studies in streams and streamside channels, we have investigated key stressors in pairs and triplets, to determine their individual and combined effects on community composition (invertebrates, fish), algal biomass and leaf decomposition. Each stressor had strong individual effects, but in combination stressors often produced synergistic or antagonistic outcomes. For example, the presence of sediment can prolong the adverse effects of herbicide in streams. Moreover, the reduced flow associated with water abstraction often acts synergistically to increase the negative impact of deposited sediment. In contrast, water abstraction acted antagonistically to decrease the adverse impact of invasive trout on native fish by providing refuges from trout predation. Because ecological consequences of multiple stressors are often unpredictable based on knowledge of single effects, resource managers need to know how stressors interact.

Mauger, **S.**, Cook Inletkeeper, Homer, AK, USA, sue@inletkeeper.org
Davis, J., Aquatic Restoration and Research Institute, Talkeetna, AK, USA, arri@mtaonline.net
Davis, G. M., Aquatic Restoration and Research Institute, Talkeetna, AK, USA, arri@mtaonline.net
Ruffner, R., Kenai Watershed Forum, Soldotna, AK, USA, robert@kenaiwatershed.org
Geist, M., The Nature Conservancy of Alaska, Anchorage, AK, USA, mgeist@tnc.org

STREAM TEMPERATURE MONITORING NETWORK FOR ALASKA'S SALMON STREAMS

Water temperature plays a critical role in all phases of the salmonid lifecycle, especially in freshwater systems where fish spawn. In recent years, summer temperatures have routinely exceeded state water quality standards established to protect spawning and migrating fish in Cook Inlet salmon streams. Yet despite the association between warm water temperatures and reduced salmonid survivorship - there is little or no consistent, long-term temperature data for streams in Alaska. In 2008, the Stream Temperature Monitoring Network was initiated to collect consistent, comparable temperature data in 48 Cook

Inlet salmon streams. We identify watershed characteristics with the greatest potential to buffer stream temperatures from climate change which is vital information to improve forecasting and in-season management to sustain healthy salmon returns in the face of warming temperatures and changing hydrological regimes. By quantifying potential thermal stressors in Alaska's salmon streams, decision makers will be better-prepared to recommend various adaptation strategies that will create and utilize the thermal buffers and habitat refugia needed to sustain Alaska's wild salmon runs for years to come.

May, **J**. **T**., USGS- CAWSC, Sacramento, USA, jasonmay@usgs.gov
Kennen, J. G., USGS-NJWSC, West Trenton, ,
Sullivan, D. J., USGS-WIWSC, Middleton, USA,
Bell, A. H., USGS-WIWSC, Middleton, ,
Beaulieu, K. M., USGS-CTWSC, East Hartford, USA,
Rice, D. E., USGS-NJWSC, West Trenton, USA,

TEMPORAL CHANGES IN BENTHIC INVERTEBRATE AND FISH ASSEMBLAGES IN STREAMS OF THE NORTH CENTRAL AND NORTHEASTERN U.S.

Understanding temporal trends in aquatic assemblages is a goal of many water-quality management agencies; however, sites are rarely monitored long enough for trend analysis. Trend analyses on benthic invertebrate- and fish-assemblage data was conducted at 27 USGS long-term monitoring sites. A 6-year time series during the period 1993-2008 was chosen as the minimum record necessary to evaluate trends. A test for serial trends was performed and significant temporal changes were identified at 20 of the 27 sites. Environmental attributes were related to the ecological time series to help explain changes in assemblage complexity. Streamflow attributes (e.g., duration and magnitude of low- and high-flows), water chemistry (e.g., NH4, SC, pH) and stream habitat (e.g., percent riffles, pools) accounted for the majority of the variance associated with changes in assemblages. Although benthic invertebrate- and fish-assemblages exhibited differences in sensitivity to change, the dual assemblage approach provided a more comprehensive evaluation of trends. Our approach demonstrates an effective pathway to understanding ecological trends and results have implications for the design of State biomonitoring programs intended to document temporal changes in aquatic assemblages.

Mazor, **R**. **D**., SCCWRP, Costa Mesa, USA, raphaelm@sccwrp.org
Schiff, K., SCCWRP, Costa Mesa, USA, kens@sccwrp.org
Ode, P. R., CA Dept of Fish and Game, Rancho Cordova, USA, pode@OSPR.DFG.CA.GOV
Fetscher, E. A., SCCWRP, Costa Mesa, USA, bettyf@sccwrp.org
Solek, C., SCCWRP, Costa Mesa, USA, chriss@sccwrp.org

MULTI-INDICATOR ASSESSMENT OF STREAMS IN SOUTHERN CALIFORNIA

2009 witnessed the debut of a multi-agency program to assess the health of streams in southern California. Although great effort was expended by earlier bioassessment programs of local agencies, they were project-specific and could not produce an assessment of the region as a whole. Through collaborations, leveraging of resources, and reallocations of existing efforts, the Stormwater Monitoring Coalition developed the first large-scale probabilistic assessment of over 7000 kilometers of streams in southern California's coastal watersheds. At 121 sites, benthic macroinvertebrates, diatoms, soft algae, riparian wetlands, water chemistry, physical habitat, and water column toxicity were sampled. Analysis of preliminary data shows that the majority of stream kilometers were in good condition, although impacts were severe in certain locations for many indicators. For example, riparian wetlands were most degraded in urban areas, and macroalgae growth was heaviest in agricultural streams. Unexpectedly, toxicity to *Ceriodaphnia* was pervasive, including in streams with undeveloped watersheds. The relationships between natural and stressor gradients on three benthic communities (i.e., macroinvertebrates, diatoms, and soft algae) are investigated using multimetric indices and multivariate analysis. Relative risks of potential stressors are also evaluated. This collaborative program demonstrates that regional assessments are possible with minimal additional cost.

McCarthy, **J**. **M**., U.S. Environmental Protection Agency, Region 8, Denver, USA, mccarthy.julia@epa.gov

WHERE ARE THE TIPPING POINTS? MANAGING AQUATIC RESOURCES WITH AND WITHOUT THEM

As human water demands increase, new diversion structures and diversions of greater magnitude increase the risk for potentially irreversible impacts on freshwater resources, especially in arid regions with growing populations and consequent increased withdrawals. Identifying and quantifying impacts create unique challenges for environmental regulators when data and methodologies to characterize these impacts are not always readily available. Current data suggest that ecological responses can vary depending on diversion magnitude, with possible threshold changes beyond certain diversion magnitudes. However, specific empirical relationships between flow alteration and ecological metrics are often noisy and subject to variable interpretation. Without existing knowledge of potential threshold responses, how can regulators protect against irreversible impacts on aquatic communities? The challenge is to estimate potential thresholds with sufficient scientific credibility to support protection efforts. Ultimately, a framework is necessary to identify indicators of ecosystem change and potential threshold responses at varying flow diversion magnitudes. Here, I discuss what types of data may be useful for environmental regulators in decision-making and provide examples of how one might define ecologically relevant impact categories and identify potential thresholds of change.

McClelland, **J**. **W**., University of Texas at Austin, Port Aransas, USA, jimm@mail.utexas.edu
Holmes, R. M., Woods Hole Research Center, Woods Hole, USA, rmholmes@whrc.org
Peterson, B. J., Marine Biological Laboratory, Woods Hole, USA, bpeterson@mbl.edu
Tank, S. E., Marine Biological Laboratory, Woods Hole, USA, setank@mbl.edu
Raymond, P., Yale University, New Haven, USA, peter.raymond@yale.edu
Striegl, R., US Geological Survey, Denver, USA, rstriegl@usgs.gov

ORGANIC MATTER EXPORT FROM ARCTIC WATERSHEDS: A SYNTHESIS OF FINDINGS FROM THE ARCTIC GREAT RIVERS OBSERVATORY AND OTHER RECENT STUDIES

Large stocks of organic matter in soils of northern permafrost regions account for approximately 50 percent of the global below-ground organic carbon pool. Much of this carbon resides within the Arctic Ocean watershed. There is increasing evidence that warming at high latitudes will mobilize this stored carbon creating a positive feedback on global warming. While a majority of the mobilized carbon would be processed and released as carbon dioxide within the continental domain, mobilization of organic matter stocks in high-latitude watersheds could also have a large impact on the net metabolism of the Arctic Ocean. Changes in terrigenous carbon inputs to the Arctic Ocean would directly impact secondary production while release of nitrogen during decomposition of terrigenous organic matter has the potential to impact primary production. This presentation will synthesize findings from recent sampling efforts on the six largest rivers draining the pan-arctic watershed (collectively this sampling program is referred to as the Arctic Great Rivers Observatory) as well as several smaller rivers draining the North Slope of Alaska. Dissolved and particulate organic matter export will be addressed.

McCormick, **M**. **M**., Appalachian State University, Boone, USA, mmccormick11@gmail.com
Gangloff, M. M., Appalachian State University, Boone, USA, gangloffmm@appstate.edu

ASSESSMENT OF SMALL DAM EFFECTS ON MOLLUSK POPULATIONS IN NORTH CAROLINA STREAMS

In the Mid-Atlantic Region, dam removals are a common component of stream restoration projects, however little is known about the potential effects on imperiled mollusk populations. In 2009 we began a 3-year study examining the impacts of small dams on habitat conditions and mollusk populations in North Carolina. During Fall 2009 we sampled mussel assemblages using multiple timed-searches (n = 15 per site) and quantified physicochemical habitat conditions at 9 sites associated with 1 intact and 2 relict dams in the upper Dan River Drainage (UDRD). Surveys revealed that mussel assemblages in the UDRD are relatively species-poor (n = 4 taxa) and dominated by Elliptio complanata. Mean catch rates were high (21.7 per hour) and ranged from 0-157 mussels per hour. Surprisingly, mean mussel diversity (Shannon H') was greatest just downstream of the intact dam. Additionally, federally endangered Pleurobema collina abundance was highest (n = 7 individuals) at this site, suggesting that the dam may actually enhance mussel habitat. In 2010 and 2011 we will target 24 other dam sites in the Roanoke, Tar, and Neuse river basins.

McCracken, **H**. **L**., University of New Brunswick, Fredericton, Canada, heather.mccracken@unb.ca

Cunjak, R. A., University of New Brunswick, Fredericton, Canada, cunjak@unb.ca

THE INFLUENCE OF FOOD ENERGY FROM HEADWATER LAKES ON DOWNSTREAM COMMUNITIES

Using carbon and nitrogen stable isotope analysis, our research aims to determine how food webs in shallow headwater lakes contribute energy to downstream communities. During spring and summer of 2008/2009 organisms (primary producers to secondary consumers) were collected from 3 lakes and their outflow streams in New Brunswick, Canada. Data were analysed using a one isotope, two-source mixing model to determine contributions of nutrient sources and graphically represented in δ13Cvs.δ15N bi-plots. Lake data indicate the diet of adult cyprinid and salmonid fishes (δ13C=-27.23, -25.04) was predominantly littoral algae-grazing invertebrates (δ13C=-27.71). In comparison, isotopic values of juvenile conspecifics (δ13C=-32.33) suggested a food source based on pelagic algae (δ13C =-34.48) during spring when phytoplankton was abundant. By summer, juvenile fishes showed a dietary shift (δ13C =-29.87) suggestive of a littoral food source. Simuliid larva isotope values (δ13C=-32.77) indicated a downstream lacustrine influence when compared with autochthonous carbon sources (δ13C=-27.42) at 0.5km from the lake. In 2009, we focused our efforts farther downstream (up to 3km) to determine reach of lacustrine influence. These results, along with other spatial comparisons, will be presented.

McCrackin, **M**. **L**., Arizona State University, Tempe, USA, mlmccrac@asu.edu

Elser, J. J., Arizona State University, Tempe, USA, j.elser@asu.edu

DENITRIFICATION AND MICROBIAL COMMUNITIES IN SEDIMENTS OF HIGH ELEVATION LAKES RECEIVING ATMOSPHERIC NITROGEN DEPOSITION

The transport and deposition of anthropogenic nitrogen (N) to downwind ecosystems is significant and continues to increase. Denitrification in lake sediments may ameliorate the effects of N loading by permanently removing such inputs. We measured denitrification in high elevation lakes of the Colorado Rocky Mountains receiving elevated (>6 kg N ha^{-1} yr^{-1}) or low (<2 kg N ha^{-1} yr^{-1}) levels of atmospheric N deposition. Background denitrification did not differ between regions and we estimate that the sampled lakes remove 11-25% of N inputs. We conducted a dose-response experiment to determine whether N loading has altered sediment denitrification capacity. Under the Michaelis-Menten model, the maximum denitrification rate and half saturation constant were 765 µmol N m^{-2} h^{-1} and 290 µM NO_3^-, respectively. The half saturation constant was 35x greater than current water nitrate concentrations, suggesting that sediments have considerable capacity to remove N by denitrification. While there is no evidence that N deposition has altered sediment function, the effects of N deposition on sediment microbial communities are not well documented. We enumerated the abundance of N cycling microbes and found no differences between high and low deposition lakes. Rather, the abundances of nitrifiers and denitirifers were interrelated and best predicted by available light to the sediment.

McCutchan, Jr., **J**. **H**., University of Colorado, Boulder, USA, james.mccutchan@colorado.edu

Lewis, Jr., W. M., University of Colorado, Boulder, USA, lewis@spot.colorado.edu

SOURCES OF LABILE ORGANIC MATTER FOR DENITRIFYING BACTERIA IN AN EFFLUENT-DOMINATED RIVER

Denitrifying bacteria require a supply of nitrate, the proper redox conditions, and a source of labile organic carbon. In the South Platte River below Denver, the denitrification rate during summer is linearly related to the concentration of dissolved organic carbon (DOC), and denitrification declines to near zero when the DOC concentration is ~5 mg/L. Thus, changes in the composition (quality) of DOC, and not only the concentration of DOC, appear to control rates of denitrification in the South Platte. Denver's main wastewater treatment facility supplies large amounts of DOC to the South Platte, but tributaries and in situ primary production also are sources of DOC. We used spectroscopic methods (absorbance and fluorescence spectroscopy) to characterize dissolved organic matter (DOM) in the South Platte, two of its tributaries, and wastewater effluent. These analyses showed that high rates of denitrification below Denver depend largely on DOM from wastewater effluent. These findings suggest that future changes in the quantity or quality of DOM in wastewater effluent could alter rates of denitrification in the South Platte River or in other effluent-dominated rivers.

McDonough, **O**. **T**., University of Maryland Center for Environmental Science, Solomons, MD, USA, otmcdo@umd.edu

Lang, M. W., USDA, Beltsville Agricultural Research Center, Beltsville, MD, USA,

Palmer, M. A., University of Maryland Center for Environmental Science, Solomons, MD, USA,

Hosen , J. D., University of Maryland Center for Environmental Science, Solomons, MD, USA,

McCarty, G. W., USDA, Beltsville Agricultural Research Center, Beltsville, MD, USA,

Welsch, D. L., Canaan Valley Institute, Davis, WV, USA,

A NEW METHOD FOR MONITORING NON-PERENNIAL STREAM FLOWS USING A STATE DATA LOGGER

Non-perennial streams represent a significant yet understudied portion of river networks. While most stream research has historically focused on perennial channels, recent work suggests non-perennial streams support valuable ecosystem services including nutrient processing, habitat and dietary resources for diverse faunal communities, and downstream delivery of energy, nutrients, and water. Because they flow episodically, however, ephemeral and intermittent streams have a surface hydrology that has proven challenging to monitor. Non-perennial stream surface hydrological permanence has historically been monitored via direct observation, temperature logging, and electrical resistance logging. Direct observation is laborious and impractical over spatial and temporal scales while temperature and electrical resistance data logging tend to be data intensive and subjective. Here we describe a novel method for monitoring non-perennial stream flow using a state data logger triggered by a binary float-switch that closes a circuit when surface water is present and opens the circuit when surface water is absent. We discuss the advantages of this approach relative to existing techniques and conclude with a discussion of the relevance of state data logging methods to current scientific and regulatory questions.

McElarney, **Y**. **R**., Agri-Food & Biosciences Institute, Belfast, United Kingdom, yvonne.mcelarney@afbini.gov.uk

Barry, C. D., Agri-Food & Biosciences Institute, Belfast, United Kingdom, chris.barry@afbini.gov.uk

THE EFFECTS OF RIPARIAN BUFFER STRIPS ON STREAMS IN FORESTED CATCHMENTS; INVERTEBRATES, MACROPHYTES AND STREAM FUNCTION

Exotic conifer plantations are believed to have detrimental effects on low order streams. Riparian buffer strips are commonly used to ameliorate such effects. This study compared stream structure and function in 25 peatland catchments in Northern Ireland; peatland being a globally rare habitat. Streams studied in forested catchments included those with no buffer, buffers vegetated with deciduous trees, open buffers, and streams in recently harvested catchments. Streams in open peatland were also studied. Invertebrate biomass and macrophyte abundance were recorded together with a suite of physical and water chemistry characteristics. Invertebrate and macrophyte community composition and physico-chemical characteristics were investigated using canonical correspondence analysis which showed that pH and dissolved organic carbon were important in explaining variation in both biological groups. Detrended correspondence and cluster analyses revealed a general biotic similarity between open peatland and open buffer sites. Average invertebrate shredder biomass was high across all stream categories. The open buffer and open peatland sites had similar proportions of predator and scraper invertebrate biomass. Results suggest that streams in forests planted on peatland may benefit from open buffers.

McEwen, **D**. **C**., Minnesota State University Moorhead, Moorhead, USA, mcewenda@mnstate.edu

Butler, M. G., North Dakota State University, Fargo, USA, malcolm.butler@ndsu.edu

INDIRECT ASSESSMENT OF FISHERIES RESPONSE TO WATER-LEVEL MANAGEMENT USING NETWORK PROPERTIES OF MACROINVERTEBRATE FOOD WEBS IN VOYAGEURS NATIONAL PARK, MN

Water levels in reservoirs are often regulated to increase fisheries production, but assessing the impact of water-level management decisions directly on fisheries can be difficult. We used a network approach to investigate how responses of benthic invertebrate communities to a change in water-level management could be linked to potential impacts on fisheries. We analyzed 23 spatially distinct food webs within two reservoirs at Voyageurs National Park, both before and after a change affecting the magnitude of winter drawdown and the timing of spring refill in one

of the reservoirs (the impact system), but not the other (the reference system). We found an increase in the complexity of food webs overall and longer food chains from basal resources to fish associated with the change in water-level management regimes. Our method has potential for assessing impacts in other cases where direct monitoring of fisheries and other vertebrates is difficult.

McGarvey, **D**. **J**., US Environmental Protection Agency, Athens, USA, mcgar002@gmail.com

PREDICTING THE TOTAL ABUNDANCE OF RESIDENT SALMONIDS WITHIN THE WILLAMETTE RIVER BASIN, OREGON – A MACROECOLOGICAL MODELING APPROACH

I present a simple, macroecological model of fish abundance that was used to estimate the total number of non-migratory salmonids within the Willamette River Basin (western Oregon). The model begins with empirical point estimates of net primary production (NPP in g C/m^2) in forested streams. These NPP estimates are combined with stream length and width measurements to obtain a total NPP estimate for the complete stream network. Two key assumptions are then used to predict fish abundance from total NPP: (i) energetic resources are transferred to higher trophic levels at a predictable rate; and (ii) population density is an allometric function of body size. When the model is calibrated with historical information on species' distributions and body sizes, it predicts species' abundances that are consistent with empirical field estimates. I therefore submit that the macroecological model is a useful tool for predicting fish abundances at large spatial scales.

McGlynn, **B**. **L**., Montana State University, Bozeman, USA, bmcglynn@montana.edu

Covino, T., Montana State University, Bozeman, USA, tpcovino@gmail.com

McNamara, R., Montana State University, Bozeman, USA, rebecca.mcnamara@msu.montana.edu

STREAM REACH TO NETWORK SOLUTE TRANSPORT: THE PHYSICAL, BIOLOGICAL, AND SPATIO-TEMPORAL DYNAMICS OF NUTRIENT RETENTION

Remarkable progress in the understanding of stream solute transport of conservative and reactive elements has been made in the last two decades building on the foundation codified in the Stream Solute workshop (1990). Here we present one perspective on the challenges facing stream solute studies as we continue to seek understanding of biological and physical retention processes, their space-time scaling, and new ways to quantify system behavior to ascertain their ultimate affect on the downstream transport of nutrients. This presentation will highlight the importance biologic uptake and hydrologic retention processes in influencing the nutrient dynamics witnessed at watershed outlets and ongoing work to assess the potential role of the stream network in maintaining, attenuating, and altering the terrestrial signatures and export of nitrogen. Further, discussion will focus on the nature of stream nitrogen retention in time, space, and as a function of dynamic in-stream concentrations. New rapid assessment methods to quantify uptake kinetics across diverse systems will be discussed as examples of possible ways forward as the community works to address continuing challenges in stream biogeochemistry and solute transport.

McGoff, **E**. **B**., SLU, Uppsala, Sweden, elaine.mcgoff@vatten.slu.se

Irvine, K., Trinity College Dublin, Dublin, Ireland, kirvine@tcd.ie

IMPLICATIONS OF MACROPHYTE COMPLEXITY FOR MONITORING LITTORAL MACROINVERTEBRATES AND CONSERVATION STRATEGIES FOR LAKES.

Habitat complexity is important for community composition of macroinvertebrates in freshwaters, and can have major effects on ecological interactions. However, there have been few studies on the effect of different macrophyte stands on macroinvertebrate community composition, diversity, abundance and biomass within the same lake, and the possible interaction with fish predators. This study examined the effect of structural complexity on macroinvertebrate community structure and biomass, and the predation refuge offered by the habitats. Habitat, in the form of macrophyte complexity, was important for macroinvertebrate metrics. Overall biomass and abundance increased with increased dry mass of macrophytes, and prevalence of particular invertebrate groups varied across habitats, with distinctive community composition within each habitat type. There was a greater range and number of larger species in denser vegetation. Enclosures designed to reduce fish predation effects on invertebrates across the habits was not, however, found to alter macroinvertebrate community composition. These results have important implications for conservation and monitoring, as in order to maintain species diversity and abundance, macrophyte diversity, health and complexity must be conserved.

McGowan, **S**., University of Nottingham, Nottingham, United Kingdom, suzanne.mcgowan@nottingham.ac.uk

Flower, R., University College London, London, United Kingdom, r.flower@geog.ucl.ac.uk

Langley, J., University of Nottingham, Nottingham, United Kingdom, lgyajjl1@nottingham.ac.uk

Simpson, G., University College London, London, United Kingdom, gavin.simpson@ucl.ac.uk

Yang, H., University of Southampton, Southampton, United Kingdom, hongyanghy@googlemail.com

LAKE AUTOTROPH RESPONSES TO A GRADIENT OF ATMOSPHERIC CONTAMINATION IN SCOTLAND OVER THE PAST 300 YEARS

Patterns of lake acidification in Scotland show that atmospheric contamination was greatest in the South-west, whereas the pH of remote lakes in north-western regions remained relatively unaffected. Acidification in South-west Scotland began in the early 19th Century but following a post-1970 decline in atmopsheric pollution there were indications of chemical and biological recovery. We used chlorophyll and carotenoid pigments in sediment cores to compare responses of lake autotrophs in an acidified and a non-acidified 'control' lake through the acidification (~1830-1970) and recovery (post-1970) period. Lake acidification coincided with an increase algal pigments and elevated production of pigments with ultra-violet radiation (UVR)-screening properties, suggesting an increase in water clarity and the expansion of benthic algae. Unexpectedly, pigments also increased in the control site during the period of maximum atmospheric deposition although UVR- protecting compounds suggested no change in water clarity. The increases in pigments in the control lake correlates with a decline in nitrogen stable isotopes and suggests that nitrogen deposition may have fertilized remote lakes that are assumed to have escaped the worst effects of acid deposition.

McGrath, A., Flinders University , Adelaide, Australia, andrew.mcgrath@flinders.edu.au

Dehaan, **R**., Charles Sturt University / EH Graham Centre, Wagga Wagga, Australia, rdehaan@csu.edu.au

Hacker, J., Flinders University , Adelaide, Australia,

Herpich, D., Charles Sturt University / EH Graham Centre, Wagga Wagga, Australia, Darren.Herpich@sa.gov.au

Wolfgang, L., Flinders University , Adelaide, ,

AIRBORNE REMOTE SENSING OF GROUNDWATER EXPRESSION: AN INTEGRATED SENSOR

When groundwater is expressed at a temperature different from the surrounding environment, thermal imaging can be used for remote sensing of this water. This presentation describes our configuration of a suite of instrumentation and data reduction process for this purpose, integrated to an environmentally friendly research aircraft. The thermal imagery is complemented by high-resolution aerial photography and multispectral scanner with sub-metre resolution. All collected data is georeferenced pixel-by-pixel by reference to a high precision inertial navigation system with GPS correction using in-house developed, open source software. We show data from a measurement campaign in South Australia's Limestone Coast region, recording thermal plumes from freshwater springs flowing into the Glenelg River as well as springs emerging from the seafloor in shallow coastal waters

McHugh, **P**. **A**., University of Canterbury, Christchurch, New Zealand, pete.mchugh@canterbury.ac.nz

McIntosh, A. R., University of Canterbury, Christchurch, New Zealand, angus.mcintosh@canterbury.ac.nz

Thompson, R. M., Monash University, Melbourne, Australia, ross.thompson@sci.monash.edu.au

VARIABLE FOOD-WEB STRUCTURE ALONG INVERSE FLOW GRADIENTS IN A TEMPERATE ALLUVIAL FAN RIVERSCAPE

Ecological theory predicts that stream size determines food-web structure, with species richness and food chain length hypothesised to increase in larger

habitats. However, little is known about how these properties are influenced by discharge reductions in natural streams. This knowledge is vital for aquatic biodiversity conservation efforts. Using alluvial fan streams, we examined the effects of extreme, but localised, flow gradients on food-web structure. We measured stream size (discharge, cross-sectional area) and surveyed communities at several locations along the perennial–intermittent continuum of twelve South Island, New Zealand streams. Flow decreased sharply on alluvial fan surfaces, often transitioning from perennial streams ranging 2-6 m in width to dry river beds over distances of 200 m or less. Biological communities exhibited similarly dramatic longitudinal change, particularly in fish-inhabited streams; fish species richness, maximum predator size, and the number of trophic levels present decreased as surface flows declined between perennial and intermittent stations. The results illustrate that ecosystem size can influence the structure of communities and food webs in fluvial habitats, and have implications for flow management in ecological networks.

McIntosh, **A. R.**, University of Canterbury, Christchurch, New Zealand, angus.mcintosh@canterbury.ac.nz
McHugh, P., University of Canterbury, Christchurch, New Zealand,
Jellyman, P. G., University of Canterbury, Christchurch, New Zealand,
Woodford, D. J., University of Canterbury, Christchurch, New Zealand,
Warburton, H., University of Canterbury, Christchurch, New Zealand,

PERVASIVE EFFECTS OF HABITAT SIZE ON FRESHWATER COMMUNITIES

Habitat loss is a major driver of species extinctions associated with global change, with destabilisation of food webs caused by reduced habitat size a likely mechanism. A comparison of New Zealand streams across three orders of size revealed larger streams support more predator biomass per unit of prey biomass than small streams. These patterns are likely a 'ghost of instability past,' whereby unstable configurations, such predator-heavy food webs (i.e., inverse biomass pyramids), are unable to persist in small streams. This could be caused by habitat compression which restricts the movement of organisms, concentrating species interactions. For example, trout predation on native galaxiids intensifies in smaller streams, and reaches contracted due to drying have disproportionately high predator abundance compared to non-contracted reaches. Community structure in smaller, or contracted, streams is also more variable than that of larger, or non-contracted, streams. These patterns provide insights into how spatial compression of habitats likely contributes to biodiversity patterns through food web destabilization, and indicate the contraction of freshwater systems associated with human water use and altered climate will have profound consequences.

McIntosh, **M. D.**, Michigan State University, East Lansing, USA, mcinto57@msu.edu
Williamson, H. R., University of Tennessee, Knoxville, USA, hwillia8@utk.edu
Benbow, M. E., University of Dayton, Dayton, USA, benbowme@notes.udayton.edu
Kimbirauskas, R. K., Michigan State University, East Lansing, USA, kimbira1@msu.edu
Miller, S. A., Michigan State University, East Lansing, USA, mill1571@msu.edu
Small, P. L., University of Tennessee, Knoxville, USA, psmall@utk.edu
Merritt, R. W., Michigan State University, East Lansing, USA, merrittr@msu.edu

SPATIAL VARIATION OF A BACTERIAL PATHOGEN WITHIN TROPICAL AQUATIC ENVIRONMENTS OF GHANA, AFRICA

Numerous studies have associated Buruli ulcer disease with disturbed aquatic habitats; however, the natural reservoir, distribution and mode of transmission of the bacterial pathogen, *Mycobacterium ulcerans*, remain unknown. High variation in *M. ulcerans* populations among samples, substrates, and sites suggest the bacteria may be naturally patchy in the environment. The main objective of this study was to (1) determine the natural spatial distribution and variation of *M. ulcerans* within an endemic water body in Ghana, Africa, and (2) evaluate abiotic and biotic conditions necessary to establish detectable *M. ulcerans* populations. The spatial distribution of *M. ulcerans* appeared non-specific, with positive samples located on each substrate type, within each water zone, and at multiple depths; however, the frequency was dependent on substrate type (natural vs. artificial). The observed distribution of *M. ulcerans* abundance was significantly associated, with higher populations at shallower depths, with higher dissolved oxygen levels and higher temperatures. This study provides insight into the ability to detect a human pathogen in aquatic environments, which could have important implications for future environmental research studies and management of Buruli ulcer disease.

McIntyre, **P. B.**, University of Michigan, Ann Arbor, USA, pbmcinty@umich.edu
Allan, J. D., University of Michigan, Ann Arbor, USA, dallan@umich.edu

ECOSYSTEM CONSEQUENCES OF DISCONNECTING LAKES FROM THEIR TRIBUTARIES BY BLOCKING FISH MIGRATIONS

River ecosystem structure and functioning are profoundly affected by dams, which also have detrimental impacts upon migratory animal populations. However, the ecosystem-level consequences of blocking migrations have received less attention. We present results from small, oligotrophic tributaries of Lake Michigan that receive large breeding migrations of suckers every spring. These fish migrations enhance stream nutrient concentrations and fluxes, contributing more even than storm events during the run. Primary productivity is strongly nutrient-limited, and stable isotope data show that lake-derived nutrients subsidize the stream food web. Leaf litter decomposition experiments also indicate enhanced respiration of organic matter during the fish migration. Fish movement into most of the tributary network of Lake Michigan and other Great Lakes is blocked by dams, and our results suggest this can strongly affect stream ecosystem functioning. This finding may be applicable to catostomid migrations throughout North America, offering a continental counterpart to results from anadromous species.

McKenna, **O.**, Loyola University Chicago, Center for Urban Environmental Research and Policy, Chicago, IL, USA, omckenna@luc.edu
Treering, D., Loyola University Chicago, Center for Urban Environmental Research and Policy, Chicago, IL, USA, dgoldb2@luc.edu
Miceli, D., Loyola University Chicago, Center for Urban Environmental Research and Policy, Chicago, IL, USA, dmiceli@luc.edu
Vail, L., Loyola University Chicago, Center for Urban Environmental Research and Policy, Chicago, IL, USA, lvail@luc.edu
Lishawa, S. C., Loyola University Chicago, Center for Urban Environmental Research and Policy, Chicago, IL, USA, slishawa@gmail.com
Tuchman, N. C., Loyola University Chicago, Center for Urban Environmental Research and Policy, Chicago, IL, USA, ntuchma@luc.edu

RECONSTRUCTING THE HISTORY OF EMERGENT WETLAND PLANT INVASIONS USING AERIAL PHOTO INTERPRETATION

Invasive aquatic macrophytes, specifically Typha x glauca are increasingly altering the flora and biogeochemistry of Great Lakes coastal wetlands. Determining the historical spatial progression of plant invasions will benefit invasion ecology research as floristic, edaphic, and biogeochemical variables could be analyzed along an invasion duration gradient. We developed Aerial Photo Interpretation (API) methods for identifying monocultures, typical of many emergent wetland plants, from photographs of varying resolution and quality in a Geographic Information System. Using these methods, we created an historical record of T. x glauca spread in four Great Lakes coastal wetlands over a 70-year span. Accuracy of our API was verified by collecting spatially located reference data using Global Positioning Systems in the field at all four wetlands. In a Lake Huron marsh and using pollen core analysis, lead-210, and cesium-137 dating, we confirmed our API results: T. x glauca has been present and spreading since 1952 +/- 5 years and reached dominance in the marsh by the early 1970s.

McKie, **B. G.**, Swedish University of Agricultural Sciences, Uppsala, Sweden, brendan.mckie@vatten.slu.se

UNDERSTANDING VARIABILITY IN THE EFFECTS OF BIODIVERSITY ON ECOSYSTEM FUNCTIONING IN STREAM DETRITAL PATHWAYS

The worldwide loss of species has stimulated research into the importance of biodiversity for ecosystem functioning. In running waters, such research has focused on leaf decomposition, a key ecosystem process regulating nutrient and energy flows. Experimental manipulations revealed that increasing detritivore species richness often affects leaf decomposition and related processes, though the form of these effects varied, with both positive and negative responses observed. Variation in species evenness, altering the relative abundance of important species traits within the detritivore guild, was found to modify richness-functioning relationships by affecting the occurrence of complementary interactions among species. Changes in stream physico-chemical characteristics (pH, nutrients) similarly altered richness-functioning relationships through effects on the balance of negative and positive inter- and intra-specific interactions. Finally, the presence of an intra-guild predator altered relationships between detritivore richness and leaf decomposition and related processes, by regulating the influences of the most efficient leaf consumers. These findings

have implications for understanding variation in the functioning of stream ecosystems, which are characterized by spatio-temporal dynamism in both environmental characteristics and the composition of benthic assemblages.

McLaughlin, **A**., University of Colorado at Boulder, Boulder, USA, mclaughlina2@gmail.com

McKnight, D. M., University of Colorado at Boulder, Boulder, USA, diane.mcknight@colorado.edu

A REVIEW ON THE EFFECT OF *D. GEMINATA* NUISANCE GROWTH ON BENTHIC MACROINVERTEBRATE COMMUNITIES IN BOULDER CREEK

Since 2005, *Didymosphenia geminata* nuisance blooms have been recorded in Boulder Creek, Colorado. The goal of this review is to determine if the degree of *D. geminata* coverage affects macroinvertebrate community composition. The data encompasses three years with varying coverage: no impact (2004), high impact (2006) and low impact (2008). The years also had varying summer discharges which may play a role in controlling nuisance blooms. The sampled sites were along Boulder Creek, below Barker Reservoir and above Boulder, Colorado. Periphyton samples and coverage values were collected throughout the summer approximately every week. Periphyton was analyzed for *D.geminata* cell density and AFDM. Macroinvertebrate samples were taken twice a year in mid-April and late-September (CBWQS). Macroinvertebrates were separated by species and functional feeding group. Then the density as well as the following indices were used to compare macroinvertebrate samples: HBI, EPT, and EPT/Chironomid. It is predicted that with increases in *D.geminata* coverage values EPT organisms will decrease and Chironomids will increase. A further prediction is that as *D.geminata* coverage increases the collectors, specifically detritivores, will dominate the macroinvertebrate communities.

McLaughlin, **C**., University of Pennsylvania, Philadelphia, USA, chmc@sas.upenn.edu

Kaplan, L. A., Stroud Water Research Center, Avondale, USA, lakaplan@stroudcenter.org

DISSOLVED ORGANIC CARBON (DOC) LABILITY AMONG TERRESTRIAL END-MEMBERS AND DURING STORMS

Stream heterotrophs depend on the supply of biodegradable DOC (BDOC) for energy and carbon. Variations in BDOC should occur among terrestrial sources as well as distinct flow paths due to variations in residence time and conditions for degradation. We determined the quality of terrestrial DOC sources and how the activation of different flow paths during storms influences BDOC in White Clay Creek. Samples of groundwater, soil water, and stream water at baseflow and storm flow were collected and analyzed for BDOC using plug-flow bioreactors colonized by microorganisms in stream water. BDOC was calculated as the difference between the inflow and outflow DOC concentrations. We observed a shift from relatively labile to more recalcitrant C sources with soil depth and suggest that differences in BDOC between storm flow and baseflow result from changes in hydrologic flow paths during storms. The linkage between soil processes and BDOC in streams is poorly understood, but this study in combination with an understanding of the relationship between water flux and C flux will help to determine energy flow across the terrestrial-aquatic interface.

McMillan, **S**. **K**., UNC Charlotte Dept of Engineering Technology, Charlotte, USA, smcmillan@uncc.edu

Clinton, S. M., UNC Charlotte Dept of Biology, Charlotte, USA, sclinto1@uncc.edu

Garris, N. E., UNC Charlotte Dept of Biology, Charlotte, USA, ngarris3@uncc.edu

LINKING GEOMORPHIC AND BIOLOGICAL CONTROLS ON DENITRIFICATION IN URBAN HEADWATER STREAMS

Geomorphic heterogeneity in headwater streams enhances rates of biogeochemical processes by increasing contact between nitrogen in stream water and biologically active, carbon-rich streambed sediments. Altered hydrology and increased pollutant loads in urban areas have led to degraded and scoured streambeds resulting in higher nitrogen transport downstream. While environmental controls on denitrification, such as carbon and nitrate supply, are well understood, links among the physical structure of the stream, denitrification and populations of denitrifying bacteria are largely untested. We measured denitrification via acetelyne block in three urban streams with varying landscape histories (urban restored, high urban, low urban). Variability correlated with seasonality but was also influenced by high flow scouring events resulting in lower sediment organic carbon and decreased denitrification, particularly in the most urbanized stream. Quick biofilm recovery in this same stream on sand/gravel substrata correlated with higher denitrification rates, suggesting a close coupling between algal and bacterial communities. Quantification of key denitrification enzymes (qPCR) and denitrifier community diversity (terminal restriction fragment length polymorphism) is ongoing to characterize the link between geomorphic and biological controls on denitrification in urban streams.

McMullen, **L**. **E**., Oregon State University, Corvallis, USA, mcmullel@science.oregonstate.edu

Lytle, D. A., Oregon State University, Corvallis, USA, lytleda@science.oregonstate.edu

EFFECTS OF LARGE-SCALE EXPERIMENTAL FLOODS ON INVERTEBRATE COMMUNITY STRUCTURE IN THE BILL WILLIAMS RIVER, AZ, USA.

Floods are important disturbance events in rivers that have the potential to reshape ecosystem structure and function. We investigated the effects of experimental flood releases of 2,430 and 1,030 cfs (baseflow ≈ 38 cfs) from Alamo Dam on aquatic invertebrate communities in the Bill Williams River, AZ, USA during 2006 and 2007. We sampled three sites downstream of the dam for invertebrates before and multiple times after flood releases. Multivariate analyses of communities by site showed that floods changed community structure, despite among site and among year community differences. Distinct taxa were associated with pre- and post-flood samples at all sampling sites. At the two lower sampling sites, invertebrate community structure post-flood converged with pre-flood community structure over time. This data also suggests which taxa may be most resistant and resilient to flood events.

McNair, **J**. **N**., Grand Valley State University, Annis Water Resources Institute, Muskegon, Michigan, USA, mcnairja@gvsu.edu

APPLYING THE LOCAL EXCHANGE MODEL TO STREAM SESTON AND BENTHIC MACROINVERTEBRATE DATA

The Local Exchange Model (LEM) is a stochastic diffusion model of turbulent particle transport. When applied to streams, it predicts basic flow properties (e.g., vertical profiles of current velocity and turbulent mixing) and various particle transport properties (e.g., distribution and moments of the time or distance at which suspended particles settle on the bed). The predicted particle transport properties are important in theories of nutrient spiraling and benthic invertebrate production, dispersal, and dynamics. Accordingly, numerous empirical studies have measured the distribution of settling time or distance for stream seston or benthic invertebrates. But because of differences in the types of supporting information these studies provide (mean stream width, depth, slope, etc.), they differ markedly in usefulness for applying and testing transport models like the LEM. I summarize a variety of empirical particle transport studies, show how their different levels of supporting information affect our ability to apply and test the LEM or similar models, and recommend a set of supporting information that should accompany observed distributions of settling time or distance in empirical studies.

McNamara, **R**. **A**., Montana State University, Bozeman, USA, rebecca.mcnamara@msu.montana.edu

McGlynn, B. L., Montana State University, Bozeman, USA, bmcglynn@montana.edu

Covino, T. P., Montana State University, Bozeman, USA, tpcovino@gmail.com

STREAM NITROGEN UPTAKE DYNAMICS FROM AMBIENT TO SATURATION ACROSS DEVELOPMENT GRADIENTS, STREAM NETWORK POSITION, AND SEASONS IN A DEVELOPING WATERSHED

Retention of nitrogen in streams determines the balance between N loading and export from headwater catchments. We quantified in-stream nitrate-N uptake kinetics from ambient to saturation across a 212 km^2 watershed. We conducted over 26 stream tracer experiments (both constant-rate and instantaneous additions) in six stream reaches across a range of development intensities, ambient nitrate-N concentrations, watershed areas, stream discharges, and seasons. Four of the six streams were paired for comparison based on similar watershed area and total discharge; each pair included a stream of high and low ambient nitrate-N, reflecting varying degrees of development and upland nutrient loading (i.e., wastewater disposal). For each experimental reach, ambient uptake parameters were calculated and Michaelis–Menten kinetics were used to quantify the maximum areal uptake rates and half-saturation constants. We found variation between streams in N uptake related to ambient

N, watershed area, discharge, and season. Our results suggest that quantifying in-stream N uptake kinetics from ambient to saturation over space, time, and land-use change gradients can yield new insight into the capacity of stream networks to modify nutrient loading.

McNeely, **C**., Eastern Washington University, Cheney, USA, camillemcn@gmail.com
Finlay, J. C., University of Minnesota, St. Paul, USA, jfinlay@umn.edu
Thomas, S., University of Nebraska , Lincoln, USA, sthomas5@unl.edu
Schade, J. D., St. Olaf College, Northfield, USA, schade@stolaf.edu
Power, M. E., University of California, Berkeley, USA, mepower@berkeley.edu

ECOSYSTEM METABOLISM ALONG A STREAM SIZE GRADIENT IN A MOUNTAIN WATERSHED

We measured ecosystem metabolism in seven streams along a size gradient in the South Fork Eel River watershed (39°43'45" N, 123°38'40" W). Some streams were measured in multiple years and seasons. Streams ranged in watershed area from 0.6 to 17 km^2. We used single-station diurnal DO curves to estimate metabolism and injections of propane or SF_6 to estimate reaeration flux. Reaeration fluxes were negatively correlated with watershed area but positively correlated with discharge ($r^2 = 0.55$, $p = 0.027$). Larger streams had lower reaeration fluxes, but we observed higher reaeration rates during higher flow conditions. We observed a clear shift from heterotrophic conditions with P/R << 1 to autotrophic conditions with P/R close to 1. Although the pattern of increasing autotrophy with increasing watershed area is expected, few studies have documented this with whole-stream measurements within a single watershed. In addition, the transition occurs more sharply and at a smaller stream size and than might be expected. This shift from heterotrophy to autotrophy is likely to be critical to nutrient uptake patterns and food web dynamics in the watershed.

McNyset, **K**. **M**., NOAA-Fisheries, Corvallis, USA, kristina.mcnyset@noaa.gov
Falke, J. A., NOAA-Fisheries, Corvallis, USA, jeffrey.falke@noaa.gov
Jordan, C. E., NOAA-Fisheries, Corvallis, USA, chris.jordan@noaa.gov

PREDICTING PRODUCTIVITY AND LIFE- HISTORY DIVERSITY OF ONCHORHYNCHUS MYKISS IN THE JOHN DAY RIVER BASIN (OR): DEVELOPLING A CONTINUOUS TEMPERATURE MODEL

The resident (rainbow trout) and threatened anadromous (steelhead) forms of *Oncorhynchus mykiss* are often sympatric and may give rise to one another, confounding recovery/management efforts. Research shows that populations exhibiting high life-history diversity are more productive and resilient to perturbation. Water temperature controls growth, survival, and ultimately influences life-history expression in these fishes. The decision to migrate or stay in freshwater may be a flexible response to variable environmental conditions. Recovery of steelhead will require knowledge of the biological and physical processes, such as the natural variation in thermal conditions across spatial scales, which influence life-history expression in *O. mykiss*. We are developing a spatially-explicit, continuous, water temperature model for the John Day River basin in eastern Oregon, based on water temperature observations collected across 20 years. The model is parameterized using remotely-sensed land surface temperatures, precipitation, runoff, and geo-physical characteristics. Our goal is to predict life-history expression and production of *O. mykiss* in the John Day, and develop an analytical framework useful for managers evaluating conservation and management actions aimed at increasing juvenile steelhead production.

McPhillips, **L**. **E**., US Geological Survey, Reston, USA, lmcphillips@usgs.gov
Harvey, J. W., US Geological Survey, Reston, USA, jwharvey@usgs.gov
Packman, A. I., Northwestern University, Evanston, USA, a-packman@northwestern.edu
Tobias, C. R., University of Connecticut, Groton, USA, craig.tobias@uconn.edu
Jerolmack, D. J., University of Pennsylvania, Philadelphia, USA, sediment@sas.upenn.edu
Bohlke, J. K., US Geological Survey, Reston, USA, jkbohlke@usgs.gov
Henry, E. J., University of North Carolina- Wilmington, Wilmington, USA, henrye@uncw.edu
Larsen, L. G., US Geological Survey, Reston, USA, lglarsen@usgs.gov
Aubeneau, A., Northwestern University, Evanston, USA, antoineaubeneau2012@u.northwestern.edu
Drummond, J., Northwestern University, Evanston, USA, j-drummond@u.northwestern.edu

HYDROGEOMORPHIC DRIVERS OF STREAM ECOLOGICAL PROCESSES: THE 2009 CLEAR RUN, NC STUDIES

Hyporheic flow and associated ecological processes are constantly adjusting with changing flow and geomorphic conditions in streams. To address how hydraulic, geomorphic, and ecological processes co-evolve in streams, we constructed two dams for flow manipulation in Clear Run, a 2nd order, sand-bed stream in Wilmington, N.C. Flow and geomorphic variability were characterized by hydraulic measurements using ADVs in the stream and piezometers in the streambed and banks, along with repeat stream surveys over three weeks in September 2009. Time-lapse photography was used to characterize bedform migration, disruption, and reformation after floods. Biogeochemical measurements and injection of conservative and reactive solute tracer and fine particle tracers characterized changes in stream metabolism, nitrogen reactions, and transport and redistribution of fine particulate organic carbon due to dam effects. Highlights include differential responses of hyporheic fluxes and solute reactions in the bed and bank in response to dam pooling and flooding, differential capacities for fine particulate storage in surface and subsurface storage zones, and a better understanding of the relation between solute and particulate storage and reaction processes to flood hydraulics and geomorphic responses.

McShane, **R**. **R**., Colorado State University, Fort Collins, USA, ryan.mcshane@colostate.edu
Poff, N. L., Colorado State University, Fort Collins, USA, poff@lamar.colostate.edu

SCALING SPECIES DISTRIBUTION MODELS FOR THE PREDICTION OF INVASIONS IN RIVER SYSTEMS

Species distribution models (SDMs) have been frequently used to predict invasions in terrestrial environments and more recently in aquatic systems. These models are predicated on combining regional-scale data of environmental predictors with local-scale data on non-native occurrences. How SDMs have been typically applied is problematic for predicting invasions in river systems because of scaling disparities between low-resolution landscape data mapped over wide extents and site-specific riverine habitat templates and anthropogenic effects. We used SDMs to demonstrate the limitation of remotely-sensed data in predicting the site-specific invasion of tamarisk and New Zealand mudsnail in the western United States. The regional envelope of potential habitat suitability for these species is described by climatic variables, which fail to explain the local distribution of these species. Using data for selected catchments in the upper Colorado River basin, we illustrate the importance of incorporating fine-grained hydrologic and geomorphic variables to build mechanistic SDMs. Further refinement of these models for use in river systems will require more attention to selecting mechanistic drivers and appropriately scaling them for effective application to predicting invasions.

McTammany, **M**. **E**., Biology Department, Bucknell University, Lewisburg, PA, USA, mmctamma@bucknell.edu
Trosch, L. B., Biology Department, Bucknell University, Lewisburg, PA, USA,
Oravec, B. S., Biology Department, Bucknell University, Lewisburg, PA, USA,

HYPOXIA IN A SHALLOW RIVER? INTERANNUAL VARIABILITY IN FLOW DETERMINES SUSCEPTIBILITY TO EUTROPHICATION IN THE SUSQUEHANNA RIVER

Lotic ecosystems resist eutrophication by exporting dead production, replacing water from upstream, and exposing water to atmospheric oxygen. However, physical changes in rivers during low-flow conditions might breakdown this resistance, as velocity declines and depth decreases to exaggerate effects of metabolism (GPP, R) on oxygen concentrations. Furthermore, microhabitats might form during low-flow periods and develop ecological signatures from 'internal' processes if isolated from the main channel. We measured ecosystem metabolism during summer and fall of years with lower than average discharge (2007) and higher than average discharge (2009) in thalweg and river margin locations of the Susquehanna River to determine the extent to which interannual flow variability affects susceptibility to eutrophication. Metabolism rates at thalweg locations were similar across years but were much higher at margins in 2007 (dry) than in 2009 (wet). As a result, daily oxygen minima at margin locations were 4.1 mg/L in 2007 and 6.8 mg/L in 2009. Because river margins are important habitats for juvenile smallmouth bass, low oxygen during dry years presents a challenge for fisheries management along the Susquehanna River.

Mead, **J**. **V**., Patrick Center for Environmental Research, Philadelphia, USA, Mead@ansp.org

Thomas, R. L., Patrick Center for Environmental Research, Philadelphia, USA, Thomas@ansp.org

Rojas, P., University of Colorado, Coyhaique, Chile, paulinrojas@gmail.com

Reid, B., Centro de Investigación en Ecosístemas de la Patagonia, Coyhaique, Chile, brian.reid@ciep.cl

Cordero, J. C., Service of agriculture and cattle, Coyhaique, Chile, julio.cerda@gmail.com

Scatena, F. N., University of Pennsylvania, Philadelphia, USA, fns@sas.upenn.edu

LEGACY SEDIMENTS AND THE RESPONSE OF CHANNEL MORPHOLOGY TO RIPARIAN FORESTS.

Streams with riparian forests can be twice as wide as streams lacking riparian forests, with the difference in channel widths explained by grasses trapping sediments and, over time, constricting channels. Most of what we know about this channel narrowing phenomenon is from temperate streams in the northern hemisphere that have a history of human development. This development includes small dams and mills that sequester fine sediments or "legacy sediments". Furthermore, much of the fine sediment sequestered is from erosion of soils during the conversion of large areas of land from forest to agriculture in the 1700–1800s. In this presentation, we test our hypothesis that bankfull widths of small streams without legacy sediments are not related to riparian forest cover. The foundation of this hypothesis is that streams without legacy sediments would not have sediments for grasses to trap, and then narrow channels. To test our hypothesis we will compare preliminary data from old growth temperate forests in Chile and the U.S. with existing data from streams with legacy sediments.

Mebane, **C**. **A**., U.S. Geological Survey, Boise, ID, USA, cmebane@usgs.gov

Simon, N. S., U.S. Geological Survey, Reston, VA, USA,

Maret, T. R., U.S. Geological Survey, Boise, ID, USA,

INFLUENCE OF SEDIMENT NUTRIENTS, FLOW, AND OTHER ENVIRONMENTAL FACTORS ON MACROPHYTE ABUNDANCE IN AGRICULTURAL STREAMS IN THE UPPER SNAKE RIVER BASIN, IDAHO

Macrophytes may be integral parts of abiotic and biotic processes in streams, particularly in some streams in the arid western regions of Canada and the United States where macrophytes can reach nuisance levels. As part of the U.S. Geological Survey's National Water Quality Assessment (NAWQA), we surveyed macrophytes, nutrients in sediments and water, and other variables in 30 streams located in agricultural watersheds in the upper Snake River basin, Idaho, USA. The sample locations represented a range of conditions from pristine reserves, to open range, to irrigation waste ways. Analyses for nutrients in sediments included total phosphorus (P), total nitrogen (N) and sequential extractions for P in sediments to separate loosely bound P, P associated with poorly crystalline iron oxides, P associated with carbonates and residual P. Factors related to macrophyte biomass included loosely bound sediment P (+),sediment N (+), shear stress (+), peak flows in the spring runoff preceding summertime sampling (-),channel shading (-), and periphyton abundance (-). A regression model using the first four of these factors accounted for about 75% of the observed macrophyte biomass.

Medvick, **P**. **A**., Northern New Mexico College, Espanola, USA, pmedvick@earthlink.net

EDUCATION FOR LIVING IN THE KNOWLEDGE SOCIETY (LIKES)

With the advent of the World-Wide Web and the integration of computing into all aspects of living, the stove-piped education of computer scientists is a disservice both to information technology students and to other educational domains. Living in the KnowlEdge Society (LIKES), a project funded by NSF, has the goal of transforming computing education for the 21st century by 1. identifying key computing concepts in disciplines and 2. developing and implementing tools and techniques to enable learning of concepts in computing and in the disciplines. This will achieve cross-pollination of computer science with other fields. This interdisciplinary effort hopes to build the framework for training to full capability for life in the global knowledge society. "Deliverables include, 1. new pedagogies in computing education; 2. integration of computing concepts into non-computing disciplines; 3. principles, guidelines, and techniques for integrating computing and non-computing curriculums; and 4. formation of new communities for enhancing that integration." These support the transforming of education in computing–related disciplines to yield next-generation builders and citizens of the knowledge society. http://www.likes.org.vt.edu/

Mehling, **M**. **G**., Miami University, Oxford, OH, USA, mehlinmg@muohio.edu

Oris, J. T., Miami University, Oxford, OH, USA, orisjt@muohio.edu

Radl, J., Miami University, Oxford, OH, USA, radljn@muohio.edu

Tylka, M., University of Maine, Orono, ME, USA, megan.tylka@umit.maine.edu

Nim, IV, C. J., Miami University, Oxford, OH, USA, nimcj@muohio.edu

TEMPORAL AND SPATIAL PATTERNS OF NEARSHORE LITTORAL BENTHIC MACROINVERTEBRATES: MOUNTAIN LAKE BIOASSESSMENT METHOD DEVELOPMENT

Although benthic macroinvertebrates are widely used as robust aquatic bioassessment agents, the rigorous evaluation of their ability to serve as biomonitors in lakes and reservoirs has only recently gained momentum. Once thought to be too heterogeneous to allow for bioassessment, the littoral zone was left unexplored. However, advancements, including the incorporation of benthic invertebrates into lentic monitoring and the increased investigation of the lake littoral, have prompted reconsideration of the potential for littoral benthic macroinvertebrates (LBMIs) to indicate impairment. In oligotrophic to mesotrophic lakes and reservoirs of the Sierra Nevada ecoregion (USA), we examined spatial and temporal patterns of nearshore LBMI diversity and community structure in relation to in-lake, riparian, and catchment attributes and human activity. Results were analyzed using multiple spatial grains and levels of taxonomic resolution. At the regional extent, we found LBMIs distinguished lake types. Within-lake results support LBMIs as indicators of local shoreline modification and suggest little annual variation in composition. Our results support the use of littoral benthic macroinvertebrates for lentic bioassessment and emphasize the importance of sampling methodology based on tested ecological theory.

Mehring, **A**. **S**., Odum School of Ecology, The University of Georgia, Athens, GA, USA, asmehr@uga.edu

Lowrance, R. R., USDA-Agricultural Research Service, Southeast Watershed Research Lab, Tifton, GA, USA, richard.lowrance@ars.usda.gov

Helton, A. M., Odum School of Ecology, The University of Georgia, Athens, GA, USA, amhelton@uga.edu

Vellidis, G., Department of Biological and Agricultural Engineering, The University of Georgia, Tifton, GA, USA, yiorgos@uga.edu

Pringle, C. M., Odum School of Ecology, The University of Georgia, Athens, GA, Canada, cpringle@uga.edu

Bosch, D. D., USDA-Agricultural Research Service, Southeast Watershed Research Lab, Tifton, GA, USA, david.bosch@ars.usda.gov

ELEVATED DISSOLVED ORGANIC CARBON IN SUB-TROPICAL BLACKWATER RIVERS MAY BE A RESULT OF ANOXIA RATHER THAN AN EXPLANATION FOR IT

Dissolved organic carbon (DOC) is a driver of ecosystem metabolism and dissolved oxygen (DO) levels in rivers. However, the process may also work in reverse in sub-tropical blackwater rivers, where high temperatures and low gradients can abiotically force decreased DO. Here we present long-term data from the Little River Experimental Watershed, located in the Suwannee River basin in southern Georgia, USA. Weekly data from nested, gauged sub-watersheds from 2002-2009 show large pulses of DOC (increasing 375% from ~20 to ~75 mg/L over two weeks) during periods of low discharge (<2500 l/s) and DO (<1 mg/L). DO and PO^{3-}_4 were the best predictors of DOC (among variables: discharge, DO, NH_4^+, NO_3^-, TKN, PO^{3-}_4, TP, and ORP) according to Akiake's Information Criterion (AIC). Temperature and DO were negatively correlated ($r^2 = 0.66$), suggesting that DOC concentrations may be a result of abiotic effects of temperature on DO rather than an explanation for low DO. Several factors may enhance DOC release during periods of anoxia, including dissolving iron/PO^{3-}_4/ DOC co-precipitates, concentration through evaporation, and increased microbial DOC release activity under high temperatures.

Memmott, **J**. **C**., Desert Research Institute, Reno, NV, USA, Jeramie.Memmott@dri.edu
Davis, C. J., Desert Research Institute, Reno, NV, USA, Clinton.Davis@dri.edu
Fritsen, C. H., Desert Research Institute, Reno, NV, USA, Christian.Fritsen@dri.edu
Wirthlin, E. D., Desert Research Institute, Reno, NV, USA, Eric.Wirthlin@dri.edu
Momberg, D. K., Desert Research Institute, Reno, NV, USA, Diane.Momberg@dri.edu
Smith, D. W., Desert Research Institute, Reno, NV, USA, David.Smith@dri.edu

HOW PRODUCTIVE CAN A RIVER BE? A CASE STUDY OF THE SOUTH FORK HUMBOLDT RIVER, NEVADA.

Rates of community metabolism (gross primary production, GPP) in the South Fork of the Humboldt River, NV were measured in excess of 10 to 30 g C m^{-2} d^{-1} during the summer of 2009 using the open water exchange approach. Limitations of the method (e.g. due to significant bubble formation and out-gassing) indicate GPP production may have actually been higher. These extremely high values (exceeding the largest reported in the literature) were associated with extensive periphyton biomass accumulations in excess of 300 mg Chla m^{-2} (n=24, per station). The river is a relatively shallow (less than 1m deep) low-gradient system in the semi-arid eastern region of Nevada and is downstream of a recreational reservoir showing significant signs of eutrophication. Community Respiration (CR) rates were less than GPP throughout the summer indicating substantial system autotrophy. The system and its productive autotrophic community may be an ideal situation to evaluate both negative and positive feedback mechanisms (e.g. self-shading, gas-transfer limitations for both respiration and photosynthesis, grazer reductions, etc…) that may work in concert to maximize or optimize system productivity.

Mendel, **M**. **J**., Mount Vernon Nazarene University, Mount Vernon, USA, mmendel@mvnu.edu
Adler, P. H., Clemson University, Clemson, USA, padler@clemson.edu
Mendel, R. J., EnviroScience, Inc., Stow, USA, rmendel@enviroscienceinc.com

A SURVEY OF BLACK FLIES (DIPTERA: SIMULIIDAE) IN SOUTHERN OHIO STREAMS USING CYTOLOGICAL METHODS

Black fly immatures can constitute a significant portion of the invertebrate life in a stream ecosystem. Prior to this study, the knowledge of the distribution of black flies in Ohio's rivers and streams was sparse, and was based primarily on surveys of black flies conducted before the improvements in cytological methods. Black fly immatures were collected from at least two streams within the 39 counties in southern Ohio. The black flies were preserved in Carnoy's solution and identified using cytological methods. One hundred and thirty-seven black fly county records were established for southern Ohio. In addition, five species not previously known to occur in Ohio were discovered (*Prosimulium arvum*, *Prosimulium multidentatum*, *Prosimulium saltus*, *Simulium hematophilum*, and *Simulium ozarkense*). Eighteen species within three genera were collected within the southern counties. Three separate ecoregions occur in southern Ohio, yet the species distribution of simuliids did not vary by ecoregion. The large number of county records and five new state records supports the idea that the distribution of black fly species in Ohio was poorly understood prior to this study.

Merbt, **S**., Centre d'Estudis Avançats (CSIC), Blanes, Spain, steffimerbt@googlemail.com
Auguet, J. C., Centre d'Estudis Avançats (CSIC), Blanes, Spain, jcauguet@ceab.csic.es
Casamayor, E. O., Centre d'Estudis Avançats (CSIC), Blanes, Spain, casamayor@ceab.csic.es
Martí, E., Centre d'Estudis Avançats (CSIC), Blanes, Spain, eugenia@ceab.csic.es

INFLUENCE OF A WASTE WATER TREATMENT PLANT ON THE RECOVERY PATTERN OF STREAM BIOFILMS AND THE SPATIAL SEGREGATION BETWEEN BACTERIAL AND ARCHAEAL NITRIFIERS

Streams receiving high loads of nitrogen (basically ammonium) from wastewater treatment plants (WWTP) are shown to be hot spots for nitrification. We examined the effects of these inputs on the recovery of stream biofilms along eight-weeks after a dramatic flood. We measured biofilm biomass, chlorophyll-a, nitrogen content, and community composition of ammonium-oxidizers. These parameters were compared between light- and dark-exposed biofilms at upstream and downstream sites of WWTP inputs, respectively. The results showed an increasing impact of the WWTP input on ammonium concentration and its N isotopic signature as flood receded. Biomass and chlorophyll-a recovery was fast (<2 weeks) and no clearly affected by WWTP inputs, but significantly distinct between light- and dark-exposed communities. Biofilm ^{15}N signature downstream of WWTP increased over time tracking the increase in ^{15}N-ammonium. Biofilm ammonium-oxidizers were composed of both bacteria and archaea. These two phyla were segregated in space and their relative dominance changed over time depending on ammonium availability and the development of photoautotrophic organisms. These shifts may influence whole-reach nitrification rates and, thus, the dominant form and amount of nitrogen exported downstream.

Merkley, **S**. **M**., Brigham Young University, Provo, UT, USA, stevemerkley@byu.edu
Rader, R. B., Brigham Young University, Provo, UT, USA, russell_rader@byu.edu

THE EFFECT OF INVASIVE SPECIES ON ECOSYSTEM FUNCTION UNDER ALTERNATIVE COMMUNITY STATES

Western mosquitofish (*Gambusia affinis*) can be harmful to native fish species because they have physiological, ecological, and behavioral traits that allow them to rapidly reproduce in a wide range of habitats. Previous research has shown how multiple negative interactions can lead to a decline in least chub (*Iotichythys plegethontis*), a native cyprinid in the desert springs of western Utah (Mills et al., 2004, Oecologia 141- 713- 721). Predation on juvenile least chub and competition for space and resources have led to the decline of least chub and the proliferation of mosquitofish in desert springs. We are interested in understanding what impact *G. affinis* may have on the overall functioning of this spring ecosystem. We will test the hypothesis that mosquitofish will interrupt the flow of energy from lower (emergent aquatic insects and primary production) to higher trophic levels, and cause a reduction in food available for numerous species that depend on emerging insects. Specifically, we expect treatments with invasive mosquitofish to have a direct negative effect on insect emergence and an indirect positive effect on primary production by reducing grazer abundances.

Merten, **E**. **C**., University of Wisconsin , Eau Claire, USA, mertenec@uwec.edu
Hintz, W. D., Southern Illinois University, Carbondale, USA,
Lightbody, A. F., St. Anthony Falls Laboratory, Minneapolis, USA,
Wellnitz, T. A., University of Wisconsin, Eau Claire, USA,

MACROINVERTEBRATE GRAZERS, VELOCITY, AND BEDLOAD TRANSPORT RATE INFLUENCE PERIPHYTIC ACCRUAL IN A FIELD-SCALE EXPERIMENTAL STREAM

We examined influences on periphytic accrual in the St. Anthony Falls Laboratory Outdoor StreamLab in Minneapolis, Minnesota, USA. Macroinvertebrate grazers were excluded from 27 of 65 clay tiles using electric pulses. We examined periphytic biomass accrual as a function of grazer presence, sampling run, and near-bed current velocity using ANCOVA. We found significant ($P < 0.01$) temporal differences between sampling runs but no significant effect of grazer presence. Along with a strong association between bedload transport rates and mean periphytic biomass (r2 = 0.98), our results suggest that grazers are relatively unimportant in stream systems with high levels of physical disturbance from floods and associated sand bedload. However, the interaction between grazer presence and velocity was marginally significant ($P = 0.08$). Regression analyses showed no relation between velocity and periphyton in the absence of grazers but a negative relation (r2 = 0.63) when grazers were present, suggesting that mechanical dislodgement of periphyton by grazers may increase with velocity. We conclude that grazers can have subtle effects on periphyton, particularly in streams with high bedload transport rates.

Miller, **M**. **P**., United States Geological Survey, Utah Water Science Center, Moab, USA, mamiller@usgs.gov
Brasher, A. M., United States Geological Survey, Utah Water Science Center, Moab, USA, abrasher@usgs.gov
Albano, C. M., United States Geological Survey, Utah Water Science Center, Moab, USA,

DIFFERENCES IN MACROINVERTEBRATE COMMUNITY STRUCTURE ALONG A GRADIENT OF HABITAT CONDITIONS IN STREAMS AND RIVERS IN THE SEMI-ARID COLORADO PLATEAU

Aquatic macroinvertebrates are sensitive to changes in their chemical and physical environment, and as such, serve as excellent indicators of overall ecosystem health. Moreover, temporal and spatial differences in macroinvertebrate community structure can be used to investigate broad issues in aquatic science, such as the

hypothesis that changes in climate are likely to have disproportionately large effects on small, intermittent stream ecosystems. We quantified macroinvertebrate community structure and abiotic conditions at nine sites in the Colorado Plateau, along a habitat gradient ranging from small, intermittent desert streams to large river ecosystems. Considerable differences were observed in community structure between sites with differing habitat characteristics. Quantitative results of non-metric multidimensional scaling (NMDS) ordination indicate that abiotic factors such as stream velocity, percent riffles, stream size and riparian shading, significantly influenced macroinvertebrate community structure. These results add to a growing base of knowledge regarding the functioning of lotic ecosystems in the Colorado Plateau, and provide timely information on anticipated changes in the structure and function of aquatic ecosystems in response to predicted future climate conditions.

Miller, **S**. **W**., Utah State University, Logan, USA, scott.miller@usu.edu
Al-Chochachy, R., US Forest Service, Logan, USA, ralchokhachy@fs.fed.us
Roper, B. B., US Forest Service, Logan, USA, broper@fs.fed.us
Hawkins, C. P., Utah State University, Logan, USA, chuck.hawkins@usu.edu
Archer, E., US Forest Service, Logan, USA, earcher@fs.fed.us

ENVIRONMENTAL DRIVERS OF MACROINVERTEBRATE STABILITY AND PERSISTENCE WITHIN THE INTERIOR COLUMBIA RIVER BASIN, USA

Lotic macroinvertebrates inhabit temporally variable environments; however, studies of assemblage dynamics disproportionately focus on short-time scales. Understanding temporal dynamics of macroinvertebrate assemblages is critical to status and trend monitoring, which assumes the long-term stability and persistence of reference assemblages and our ability to discriminate anthropogenic from natural temporal variability. We quantified 8 years of macroinvertebrate inter-annual variability for 19 reference and 29 managed sites within the Interior Columbia Basin, USA and related assemblage dynamics to environmental variability and watershed attributes. Macroinvertebrate stability and persistence were relatively high for reference sites; time lag regression slope coefficients did not significantly differ from zero. Furthermore, O/E scores were relatively consistent through time (CV = 15%). In contrast, macroinvertebrate stability and persistence decreased as O/E scores deviated from one (R^2 = 43 and 46%, respectively). The reduced stability and persistence of potentially impaired sites was most strongly related to inter-annual water temperature fluctuations and reach slope. Despite inter-annual changes in environmental variables, macroinvertebrate stability, persistence, and biological condition were relatively stable for reference sites, while impaired sites were less resistant to environmental fluctuations.

Miller, **S**. **A**., Michigan State University, East Lansing, USA, mill1571@msu.edu
Benbow, M. E., University of Dayton, Dayton, , benbowme@notes.udayton.edu
Williamson, H., University of Tennessee, Knoxville, USA, hwillia8@utk.edu
McIntosh, M., Michigan State University, East Lansing, , mcinto57@msu.edu
Kimbirauskas, R., Michigan State University, East Lansing, USA, kimbira1@msu.edu
Stevenson, R. J., Michigan State University, East Lansing, USA, rjstev@msu.edu
Quaye, C., Noguchi Memorial Institute of Medical Research, Legon, Ghana,
Boakye, D., Boakye, Noguchi Memorial Institute of Medical Research, Ghana,
Small, P., University of Tennessee, Knoxville, USA,
Merritt, R., Michigan State University, East Lansing, USA,

USING DIATOMS TO CHARACTERIZE MACROPHYTE BIOFILMS ASSOCIATED WITH *MYCOBACTERIUM ULCERANS*

Mycobacterium ulcerans is the etiological agent of Buruli ulcer, a devastating skin and bone disease. Observations of *M. ulcerans* on macrophyte surfaces suggest biofilms may be a key niche, but specific habitat requirements of *M. ulcerans* in biofilms are unknown. We hypothesized that diatoms could be used to characterize the microhabitat of biofilms suitable for *M. ulcerans* colonization. We collected biofilms from 150 macrophytes in Ghana, Africa and used PCR-based methods to assess the presence of *M. ulcerans*. Diatom species in each biofilm were identified, and habitat preferences of each species used to characterize microhabitat conditions. In lotic habitats, classification tree analysis using diatom-indicated conditions showed that *M. ulcerans* was more likely to occur in low salinity biofilms, or in mildly saline biofilms with relatively higher pH. In lentic habitats, *M. ulcerans* was more likely to be present in high sediment biofilms, or in lower sediment biofilms in eutrophic conditions. Our data indicate that the presence of *M. ulcerans* in macrophyte biofilms may be driven by environmental factors, but that relationships are complex and differ between lotic and lentic habitats.

Miller-DeBoer, **C**. **J**., University of Oklahoma, Norman, USA, cmiller4462@ou.edu
Vaughn, C. C., University of Oklahoma, Norman, USA, cvaughn@ou.edu

PILOT STUDY: A COMPARISON OF FRESHWATER MUSSEL IMPACTS ON PLANKTON AND WATER QUALITY IN TWO OKLAHOMA RIVERS

Diminished water quality raises the cost of surface water treatment for municipal use and millions of dollars can be saved annually by improving water quality prior to treatment. Changes in flow regimes and nutrient delivery often result in eutrophication and biodiversity loss within a watershed. Freshwater mussels are natural filter feeders and thus potential biofiltration systems to reduce organic loads within a stream. In this pilot study, we compare freshwater mussel effects on zooplankton and algal abundance and community composition, bacteria abundance, and nutrient concentrations between two southeastern Oklahoma rivers. The Kiamichi River is a nutrient-limited, low-productivity river, while the Little River has high productivity and increased nutrient loads. Preliminary data suggests that top-down mussel effects are stronger on the algal community in the high productivity system. Plankton community composition also appears to shift as water flows over the mussel bed, perhaps maintaining plankton species richness within the river. As freshwater mussels are globally declining organisms, with several threatened and endangered species, mussel bed restoration and conservation may be a solution to improving surface water quality and protecting aquatic biodiversity.

Mills, **C**. **E**., Australian Rivers Institute, Griffith University, Brisbane, Australia, courtenay.mills@griffith.edu.au
Hadwen, W. L., Australian Rivers Institute, Griffith University, Brisbane, Australia, w.hadwen@griffith.edu.au
Schmidt, D., Australian Rivers Institute, Griffith University, Brisbane, Australia, d.schmidt@griffith.edu.au
Hughes, J. M., Australian Rivers Institute, Griffith University, Brisbane, Australia, jane.hughes@griffith.edu.au

THE RAINBOW CONNECTION: AN INTEGRATIVE APPROACH TO IDENTIFYING MELANOTAENIID (*MELANOTAENIA SPLENDIDA INORNATA*) DISPERSAL IN RESPONSE TO FLOODING

While genetic markers or stable isotope signatures are frequently applied to resolve patterns of dispersal, very rarely are these methods used in conjunction as a way of determining migration events in different time scales. As genetic markers can investigate gene flow in ancestral populations, stable isotope analyses can complement dispersal studies by revealing very recent patterns of migration. A combination of microsatellite loci and stable isotope analyses (using C and N) were used to investigate the effects of Wet Season flooding on dispersal of the Chequered Rainbowfish (*Melanotaenia splendida inornata*) in tropical Queensland (Australia). Samples were collected from the Mitchell River headwaters to capture the 2009/2010 Wet Season. Populations were identified using genetic and stable isotope analyses, with immigrants being outlying individuals of defined populations. By comparing and contrasting these two measurements of dispersal, an integrated and holistic approach to identifying important dispersal corridors may be gained.

Milner, **A**. **M**., University of Birmingham, Birmingham, United Kingdom, a.m.milner@bham.ac.uk
Robertson, A. E., University of Roehampton, London, United Kingdom, A.Robertson@roehampton.ac.uk
Brown, L. E., University of Leeds, Leeds, United Kingdom, L.E. Brown@leeds.ac.uk

LONG-TERM DYNAMICS OF MACROINVERTEBRATE BIOLOGICAL TRAITS WITH CLIMATE CHANGE.

Rapid glacial retreat in southeast Alaska has created watersheds of different ages. Here we quantify changes in biological traits across 13 streams aged from 45 to 200 years, and examine inter-annual dynamics from a 28-year study of Wolf Point Creek (WPC)to infer climate change effects on traits. Across the stream chronosequence, enhanced macroinvertebrate mobility was evident with stream age, with clear increases in female dispersal ability, occurrence in the drift, swimming ability, maximum crawling rates and streamlining of body shape. In WPC, the number of biological traits represented within the macroinvertebrate community and Simpson's Index of trait diversity increased over time. Significant increases in female dispersal abilities, adult flying strength and maximum crawling rates occurred. The relative abundance of collector-gatherer feeding habit decreased linearly as glacierization reduced. Disturbance

associated with redd digging by salmon enhanced the persistence of fugitive species with smaller body size and more rapid life histories. These insights are used to develop a conceptual model of environmental filters operating at different stream ages (50, 100, 150 and 200 years) to determine the composition of the macroinvertebrate community and their associated dominant traits.

Mims, **M. C.**, University of Washington, Seattle, USA, mmims@uw.edu
Olden, J. D., University of Washington, Seattle, USA, olden@uw.edu

FISH LIFE HISTORY STRATEGIES DETERMINE ASSEMBLAGE RESPONSES TO ALTERED FLOW REGIMES

The magnitude, timing, and variability of flows are some of the most influential physical characteristics of freshwater ecosystems, yet our understanding of how flows shape freshwater fish diversity remains limited. Using pre-existing hydrologic gauge data, impoundment data, and fish occurrence data from surveys throughout the United States, we examined the relationships between flow regimes and life history strategies of freshwater fishes throughout the United States by 1) determining whether predictable relationships exist between natural (i.e. unaltered) flow regimes and life history strategies of freshwater fishes, and 2) examining whether altered flow regimes (via impoundments) impact strategy composition of freshwater fish assemblages downstream of dams. Our results show that altered flow regimes affect life history trait composition of freshwater fish communities, with the direction of these changes being largely in agreement with predictions from life history theory. This study contributes to the understanding of how fish species and biodiversity respond to anthropogenic changes in the hydrologic regime and has implications for flow regulation and restoration via managed flow releases from dams.

Mineau, **M. M.**, Idaho State University, Stream Ecology Center, Department of Biological Sciences, Pocatello, ID, USA, minemade@isu.edu
Baxter, C. V., Idaho State University, Stream Ecology Center, Department of Biological Sciences, Pocatello, ID, USA, baxtcold@isu.edu
Marcarelli, A. M., Michigan Technological University, Department of Biological Sciences, Houghton, MI, USA, ammarcar@mtu.edu
Minshall, G. W., Idaho State University, Stream Ecology Center, Department of Biological Sciences, Pocatello, ID, USA, minswayn@isu.edu

RETENTIVE OR LEAKY: HOW DO STREAM ECOSYSTEMS RESPOND TO CARBON AND NITROGEN SUBSIDIES FROM NON-NATIVE RUSSIAN OLIVE (*ELAEAGNUS ANGUSTIFOLIA*)?

Russian olive (RO) is an invasive riparian tree widespread throughout the western USA. RO fixes nitrogen and consequently provides subsidies of nitrogen-rich litter and groundwater to streams. RO also contributes a subsidy of carbon via litter fall. We evaluated nutrient limitation of biofilms and measured nitrate and ammonium uptake in upstream-reference and downstream-invaded reaches of 6 streams in Idaho and Wyoming. Magnitude of chlorophyll-*a* increase on nitrogen addition treatments was lower in invaded compared to reference reaches. Nitrate and ammonium uptake velocities were significantly faster in invaded compared to reference reaches (paired t-test P= 0.05 and 0.03 respectively). In one stream, we constructed carbon budgets for an invaded and a reference reach and compared these to pre-invasion data. At the invaded reach, we observed a 30-fold increase in leaf-litter inputs, but little change in community respiration. We found RO doubled in-stream carbon storage as benthic organic matter and increased particulate terrestrial carbon export from 0.15 to 7.91 g/day. These findings indicate that the nitrogen subsidy from RO is processed in streams biologically while carbon inputs are primarily stored and exported.

Miner, **B. E.**, University of Washington, Seattle, WA, USA, miner@u.washington.edu
Kerr, B. B., University of Washington, Seattle, WA, USA, kerrb@u.washington.edu

ADAPTATION TO ULTRAVIOLET RADIATION CONDITIONS OVER SMALL SPATIAL SCALES

Many zooplankton taxa have been shown to have high dispersal capacity over regional scales yet typically exhibit minimal levels of gene flow among neighboring habitats, a seeming contradiction termed the "dispersal-gene flow paradox." Here we present a study of adaptation to ultraviolet radiation (UVR) threats in multiple neighboring subpopulations of the zooplankter *Daphnia melanica* inhabiting an array of shallow subalpine ponds in a single subwatershed within the Olympic Mountains of the Pacific Northwest. These ponds vary widely in the concentration of dissolved organic carbon and subsequent transparency to UVR. We ask whether the UVR tolerance of organisms from different subpopulations reflects the UVR threat in their native habitat and investigate the process of such adaptation by evaluating the roles of population differentiation and local adaptation in establishing natural patterns of phenotypic divergence. Although we find clear evidence of adaptation to UVR exposure, the lack of a demonstrated fitness cost for this phenotype in the absence of UVR suggest that local adaptation may not be necessary to resolve the dispersal-gene flow paradox.

Mines, **C. H.**, The University of Western Australia, Perth, Australia, mines@sese.uwa.edu.au
Ghadouani, A., The University of Western Australia, Perth, Australia, anas.ghadouani@uwa.edu.au
Yan, N. D., York University, Toronto, Canada, nyan@yorku.ca
Legendre, P., Université de Montréal, Montréal, Canada, Pierre.Legendre@umontreal.ca
Ivey, G. N., The University of Western Australia, Perth, Australia, greg.ivey@uwa.edu.au

CATASTROPHIC SHIFTS IN ZOOPLANKTON COMMUNITY STRUCTURE FOLLOWING THE INTRODUCTION OF BYTHOTREPHES: EVIDENCE FROM TWENTY YEARS OF ZOOPLANKTON DATA

Twenty years of zooplankton samples collected from Harp Lake (Muskoka, Ontario) have recently been analysed using a Laser Optical Plankton Counter (LOPC). This new technology is a fast and efficient means by which to collect the size and shape of large numbers of individuals with high temporal and spatial resolution, with the largest sample of almost 60 000 individuals taking approximately two minutes to process. The resulting LOPC dataset was used to provide insight into how the zooplankton community responded to the introduction of the invasive planktivore Bythotrephes longimanus in 1993. As predicted, statistical analysis revealed a marked shift in the community size structure following invasion, which was in turn followed by a period of instability before the ecosystem reached a new state. This method may be extended to investigate the effects of multiple stressors acting simultaneously and may also provide insight into detectable community characteristics in the lead up to a catastrophic shift.

Mitchell, **M. E.**, Loyola University Chicago, Chicago, USA, mmitchell4@luc.edu
Geddes, P., Northeastern Illinois University, Chicago, USA, pamelageddes@gmail.com
Larkin, D., Chicago Botanic Garden, Glencoe, USA, dlarkin@chicagobotanic.org
Lishawa, S., Loyola University Chicago, Chicago, USA, slishawa@luc.edu
Treering, D., Loyola University Chicago, Chicago, USA, dgoldb2@luc.edu
Olszewski, M., Loyola University Chicago, Chicago, USA, molszew@gmail.com
Tuchman, N. C., Loyola University Chicago, Chicago, USA, ntuchma@luc.edu

CONSTRUCTING A TIMELINE OF TYPHA X GLAUCA INVASION: ECOLOGICAL IMPACTS AFTER MORE THAN FIFTY YEARS OF INVASION IN GREAT LAKES COASTAL WETLANDS

The invasive hybrid cattail, Typha x glauca, has established in wetlands across the Great Lakes Region decreasing native plant diversity and altering soil and microsite characteristics. We utilized 50 years of historical aerial photographs from the Illinois Beach State Park wetland complex to map the spread and determine the age of T. x glauca stands. Floristic, edaphic, and environmental data were collected from plots across an invasion age gradient. Compared with reference uninvaded sites, litter mass was more than 2 times greater ($p<0.001$) within 11 years of invasion, plant diversity declined by more than 50% ($p<0.05$) within 25 years of invasion, and soil organic depth was more than 29 cm deeper ($p<0.05$) in areas invaded for more than 35 years compared with areas invaded for less than 11 years. These progressive changes in plant communities, soil, and environmental conditions through time will likely alter the fundamental structure of invaded wetlands, affecting a range of wetland ecosystem services. We believe this timeline of invasion can aid land managers in assessing the status of invaded parcels and in designing management strategies.

Miyake, **Y.**, Ehime University, Matsuyama, Japan, miyake@dpc.ehime-u.ac.jp
Sakai, T., Ehime University, Matsuyama, Japan, toru.sakai.06@cee.ehime-u.ac.jp
Nakano, H., Ehime University, Matsuyama, Japan, nakano.hiroshi.04@cee.ehime-u.ac.jp
Inoue, M., Ehime University, Matsuyama, Japan, inom@sci.ehime-u.ac.jp

RESPONSES OF MACROINVERTEBRATES TO FLOOD AND DRYING DISTURBANCES: A TEST OF THE HYPORHEIC REFUGE HYPOTHESIS IN A JAPANESE INTERMITTENT RIVER

The hyporheic zone is thought to provide an important refuge for stream invertebrates from flood and drying disturbances (hyporheic refuge hypothesis). We compared surface and hyporheic macroinvertebrates in pools found in perennial and intermittent reaches during flood, dry, and normal flow conditions. We anticipated that surface invertebrates would move to a hyporheic zone during flood and dry conditions. Benthos and hyporheos samples were taken from four and two pools within intermittent and perennial reaches, respectively, in the Shigenobu River, Japan. Sampling was conducted on five dates over 6 weeks, which included two drying and two flooding events. The community structure of hyporheos was in general different from that of benthos, but became similar in pools within intermittent reaches under drying conditions (non-metric multidimensional scaling based on relative abundance). The density of *Neonectes natrix* adult (Dytiscidae, Coleoptera) and Tanipodinae (Chironomidae, Diptera) increased in hyporheic zones in pools within intermittent reaches under drying conditions (generalized linear models. We postulated that hyporheic zones serve as refuges for some macroinvertebrate taxa under drying conditions and thus contribute to maintaining surface invertebrate assemblages.

Miyazono, **S**., Texas Tech University, Lubbock, USA, seiji.miyazono@ttu.edu
Taylor, C. M., Texas Tech University, Lubbock, USA,

CONSERVATION OF DESERT STREAM FISH ASSEMBLAGES IN THE TRANS-PECOS REGION OF TEXAS

The Rio Grande and its tributaries in the Trans-Pecos region of Texas have been impacted by a variety of anthropogenic activities such as dewatering, reduced water quality, impoundment, channelization, and the introduction of non-native species. These environmental manipulations have negatively affected the native fishes leading to extirpations and population declines throughout the region. It is imperative to gain an understanding of the factors that determine the persistence and maintenance of these fish assemblages, in the Rio Grande and its spring-fed, tributary habitats. We hypothesize that the persistence and maintenance of fish assemblages in these spring-fed habitats can be modeled by three primary processes: 1) adequate fish dispersal through the river corridor, 2) local environmental conditions that are maintained by spring flow, and 3) the presence/abundance of introduced species such as the plains killifish, Fundulus zebrinus. To understand these local and regional processes, we will determine seasonal and yearly patterns of abundance, distribution, and habitat use for fish assemblages from Alamito, Terlingua and Tornillo Creeks, as well as the Rio Grande proper. Preliminary data and analyses will be presented in light of this hypothetical framework.

Mock, **K**. **E**., Utah State University, Logan, USA, karen.mock@usu.edu
Brim Box, J. C., Freshwater Mussel Project, Confederated Tribes of the Umatilla Indian Reservation, Pendleton, USA, brimbox@gmail.com
Chong, J. P., Utah State University, Logan, USA, jer.chong@aggiemail.usu.edu
Howard, J. K., The Nature Conservancy, San Francisco, USA, jeanette_howard@TNC.ORG
Nez, D., Mussel Project, Confederated Tribes of the Umatilla Indian Reservation, Pendleton, USA,
Furnish, J., USDA Forest Service, PSW Region, Vallejo, USA, jfurnish01@fs.fed.us

PHYLOGEOGRAPHIC TALES OF NATIVE FRESHWATER MUSSELS IN WESTERN NORTH AMERICAN LANDSCAPES

Only three genera of native freshwater mussels are recognized in the western US and Canada. We compare phylogeographic structure in two of these genera, *Anodonta* and *Margaritifera* , using both nuclear and mitochondrial markers. In *Anodonta* we found deep phylogenetic subdivision among groups of species, and a strong genetic signal of affiliation with major hydrologeologic basins (Bonneville, Lahontan, Columbian). *Anodonta* population subdivision was generally pronounced, even among proximal populations in the same river systems, and population-level genetic diversity was relatively high. *Margaritifera* populations showed strikingly different patterns, although they occupy many of the same drainages and are sometimes sympatric with *Anodonta*. We detected no ancient or basin-specific subdivisions among *Margaritifera* populations. These populations were very distinct with respect to microsatellite allele frequencies, however, and had very low genetic diversity, often with high numbers of identical multilocus genotypes. We attribute these differences between *Anodonta* and *Margaritifera* to differences in host fish dispersal and life history. Our findings demonstrate that organisms in a common landscape, with apparently similar ecological roles, morphologies, and habitats, can have remarkably different phylogeographic signatures.

Moerke, **A**. **H**., Lake Superior State University, Sault Sainte Marie, USA, amoerke@lssu.edu
Kosiara, J., Lake Superior State University, Sault Sainte Marie, USA, jkosiara@lssu.edu
Gay, R., Lake Superior State University, Sault Sainte Marie, USA, rgay@lssu.edu
Kratschmer, E. M., University of Notre Dame, Notre Dame, USA, ekratsch@nd.edu
Janetski, D. J., University of Notre Dame, Notre Dame, USA, djanetsk@nd.edu
Chaloner, D. T., University of Notre Dame, Notre Dame, USA, dchalone@nd.edu
Lamberti, G. A., University of Notre Dame, Notre Dame, USA, glambert@nd.edu

DISTURBANCE EFFECTS OF INTRODUCED PACIFIC SALMON ON BIOFILM AND MACROINVERTEBRATES IN GREAT LAKES TRIBUTARIES

We evaluated benthic disturbance by Pacific salmon (*Oncorhynchus* spp.) on biofilm and macroinvertebrates in Great Lakes tributaries, where stream biota are thought to be evolutionarily "naïve" to non-native salmon. Changes in biofilm before and after a spawning run were assessed by sampling tiles in exclosure and open plots installed above and below a barrier to salmon migration. Macroinvertebrate density and drift were measured above and below a barrier in three streams. During the spawning run, chlorophyll a decreased in open plots compared to exclosure plots in the salmon reach. Macroinvertebrate densities also decreased during and after the spawning runs in the salmon reach. Macroinvertebrate drift was low in all streams and increased throughout the sampling period, but this did not coincide with salmon spawner mediated disturbance. Our results suggest that salmon disturbance depressed biofilm and macroinvertebrate densities, but did not increase macroinvertebrate drift. However, it is unclear how changes in activity of drift-feeding fishes during spawning runs may influence these findings. Understanding the influence of introduced salmon will help predict outcomes of salmon introductions and barrier removals in streams.

Monaghan, **K**. **A**., University of Aveiro, Aveiro, Portugal, kamonaghan@ua.pt
Machado, L., University of Aveiro, Aveiro, Portugal, luisamachado@ua.pt
Soares, A., University of Aveiro, Aveiro, Portugal,

THE EFFECTS OF WILDFIRE ON FISH COMMUNITIES IN UPLAND MEDITERRANEAN STREAMS: EVIDENCE FROM A PORTUGUESE CHRONOSEQUENCE SURVEY (1990-2007)

The increasing frequency of wildfire in Portugal poses a risk to lotic biodiversity. In 2008 we conducted quantitative electrofishing surveys in upland streams impacted by a single, extensive (ca. 100% catchment) fire event at various times since 1990. Fish were caught at 6 of the 15 streams surveyed. Where present, S. trutta were scarce while S. carolitertii, S. alburnoides and A. oligolepis were more abundant. Comparison with reference sites (surveyed in 2004) emphasized the high frequency of fish absences and otherwise low trout densities at wildfire impacted sites. The 2004 database permitted before – after impact assessment for two sites. At one previously supporting trout, impacted in 2006, no fish were captured. At a second, impacted in 2005, densities and biomass of S. carolitertii, A. oligolepis were comparable to their 2004 values. These data indicate the potentially devastating impact of wildfire to upland fish communities, suggesting Iberian endemic species are more resistant than trout. Widespread management intervention (channelization and damming) in these remote upland streams may exacerbate the effects of wildfire by limiting resistance and resilience of fish assemblages.

Montagna, **P**. **A**., Texas A&M Univ.-Corpus Christi, Corpus Christi, USA, paul.montagna@tamucc.edu
Kim, H. C., Texas A&M Univ.-Corpus Christi, Corpus Christi, USA, TAMUCC-Harte Research Institute

EFFECT OF FRESHWATER INFLOW ON BENTHIC SECONDARY PRODUCTION IN TEXAS LAGOONS

Freshwater inflow maintains estuarine productivity because it is a conduit for loading nutrients and organic matter from the watershed to the coast. The objective of the current study was to implement an ecological model to predict system-wide secondary production for two trophic groups (deposit

and suspension feeders) of benthic organisms in response to freshwater inflow variability in four Texas estuaries. The estuaries lie in a climatic gradient where inflow decreases and salinity increases, and there is a pattern of wet and dry years. The combination of the climatic gradient and temporal variability can be used to identify the effects of inflow on estuarine productivity. The bioenergetic model was calibrated using an 11-year dataset (1988-1999) and validated with a 20-year data from (1988-2008). Within estuaries, increased salinity and decreased inflow benefited deposit feeders, while suspension feeders were harmed. The benthic community of secondary bays near the river source is harmed by reduced inflow, while the community in primary bays near the ocean appears to benefit in biomass increase by reduced inflow. This effect is probably due to the benthic community acclimating to the different salinity regimes, or more (or less) salt tolerant species populating the area. The results demonstrate that freshwater inflow is important in maintaining secondary productivity in estuaries.

Moody, **E**. **K**., University of Wisconsin-Madison, Madison, WI, USA, eric.k.moody@gmail.com

Weidel, B. C., U.S. Geological Survey, Oswego, NY, USA, bweidel@gmail.com

Kitchell, J. F., University of Wisconsin-Madison, Madison, WI, USA, kitchell@wisc.edu

SEA LAMPREY IN FLUX: CLIMATE INFLUENCES HOST SELECTION IN THE WORLD'S LARGEST AND FASTEST WARMING LAKE

Lake Superior is among the fastest warming lakes in the world over the past 30 years. We examined how this warming has influenced interactions between the lake's apex predator, sea lamprey, and the recreationally and commercially important salmonids that serve as lamprey hosts. Hosts include lean lake trout (*Salvelinus namaycush namaycush*), siscowet lake trout (*S. namaycush siscowet*) and stocked Pacific salmon (*Oncorhynchus spp.*). Each of these hosts has a different preferred thermal niche (range 4-13°C) and warming has increased the duration that preferred temperatures exist. Pelagic water temperatures from 1980 to 2006 characterized how host thermal habitat has changed and bioenergetic models estimated subsequent lamprey growth changes. Days of preferred thermal habitat for lean lake trout and salmon have increased 40% and 30%, respectively and are projected to continue increasing. Bioenergetics estimates fit to Lake Superior lamprey growth data were compatible with lean lake trout and Pacific salmon as host species, but siscowets as hosts required at least two years of parasitism. Ecosystems with the fastest rates of warming provide case studies to determine how climate influences predator-prey interactions.

Moore, **B**. **T**., California State University, Fresno, Fresno, USA, bmoore29@csufresno.edu

Blumenshine, S. C., California State University, Fresno, Fresno, USA, sblumens@csufresno.edu

DEVELOPMENT INFLUENCES FINE PARTICULATE MATTER COMPOSITION AND MACROINVERTEBRATE ASSEMBLAGES IN A SIERRA FOOTHILL WATERSHED

Urbanization and development alter macroinvertebrate assemblages, but little is known about the ecological mechanisms causing these changes. We investigate fine sediment composition as a possible mechanism influencing macroinvertebrate distribution in a partially developed watershed. Fine sediment composition was characterized by the total amount (mg/cm^2), size distribution (1.5-250 microns), and organic matter content of particles in the substrate matrix. Macroinvertebrate assemblages differed among seven sites spaced throughout 169 stream kilometers representing 420 km^2 of drainage area. Percent impervious area drained also varied among sites (0.5-3.8%). Discharge was responsible for most of the variation in particle size distribution, whereas the amount of fine inorganic particles was more related to characteristics of the drainage area. Six substrate parameters: Dmean, Pareto c, specific surface area, dry weight, % FPOM, and pebble count were used to construct fine sediment specific tolerance values for 21 common macroinvertebrate genera, identifying taxa that may be sensitive to fine sediment accumulation. Results demonstrate links between fine sediment composition and macroinvertebrate assemblages, and suggest a possible mechanism for how development may change measures of ecological integrity for a watershed.

Moore, **J**. **W**., University of California Santa Cruz, Santa Cruz, USA, jwmoore@biology.ucsc.edu

Twardochleb, L. A., University of California Santa Cruz, Santa Cruz, USA, lauratwardochleb@yahoo.com

Carlson, S. M., University of California Berkeley, Santa Cruz, USA, smcarlson@berkeley.edu

Fox, J., University of California Santa Cruz, Santa Cruz, USA, jfox1@ucsc.edu

Hwan, J., University of California Berkeley, Berkeley, USA, jhwan@nature.berkeley.edu

Hayes, S., NOAA, Santa Cruz, USA, sean.hayes@noaa.gov

TROPHIC CASCADES, DETRITAL DYNAMICS, AND INVASIVE CRAYFISH

Community change is driven by processes of loss (i.e., extinction) as well as gain (i.e., invasion). Here we examined the direct and indirect impacts of an invasive omnivore, Signal Crayfish, on stream communities and ecosystems. We compare the results obtained from a large-scale density manipulation with a comparative approach. We found that crayfish cause a trophic cascade, driving a threefold decrease in benthic invertebrate densities and the same magnitude increase in algal accrual rates. Crayfish also had strong direct impacts on leaf detritus dynamics, explaining over 70 percent of the variation in leaf litter breakdown rate. However, it appears that over time this strong negative direct effect is negated by an opposing indirect effect caused by crayfish predation on shredding benthic invertebrates, especially large caddisflies. Thus, in order for accurate predictions, manipulative experiments need to be paired with observational studies or be long-term enough for the manifestation of indirect effects. Understanding the ecosystem consequences of community change will necessitate integrating the direct and indirect impacts of species.

Moore, **J**. **N**., Brigham Young University, Provo, USA, jeffreynickmoore@gmail.com

Rader, R. B., Brigham Young University, Provo, USA, russell_rader@byu.edu

Unmack, P., Brigham Young University, Provo, USA,

LARGE DIFFERENTIATION AT SMALL SCALES: THE POPULATION STRUCTURE OF THE FLATWORM POLYCELIS CORONATA

The objective of this study was to determine the amount of fine scale genetic differentiation among Polycelis coronata populations across multiple scales within three adjacent drainages of the Wasatch Mountains, Utah. Polycelis coronata is a freshwater flatworm with limited dispersal ability and strict cold water habitat requirements. We used a nested hierarchical multiscale sampling design to distinguish genetic differences in mtDNA sequences between populations within tributaries of the same third or fourth order basin, between tributaries in the same basin, and between adjacent basins. We detected multiple distinct local haplotype isolates, as well as one widely distributed haplotype. We are currently using a population genetics approach to explore the unusual distribution of both widespread and clustered isolate haplotypes within the three watershed drainages. We are considering two hypotheses: 1) Ecological speciation 2) ancestral polymorphism If the second hypothesis is correct, there are two possibilities: 1) Population size: if the population sizes are sufficiently large, the haplotypes may not have sorted out. 2) Gene flow: only the widespread haplotype is dispersing and exchanging genes. Final results are forthcoming.

Morales, **A**. **M**., Trent University, Peterborough, Canada, anamorales@trentu.ca

Frost, P. C., Trent University, Peterborough, Canada, paulfrost@trentu.ca

SPATIAL DISTRIBUTION AND OPTICAL CHARACTERISTICS OF DISSOLVED ORGANIC MATTER IN THE KAWARTHA LAKES OF SOUTHERN ONTARIO, CANADA

The Kawartha Lakes are a system of shallow, mesotrophic lakes on the boundary of the Precambrian Canadian Shield in southern Ontario. While hydrologically connected, each lake varies in upstream land use and watershed characteristics. We examined the spatial distribution and optical properties of dissolved organic matter (DOM) within and between the Kawartha Lakes. We surveyed 34 sites in 11 lakes in August 2009 and epsilon;&February 2010. DOM molar-absorptivity ($_{280}$), the humification index (HIX) and β:α ratios were calculated using fluorescence data to determine the allochthonous or autochthonous epsilon;&nature of the DOM pool at each site. $_{280}$ values ranged from 138 L mol C^{-1} cm^{-1} (Chemong Lake) to 413 L mol C^{-1} cm^{-1} (Balsam Lake), indicating greater humic acid content in the most upstream lakes. Similarly, HIX values and β:α ratios ranged between 5.42 (Chemong Lake) to 12.0 (Little Bald Lake), and 0.6-0.8, respectively. Our results indicate that the DOM pool varies among the Kawartha Lakes due to the influence of both terrestrially derived and internally derived sources of organic matter.

Morehouse, **R. L.**, Oklahoma St. University, Stillwater, USA, reid.morehouse@okstate.edu

Dzialowski, A. R., Oklahoma St. University, Stillwater, USA, andy.dzialowski@okstate.edu

Jeyasingh, P. D., Oklahoma St. University, Stillwater, USA, puni.jeyasingh@okstate.edu

STOICHIOMETRY IN A BENTHIC INVASIVE: EFFECTS OF FOOD QUALITY AND QUANTITY ON ZEBRA MUSSEL (DREISSENA POLYMORPHA) GROWTH AND CONDITION

Consequences of elemental imbalances have been well studied when nutrients are limiting relative to carbon (C). Less research, however, has focused on excessive nutrients to reveal potential toxic effects. The growth and condition of zebra mussels (ZM; somatic C:P ~ 600) in response to two algal qualities (C:P of 20 and 45) were studied at two algal quantities (1mg C L-1 and 4mg C L-1). ZM shell growth was not affected by algal C:P or quantity. However, dry tissue mass and Tissue Condition Index (TCI) were significantly lower at C:P = 20. Significantly more ammonia and soluble reactive phosphorus (SRP) were excreted at C:P = 20. There were no food quantity effects on growth, TCI, or excretion ay C:P = 20. Despite enhanced excretion of excessive nutrients, there were significant growth and condition penalties at C:P = 20, clearly indicating toxic effects of excess dietary P. The response of consumers to stoichiometric imbalances driven by not only limiting nutrients but also nutrient excess should be considered, especially under rapid cultural eutrophication.

Mori, **N.**, National Institute of Biology, Ljubljana, Slovenia, natasa.mori@nib.si

Smrekar, A., Anton Melik Geographical Institute, Ljubljana, Slovenia, asmrekar@zrc-sazu.si

Breg Valjavec, M., Anton Melik Geographical Institute, Ljubljana, Slovenia, mateja.breg@zrc-sazu.si

Brancelj, A., National Institute of Biology, Ljubljana, Slovenia, anton.brancelj@nib.si

THE RELATIONSHIP BETWEEN CATCHMENT SCALE CHARACTERISTICS AND HYPORHEIC INVERTEBRATE COMMUNITY

The land use and some other catchment scale impacts to hyporheic invertebrate communities were studied in four river catchments from central Slovenia (SE Europe). GIS tools were used to determine the land use and landscape characteristics such as the slope, geology, soil cover and human impacts within the four catchments. 12 sampling sites were selected along each of the four rivers. Physical and chemical characteristics of the hyporheic water were measured and hyporheic invertebrate community was sampled using Bou-Rouch method. The whole catchment and 100 m buffer zone influences on hyporheic invertebrate community were compared. The variation in hyporheic invertebrate community was analyzed at two spatial scales (variation between rivers and variation among sites) using hierarchical analysis of community variation. The variation explained at the whole rivers level was much lower (5.9%) than variation between sampling sites (27.6%) and within sampling site (66.5%), but still significant (p=0.002). The main catchment scale parameter determining the hyporheic invertebrate community revealed to be geology and type of soil.

Morley, **S. A.**, Northwest Fisheries Science Center, Seattle, USA, sarah.morley@noaa.gov

Leavy, T., U.S. Fish and Wildlife Service, Lacey, USA, Tracy_Leavy@fws.gov

Roni, P., Northwest Fisheries Science Center, Seattle, USA, phil.roni@noaa.gov

Peters, R., U.S. Fish and Wildlife Service, Lacey, USA, Roger_Peters@fws.gov

Bakke, P., U.S. Fish and Wildlife Service, Lacey, USA, Paul_Bakke@fws.gov

Koehler, M., Seattle Public Utilities, Seattle, USA, Michele.Koehler@Seattle.Gov

Hanson, K., Northwest Fisheries Science Center, Seattle, USA, karrie.hanson@noaa.gov

URBAN STREAM RESTORATION OPPORTUNITIES IN THE CITY OF SEATTLE: TESTING THE BIOLOGICAL EFFECTIVENESS OF NEW STORMWATER MANAGEMENT APPROACHES

Relatively little scientific research or monitoring has occurred in the Northwest United States or elsewhere on the biological effectiveness of restoration efforts in heavily urbanized watersheds. With the overarching goal of improving ecological health of its urban creeks, the City of Seattle is testing innovative approaches to stormwater management. We report pre-implementation data for two such projects designed to promote natural drainage and increase floodplain connectivity. Currently, the health of both urban streams is poor. Disturbance-tolerant, multivoltine taxa dominate benthic invertebrate samples; a high proportion of diatom species are tolerant to nutrient enrichment and metals; and zinc concentrations in soil, periphyton, and invertebrate tissues are typically at least double those of regional forested streams. Using PIT-tag technology and a combination of mobile and fixed antennas, we are also examining fish movement and growth. Based on preliminary results, on average only 10% of fish are present in study reaches following storm events. Given the considerable investment of restoration funds and the as yet untested potential of these new approaches to improve stream health, it is critical that post-project data be collected.

Morrongiello, **J.**, School of Biological Sciences, Monash University, Melbourne, Australia, john.morrongiello@sci.monash.edu.au

Bond, N., School of Biological Sciences, Monash University, Melborune, Australia, nick.bond@sci.monash.edu.au

Crook, D., Arthur Rylah Institute, Department of Sustainability and Environment, Melbourne, Australia, david.crook@dse.vic.gov.au

Wong, B., School of Biological Sciences, Monash University, Melbourne, Australia, bob.wong@sci.monash.edu.au

CHRONIC EXPOSURE TO A NATURAL TOXICANT AFFECTS BEHAVIOUR, GROWTH AND SURVIVAL IN A FRESHWATER FISH

Many streams in south-eastern Australia are currently experiencing significant flow declines due to prolonged drought. The loss of water from these systems influences the physiochemical environment and often increases stress on aquatic organisms. One such stressor exacerbated by declining flows is polyphenols, a natural leachate from *Eucalypus* leaves that is toxic at high concentrations. Eucalypts drop their leaves year round, with a slight peak in summer, which coupled with declining water levels can lead to elevated concentrations in remnant pools. We investigated the lethal and sub-lethal effects of polyphenols using Southern pygmy perch (*Nannoperca australis*) larvae, sourced from sites along a natural polyphenol gradient. Each population was exposed to concentrations mirroring those from the sampling sites in a cross design, allowing us to explore potential adaptations to chronic exposure. Larval survival was negatively affected by increasing polyphenol concentration and mortality rates varied amongst populations. Larvae exposed to high polyphenol concentrations also displayed slower growth indicating a significant ontogenetic effect. Predicted decreases in future stream flows will increase stress on aquatic organisms and could potentially alter population composition via natural selection.

Mosher , **J. J.**, Oak Ridge National Laboratory, Oak Ridge , USA, MosherJJ@ornl.gov

Mulholland, P. J., Oak Ridge National Laboratory, Oak Ridge, USA, MulhollandPJ@ornl.gov

Fortner, A. M., Oak Ridge National Laboratory, Oak Ridge, USA, FortnerAM@ornl.gov

Smith, B. T., Oak Ridge National Laboratory, Oak Ridge, USA, SmithBT@ornl.gov

GREENHOUSE GAS EMISSIONS FROM A TEMPERATE U.S. HYDROPOWER RESERVOIR

Recent studies have shown significant emissions of greenhouse gases (GHG) from some tropical hydropower reservoirs. However, there is little information on emissions from temperate reservoirs. We selected a reservoir in eastern Tennessee (Douglas Lake) known to have summer hypolimnetic hypoxia to assess GHG emissions (CO_2, CH_4, N_2O) via three pathways: reservoir surface, spillway/turbine passage, and downstream tailwaters. Spillway/turbine emissions are determined from changes in GHG concentrations between the intake and tailwaters. A floating chamber is used to determine emissions from the water surface at five main channel, five cove, four tailwater sites, and two free-flowing river sites serving as reference. Potential predictors (vertical profiles of water temperature, dissolved oxygen, pH, chlorophyll, sediment organic matter content, and nutrient and DOC concentrations) are also measured at each site. Data from the first two monthly sampling campaigns indicated that cove sites had a higher CH4 fluxes than the main channel and tailwaters. CO_2 fluxes were similar for all sites and there were no significant differences in CO_2 and CH_4 concentrations passing through the turbines. Monthly sampling is continuing to account for seasonal variations.

Mosley, **D. F.**, Pyramid Lake Paiute Tribe, Nixon, USA, dmosley@plpt.nsn.us

TRIBAL PERSPECTIVE ON CLIMATE CHANGE ON THE PYRAMID LAKE INDIAN RESERVATION, NEVADA

This presentation is a Tribal perspective on Climate Change within the Pyramid Lake Paiute Indian Reservation, located within the great basin, east of the Sierra Nevada mountain range of Northern Nevada. Pyramid Lake is home to two federally listed fish species, the Lahontan Cutthroat Trout (Oncorhynchus clarki), and Cui-ui (Cujus chasmistes), and other sensitive plant and wildlife species. The Pyramid Paiute Tribe has taken some mitigation measures to deal with effects of Climate Change.

Moss, **A**. **G**., Auburn University, Auburn, USA, mossant@auburn.edu
Donovan, E. W., Auburn University, Auburn, USA, donovew@auburn.edu
Dodson, M. B., Auburn University, Auburn, USA, dodsomb@auburn.edu

BACTERIAL ASSEMBLAGES OF THE LOBATE CTENOPHORE *MNEMIOPSIS*.

Mnemiopsis is a common Western Atlantic comb jelly notorious for its invasion of Eurasia, from the Ponto-Caspian in the 1980s and 1990s (Oceanography 18:76) to North and Baltic Seas in 2006 (Helgoland Marine Research 61:153; Aquatic Invasions 1:270), and the Western Mediterranean (2009-Aquatic Invasions 4:270). TEM, fluorescence, and molecular analysis reveal no surface ectoderm bacteria. *Mnemiopsis* secretes vast quantities of mucus, which may sweep the surface clean, leaving only a single gymnamoeba (Hydrobiologia 451:295). Mucus is released from ectodermal papillae located on aboral and proximal-lateral oral lobes. Papillae are supported by a basket of smooth muscles that underlie centrally-positioned goblet cells. Gland cell nuclei and numerous basally-positioned bacteria are located near the cell bases. Papillar stimulation evokes contraction of the muscular basket and pulsatile release of mucus. DGGE and sequencing of 16S target sequences reveal that gut bacterial taxa mirror food and water-borne bacterial taxa, while papillae bear distinctly different populations. Our results underscore *Mnemiopsis's* capacity to be a paratenic host that could play an important role in microbial trophic transfer. Support: NSF-AL-EPSCoR EPS0447675, AU-CMB scholarship (EWD),NSF-MCB-0348327 (AGM).

Moulton, **T**. **P**., Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil, moulton@uerj.br
Lima, V. N., viniciusbus@ig.com.br
Sato, C. Y., yujisato@gmail.com
Andrade, P. M., pedrock_br@yahoo.com
Machado-Silva, F., IBGE, Rio de Janeiro, Brazil, fausto.silva@ibge.gov.br
Silveira, R. M., Universidade Federal de Mato Grosso, Cuiaba, Brazil, rmlsilveira@hotmail.com
Krsulovic, F. A., Pontificia Universidad Católica de Chile, Santiago, Chile, famk@globo.com
Souza, M. L., INCRA, São Luiz, Brazil, souzademarcelo@gmail.com
Brito, E. F., fuentesbrito@wb.com.br

CARBON FLOW THROUGH THE FOOD WEB OF A NEOTROPICAL STREAM INVOLVES NON-TROPHIC PATHWAYS AND INDIRECT EFFECTS (TROPHIC CASCADES) AND IS BASED ON MICROALGAE

Stream ecological research tends to be done at small scale with intensive experiments that seek to explain specific phenomena. Scaling up this information to the level of stream ecosystem and integration of the different parts is a great challenge. In 2-3 order streams in Atlantic forest south-eastern Brazil a series of exclusion experiments show fauna deplete periphyton -- atyid shrimps (Potimirim) are active under certain conditions and baetid mayflies in shallower exposed sites. Strong trophic cascades act at different sites – Macrobrachium shrimps interact strongly with baetids and characine fish act on atyids. Although classic macroinvertebrate shredders are present (caddisflies Triplectides and Phylloicus) they appear not to process substantial quantities of leaf litter, whereas macroconsumers (shrimps, fish and tadpoles) do. Stable isotope analysis using delta13C and delta15N indicates that the food web derives predominantly from microalgae. This implies that fauna "process" litter and non-algal parts of the periphyton without assimilating the carbon. We measured "non-trophic loss" by atyid shrimps and baetid mayflies as approximately 90% of the material that they process. We are assembling this evidence into models of carbon flow.

Muehlbauer, **J**. **D**., University of North Carolina - Chapel Hill, Chapel Hill, USA, jeffreym@unc.edu
Doyle, M. W., University of North Carolina - Chapel Hill, Chapel Hill, USA, mwdoyle@email.unc.edu

DOES URBANIZATION OVERCOME MICRO-SCALE HETEROGENEITY? KNICKPOINT EFFECTS ON MACROINVERTEBRATES, SEDIMENT, AND DISCHARGE IN URBAN AND FORESTED STREAMS.

Knickpoints are dynamic geomorphic features, often exemplified by waterfalls, which may migrate upstream due to erosive processes at the knickpoint face. They are particularly prevalent in disturbed streams, where the flow concentration provided by these structures may have important implications in providing refugia for aquatic organisms. In this presentation we will quantify knickpoint-induced habitat and community heterogeneity in terms of localized hydrology, bed sediment grain distributions, and macroinvertebrates above, at and below knickpoints. The biotic, geomorphic, and hydrologic implications of knickpoint formation relative to macro-scale influences in urban vs. forested catchments will be discussed, especially in the context of restoration activities that are often structured to minimize knickpoint bed erosion.

Mueller-Solger, **A**. **B**., Califoria Delta Stewardship Council, Sacramento, USA, amueller@deltacouncil.ca.gov

CASTLE LAKE LESSONS FOR DOING SCIENCE IN THE CALIFORNIA DELTA

Castle Lake limnology has been led for over five decades by Dr. Charles Goldman. It provides important lessons not just for conducting academic science in a beautiful mountain setting, but also for doing science in one of the most ecologically and economically challenging aquatic ecosystems on the west coast of the United States, the California Delta. The Delta is the freshwater portion of the San Francisco Estuary and the central hub for California's water infrastructure. It is also the focus of a multi-agency science program, the Interagency Ecological Program (IEP) which was founded in 1970 to conduct monitoring and research needed for management of the estuary. As the current IEP lead scientist, I often draw on lessons learned at Castle Lake, such as the critical value of consistent, long-term monitoring coupled with cutting-edge, relevant research, good communication with scientists and non-scientists alike, and turning crises into opportunities. IEP investigations about the causes of a recent abrupt pelagic organism decline serve as an example of applying Castle Lake lessons to doing science down in the California Delta.

Mullabaev, **N**., Institute of Water Problems, Uzbekistan Academy of Sciences, Tashkent, Uzbekistan, nodirbek76@mail.ru
Bekchonova, M., Urgench State University, Urgench, Uzbekistan, marhabo84@inbox.ru
Chandra, S., University of Nevada Reno, Reno, USA, sudeep@cabnr.unr.edu
Scott, J. A., U.S. Geological Survey, Fort Collins, USA, scottj01ster@gmail.com
Ginatullina, E., Institute of Water Problems, Uzbekistan Academy of Sciences, Tashkent, Uzbekistan, e-ginatullina@yandex.ru
Shermetova, D., Urgench State University, Urgench, Uzbekistan, dianasher@yahoo.com
Nishonov, B., Hydrometeorological Research Institute, Tashkent, Uzbekistan, bnishonov@mail.ru
Saito, L., University of Nevada Reno, Reno, USA, lsaito@cabnr.unr.edu
Fayzieva, D., Institute of Water Problems, Uzbekistan Academy of Sciences, Tashkent, Uzbekistan, dfayzieva@gmail.com
Lamers, J., ZEF-UNESCO German-Uzbek Khorezm Project, Urgench, Uzbekistan, j.lamers@zef.uzpak.uz

HYDROECOLOGICAL CONDITION AND PERSPECTIVES FOR POTENTIAL FISHERIES IN LAKES OF KHOREZM, UZBEKISTAN

Large-scale irrigation resulted in accumulation of groundwater and return flows which have led to the formation of a network of lakes in the Khorezm region of Uzbekistan. On a Landsat image from July 2002, 421 lakes were counted with a total area of 6076.3 ha. The lakes of Khorezm may be divided into those that receive water directly from the Amu Darya River through the irrigation system and those that receive water only from collectors that carry agricultural return flows.We investigated the hydrochemistry, hydrobiology and fish communities of several lakes of Khorezm in 2006-2008 to assess their potential for aquaculture. By comparing fish body condition and rate of growth with environmental conditions, it was determined that the hydroecological condition of the lakes

depends on a hydrological regime that currently results in generally low fish productivity. This is consistent with findings in other parts of Uzbekistan, but new technologies may make it possible to increase fish productivity significantly.

Munawar, M., Fisheries & Oceans Canada, Burlington, Canada, mohi.munawar@dfo-mpo.gc.ca
Fitzpatrick, **M. A.**, Fisheries & Oceans Canada, Burlington, Canada, mark.fitzpatrick@dfo-mpo.gc.ca
Lorimer, J., Fisheries & Oceans Canada, Burlington, Canada, jennifer.lorimer@dfo-mpo.gc.ca

THREATENED NEARSHORE ECOSYSTEMS OF THE NORTH AMERICAN GREAT LAKES: STRUCTURE, FUNCTION AND INTEGRITY OF PLANKTONIC FOOD WEBS

Nearshore areas of the North American Great Lakes are vulnerable to multiple anthropogenic stressors including eutrophication, contaminants, exotic species and climate change. However, the linkages between nearshore–offshore–main lake have been ignored due to the emphasis on lake wide surveys. In nearshore Lake Ontario, peak summer primary productivity is roughly 75 times greater than that observed in mid Lake Ontario. In Georgian Bay, Lake Huron, peak summer primary productivity in the nearshore is about 25 times greater than observed offshore. As nearshore areas are the cradle of biological activity including fish spawning and foraging, the observed differences in productivity would have important implications for energy transfer between trophic levels as well as spatially. Additionally, a suite of parameters including bacterial growth, phytoplankton biomass and composition, microbial loop (bacteria, autotrophic picoplankton, heterotrophic nanoflagellates and ciliates) will also be considered for assessing the characteristics and integrity of various types of food webs. The implications for ecosystem health and management will be discussed.

Munyon, **J. W.**, Florida International University, Miami, USA, jmuny001@fiu.edu
Schedlbauer, J. L., Florida International University, Miami, USA,
Oberbauer, S. F., Florida International University, Miami, USA,
Gaiser, E. E., Florida International University, Miami, USA,
Starr, G., University of Alabama, Tuscaloosa, USA,

CONTRASTING ECOSYSTEM PRODUCTIVITY BETWEEN A LONG- AND SHORT- HYDROPERIOD MARSH IN THE FLORIDA EVERGLADES

Freshwater wetlands of the Florida Everglades are oligotrophic with published values for net primary productivity of sawgrass ranging from 255-606 g C m^{-2} yr^{-1} and periphyton from 17-10,371 g C $m^{-2}yr^{-1}$. High temporal and spatial variability in these estimates, derived by harvesting and small-scale gas exchange techniques, have been attributed to the geology and hydrology of the landscape and phenology of dominant species. We are conducting a whole ecosystem chamber-based study of ecosystem productivity at two sites of contrasting hydroperiod in Everglades National Park. We performed monthly measurements of CO2 flux in 5 replicate plots at both sites using an LI-840 infrared gas analyzer connected to a clear, polycarbonate chamber. We found the short-hydroperiod site to be a source of carbon (+84 g C $m^{-2}yr^{-1}$) and our long-hydroperiod site to be a sink for carbon (-342 g C $m^{-2}yr^{-1}$). Our results indicate that prolonged inundation of the short-hydroperiod ecosystem causes significant decreases in net ecosystem productivity. As hydrologic restoration of the Everglades proceeds, it is imperative that we understand the consequences of these actions to carbon sequestration.

Murdock, **J. N.**, USDA ARS, Oxford, MS, USA, justin.murdock@ars.usda.gov
Wetzel, D. L., Kansas State University, Manhattan, KS, USA, dwetzel@ksu.edu
Shields, F. D., USDA ARS, Oxford, MS, USA, doug.shields@ars.usda.gov
Lizotte, R. E., USDA ARS, Oxford, MS, USA, richard.lizotte@ars.usda.gov

SPECIES-SPECIFIC ALGAL RESPONSE TO A NUTRIENT AND HERBICIDE MIXTURE IN BENTHIC ASSEMBLAGES MEASURED WITH INFRARED MICROSPECTROSCOPY

Algae in aquatic systems receiving agricultural runoff are often exposed to mixtures of nutrients and herbicides. It is not clear how these antagonistic substances interact to alter assemblage structure and function because individual species can have varying responses to each. Biofilms were exposed to mixtures of nutrients (nitrogen and phosphorus) and atrazine for six days in microcosms. Individual cell physiology (e.g. relative carbohydrate, lipid, and protein content) of the dominant green algae, diatom, and cyanobacteria species were measured with infrared microspectroscopy. Biofilm structure and metabolism were also assessed. High atrazine levels (100 µg/L) negated the positive effects of elevated nutrients on overall algal biomass, while low atrazine (10 µg/L) stimulated growth. Diatoms and cyanobacteria increased cellular protein and decreased lipids, a sign of decreasing stress. Green algae had no strong shift in cellular composition. We initially predicted a decrease in the proportion of green algae with atrazine mixtures because greens have a closer evolutionary relationship to the target plant; however, species level analysis suggests that their proportions could decrease because diatoms and cyanobacteria benefit more physiologically from exposure to mixtures.

Murrell, **M. C.**, US Environmental Protection Agency, Gulf Breeze, FL, USA, murrell.michael@epa.gov
Lehrter, J. C., US Environmental Protection Agency, Gulf Breeze, FL, USA, lehrter.john@epa.gov
Hagy, J. D., US Environmental Protection Agency, Gulf Breeze, FL, USA, hagy.jim@epa.gov
Kurtz, J. C., US Environmental Protection Agency, Gulf Breeze, FL, USA, kurtz.jan@epa.gov
Schaeffer, B. A., US Environmental Protection Agency, Gulf Breeze, FL, USA, schaeffer.blake@epa.gov
Greene, R. M., US Environmental Protection Agency, Gulf Breeze, FL, USA, greene.rick@epa.gov

WATER COLUMN CARBON AND NUTRIENT CYCLING ON THE LOUISIANA CONTINENTAL SHELF: IMPLICATIONS FOR HYPOXIA

We examined water column hydrographic and metabolic characteristics at sites on the Louisiana Continental Shelf that are characterized by bottom water hypoxia during summers. The prevailing paradigm is that increases in anthropogenic nutrient pollution have increased oxygen consumption in bottom waters, thereby increasing the incidence of hypoxia. On 2 spring and 3 summer cruises, we conducted 30-36 hour intensive studies at 3 sites that typically experience hypoxia and span a gradient of river influence. Discrete water samples were collected from multiple depths and analyzed for particulate and dissolved constituents (e.g., chlorophyll-a, nutrients, CDOM, TSS) and metabolic process rates; the latter included primary production, bacterioplankton production, and community respiration. Budgets were prepared from observed changes in high-resolution water-column profiles of inorganic and organic carbon, oxygen, and nutrients and repeated measurements of production and respiration rates. The 3 sites varied markedly in phytoplankton and bacterioplankton biomass and productivity, and exhibited differing levels of hypoxia. The results from these studies will be placed in a physical context using ADCP data to evaluate the spatial domain effectively sampled by the time series. Dominant mechanisms regulating hypoxia across the gradient of riverine influence will be proposed.

Mutz, **M.**, Brandenburg University of Technology, Cottbus, Germany, m.mutz@tu-cottbus.de
Gerull, L., Brandenburg University of Technology, Cottbus, Germany, gerull@tu-cottbus.de
Frossard , A., Eawag/ETH Swiss Federal Institute of Technology, Zurich, Switzerland, aline.frossard@eawag.ch
Gessner, M. O., Eawag/ETH Swiss Federal Institute of Technology, Zurich, Switzerland, gessner@eawag.ch

REMARKABLY CONSTANT RESPIRATION POTENTIAL ACROSS THE TERRESTRIAL-AQUATIC INTERFACE IN AN EARLY SUCCESSIONAL STREAM NETWORK

Metabolic activity in expanding and contracting streams is regulated by a complex combination of factors that are difficult to disentangle in mature ecosystems. Chicken Creek in Germany, an artificial watershed in an early successional stage, offers the opportunity to study spatio-temporal variation in metabolic activity in a simplified system. We assessed microbial respiration in sediments and soil of three parallel channels in the stream network. Samples were collected from permanently aquatic to semi-aquatic to terrestrial sites. Dry soil and sediment were wetted before respiration measurements were taken to simulate stream expansion during precipitation events. Respiration rates of wetted soil and sediments from dry channels were similar to rates measured with sediments collected in permanently wet channels. This observation suggests that *long-term* water availability is not the main factor determining metabolic potential in the Chicken Creek watershed. Accretion of vascular plant fragments in the channels increased respiration pointing to the importance of organic matter quality.

Muylaert, K., K.U.Leuven Campus Kortrijk, Lab. Aquatic Biology, Kortrijk, Belgium, koenraad.muylaert@kuleuven-kortrijk.be

HYDRODYNAMIC CONTROL OF PHYTOPLANKTON BLOOMS IN THE FRESHWATER TIDAL REACHES OF THE SCHELDT ESTUARY (BELGIUM)

The Schelde estuary is a macrotidal estuary in Western Europe with an extensive freshwater tidal zone. The phytoplankton community in the freshwater tidal reaches is distinct from the community in the river and the brackish zone and is dominated by diatoms. Turbidity is very high and modeling indicates that phytoplankton primary production is mainly light-limited. Phytoplankton bloom development is regulated by river discharge at interannual, seasonal and weekly time-scales. Phytoplankton blooms develop during prolonged periods of low discharge in summer. Phytoplankton blooms are more pronounced during dry summers than during wet summers. During dry summers, chlorophyll a concentrations often exceed 200 µg l-1, which is much higher than in the more downstream situated reaches of the estuary. Silica may potentially be limiting during summer blooms. Short increases in discharge due to rainfall events supply new silica and stimulate phytoplankton blooms.

Myers, **A**. **K**., U.S. Geological Survey, Salt Lake City, USA, amyers@usgs
Brasher, A., U.S. Geological Survey, Moab, USA, abrasher@usgs.gov
Miller, M., U.S. Geological Survey, Moab, USA, mark_miller@usgs.gov
Scott, M., U.S. Geological Survey, Fort Collins, USA, scottm@usgs.gov
Miller, M. P., U.S. Geological Survey, Moab, USA, mamiller@usgs.gov
Schelz, C., NPS, Moab, USA, charlie_schelz@nps.gov

USING MULTIDISCIPLINARY DATA TO ASSESS THE IMPACTS OF VEHICLE USE IN SALT CREEK, CANYONLANDS NATIONAL PARK, UTAH

Salt Creek is an intermittent stream in Canyonlands National Park, UT, and provides one of the most extensive and ecologically important riparian habitats in the park. In the 1940's a four-wheel drive road developed in Salt Creek. In the 1970's, a series of road closures began to limit travel to only a small portion of the original road. We used a multidisciplinary, ecosystem approach to quantify the impacts of vehicular use, and the restoration potential following closure of sections of the road. Here we present a syntheses of data from upland systems, geomorphic characteristics, riparian vegetation, water quality monitoring, in-stream habitat characterization, and aquatic and terrestrial invertebrate assemblages. Initial results suggest that driving in Salt Creek has significant impacts on channel form and riparian vegetation. However, isolating the direct affect of active driving on ecosystem structure and function, independent of hydrologic data, is difficult and warrants further investigation. The results of this study demonstrate how complex ecological and physical data can be integrated to provide park managers with information to effectively manage Salt Creek for multiple uses.

Naik, **A**. **P**., Wright State University, Dayton, USA, naik.15@wright.edu
Hammerschmidt, C. R., Wright State University, Dayton, USA, chad.hammerschmidt@wright.edu

TOTAL MERCURY AND METHYLMERCURY IN SOUTHWEST OHIO STREAMS

Land use and watershed characteristics affect the cycling and transport of mercury (Hg) species in rivers. Atmospheric deposition of Hg is pronounced in Ohio and, through watershed leaching and transport, impacts sensitive aquatic ecosystems. We are investigating the influence of different land uses and water physicochemistry on loadings, partitioning, and speciation of Hg in three contrasting watersheds near the Dayton metropolitan area; Wolf Creek (urban), Holes Creek (residential), and Little Miami River (residential/agricultural). Preliminary results indicate differences in total Hg and monomethylmercury (MMHg) loadings among streams, with greater total Hg in Wolf Creek and increased MMHg in Little Miami River. Suspended particles and dissolved organic carbon affect the partitioning and transport of total Hg and, to a lesser extent, MMHg. It appears that agricultural watersheds sequester comparatively more total Hg and promote MMHg production/mobilization to streams.

NAKANO, **D**., Central Research Institute of Electric Power Industry, Abiko, Japan, d-nakano@criepi.denken.or.jp
Kobayashi, T., Central Research Institute of Electric Power Industry, Abiko, Japan, t-koba@criepi.denken.or.jp
Sakaguchi, I., Central Research Institute of Electric Power Industry, Abiko, Japan, skgch@criepi.denken.or.jp

LARVAL DYNAMICS OF GOLDEN MUSSEL LIMNOPERNA FORTUNEI IN DAM RESERVOIRS: THE AERATION FOR WATER QUALITY CONSERVATION INDUCES THE HEAVY INFECTION?

Golden mussel Limnoperna fortunei is a freshwater bivalve that adheres to water intake facilities, resulting in major biofouling problems. We investigated population dynamics of larva of L. fortunei in two dam reservoirs, Lake Ohshio and Lake Takenuma, which are connected by a headrace channel. The larval density in Lake Ohshio was much higher than those in Lake Takenuma in summer. Water temperature (WT) and dissolved oxygen concentration (DO) were almost uniform regardless of water depth in Lake Ohshio because of destratification due to continuous aeration. Summer WT and DO in the lake were considered to be kept good for the survival and reproduction of L. fortunei. On the other hand, summer stratification was found for WT and DO in Lake Takenuma as common deep reservoirs. Low WT and DO in summer found in deep stratum of the lake are not considered to be acceptable for the survival of this species. Results of this study suggest that the changes in water quality by aeration for water quality conservation could induce the heavy infestations of L fortunei in Lake Ohshio.

Nakov, **T**., University of Texas at Austin, Austin, USA, teofil.nakov@mail.utexas.edu
Theriot, E. C., Texas Natural Science Center, Austin, USA, etheriot@austin.utexas.edu

THE PHYLOGENETIC POSITION OF DIDYMOSPHENIA GEMINATA (LYNGBYE) M. SCHMIDT AND EVALUATING MOLECULAR MARKERS FOR DISTINGUISHING POPULATIONS

Research towards Didymosphenia geminata's distribution and ecology has taken off in recent years. Information on its evolutionary history, however, remains scarce, both in terms of its phylogenetic position and the relatedness of populations. Understanding the distribution or spread of this species will be incomplete in the absence of phylogeographic evidence. We therefore set out to reconstruct its phylogenetic position and evaluate molecular markers for phylogeographic inference. Using DNA extractions obtained from uncultured single or multiple cells we sequenced nuclear (SSU, LSU and ITS1-ITS2) and chloroplast (rbcL) markers for D. geminata. The SSU, LSU and rbcL data was added to a set of 68 cymbelloid taxa to assess the phylogenetic affinity of D. geminata. The ITS1-ITS2 region was sequenced for several populations of D. geminata in order to evaluate its utility in phylogeographic analyses. Preliminary results indicate that D. geminata is sister to the C. mexicana group and that intragenomic polymorphisms of the ITS1-ITS2 region are limiting the phylogeographic utility of this region.

Narr, **C**. **F**., University of Wyoming, Laramie, USA, cnarr@uwyo.edu
Krist, A., University of Wyoming, Laramie, USA, krist@uwyo.edu

INVESTIGATING FRESHWATER GASTROPOD DIVERSITY IN THE WESTERN INTERIOR: WHAT DO WE HAVE AND HOW DO WE KEEP IT?

Greater than 60% of the planet's freshwater snails are imperiled, critically imperiled, or presumed extinct. Freshwater gastropods are North America's most vulnerable major animal group. Habitat loss, invasive species, and inadequate distributional information synergistically threaten freshwater gastropods. To generate distributional data and ascertain which habitats are critical for gastropod species of greatest conservation need in the Western Interior, I qualitatively surveyed freshwater gastropods throughout two major river drainages in Wyoming. From May through August 2009, I sampled freshwater snails from 110 sites in 24 subdrainages gathering distributional information and assessing habitat associations. I found members of 4 freshwater gastropod families and 7 genera distributed throughout both drainages. Additionally, although invasive New Zealand mudsnails have been reported in my study area, I did not find them. Contrary to the literature, I found only weak statistical evidence for habitat differentiation by genus. I will also report comparisons between my results and neighboring states to assess the similarity of freshwater snail assemblages within a broader geographic context.

Neff, **M**. **R**., University of Toronto, Toronto, Canada, maggie.neff@utoronto.ca
Jackson, D. A., University of Toronto, Toronto, Canada, don.jackson@utoronto.ca

EFFECTS OF REGIONAL-SCALE GEOLOGICAL CHANGES ON PATTERNS IN MACROINVERTEBRATE ASSEMBLAGES

Understanding the broad-scale variables that influence biological communities has long been a focus of community ecology. In North America, the Precambrian Canadian Shield provides an interesting backdrop on which to examine the effects of a regional geological feature, which creates distinct physical and chemical conditions in aquatic systems, on patterns in macroinvertebrate community composition. In south-central Ontario, Canada, Precambrian Shield geology transitions into "off-Shield" limestone and dolomite bedrock, providing an opportunity to examine how community composition patterns change across this relatively sharp abiotic boundary. Multivariate analysis on both historical and contemporary macroinvertebrate data indicates that low-order lotic systems of the Precambrian Shield have distinct macroinvertebrate assemblages from off-Shield systems. Differences in assemblages are related to abiotic differences between these two areas, particularly in regards to levels of dissolved oxygen, conductivity, pH and canopy cover. Spatial analysis indicates that distinct Shield and off-Shield macroinvertebrate communities are likely due to a combination of intertwined abiotic and spatial factors, and that even within Shield systems, there is variability in abiotic conditions and by association, biological communities.

Negroni-Miranda, **A**., University of Puerto Rico - Cayey/ Department of Biology, Cayey, Puerto Rico, shizenko@gmail.com
Shea, C., University of Vermont/ Environmental Sciences, Burlington, USA, cshea@uvm.edu
Torres, P. J., University of Georgia/ Odum School of Ecology, Athens, USA, pjtorres@uga.edu
Colon-Gaud, C., University of Puerto Rico - Rio Piedras/ Institute for Tropical Ecosystem Studies, San Juan, Puerto Rico, checo@ites.upr.edu
Ramirez, A., University of Puerto Rico - Rio Piedras/ Institute for Tropical Ecosystem Studies, San Juan, Puerto Rico, aramirez@ites.upr.edu

MACROCONSUMER EFFECTS ON STREAM BENTHOS AND ORGANIC MATTER PROCESSING IN A TROPICAL HEADWATER STREAM: ARE SHRIMPS MORE ACTIVE AT NIGHT?

Stream macroconsumers are capable of influencing ecosystem processes and properties such as leaf breakdown, benthic community structure, and resource standing stocks. While several studies have addressed the individual influences of shrimps and fishes on litter decay and benthic environments, few studies have assessed the significance of nocturnal versus diurnal behavior of these consumers on ecosystem processes. We used an electric exclusion technique to assess the effect of macroconsumers on leaf breakdown and sediment removal in five blocks along a 130m stream reach in the Luquillo LTER. Each block contained electrified day and night frames, each with corresponding controls. We found no significant differences between the rates of leaf litter decomposition (P = 0.74) or organic sediment stocks (P = 0.45) in day, night, and control treatments. Despite the lack of significant effects, day shrimp exclusions had the highest rates of leaf decomposition (k = 0.010). No clear patterns were observed for organic sediment accrual in benthic substrates. Results suggest that shrimps can be equally active both nocturnally and diurnally and can thus influence patterns in ecosystem processes.

Nejstgaard, **J**. **C**., University of Bergen, Dep. of Biology, Bergen, Norway, jens.nejstgaard@bio.uib.no
Berger, S. A., University of Bergen, Dep. of Biology, Bergen, Norway, stella.berger@bio.uib.no

MESOAQUA: AN OPPORTUNITY FOR TRANSNATIONAL ACCESS TO EUROPEAN MESOCOSM FACILITIES, ALSO FOR NON-EUROPEANS.

This talk will give an overview of the infrastructures and the activities in the EU FP7-Capacities Project "MESOAQUA - Network of Leading Mesocosm Facilities to advance the studies of future aquatic ecosystems from the Arctic to the Mediterranean". In MESOAQUA we offer access for European and Non-European applicants to mesocosm facilities in contrasting European environments, with up to 250 man-months per year and facility. We offer experimental ecosystem research training of scientists and students, in open workshops, PhD/PostDoc courses and through participation as trainees in the transnational mesocosm experiments. Our aim is also to facilitate international cross-disciplinary fertilization and better coordination of mesocosm research, as well as improving existing facilities by exchange of technology & experience. Lastly, MESOAQUA also supports development and testing of new off-shore mesocosm systems. The project started in 2009 and runs until Dec 2012. The deadline for access to the facilities in 2011 is 15 Nov 2010. More info is available at http://mesoaqua.eu/.

Nelson, **C**. **R**., Brigham Young University, Provo, USA, rileynelson@byu.edu
Judson, S. W., Brigham Young University, Provo, USA, swjudson@byu.edu

THE IDENTIFICATION AND DISTRIBUTION OF STONEFLIES OF MONGOLIA: A MODEL IN INTERNATIONAL COOPERATION.

The stoneflies (Plecoptera) of Mongolia consist of 54 species, 27 genera, and 8 families. Several species we have found are new records for the country and at least one is a new species. Fifteen years of intensive expeditions with the international Mongolian Aquatic Insect Survey team to far-flung parts of the country have added greatly to our knowledge of these insects. Past works focused on taxonomy. We have sampled adults heavily to clarify taxonomic status of species and give detailed distributional information. Additionally, members of our expedition teams gather physical and chemical properties of the aquatic habitats we sample. We have yet to correlate these factors with the distribution of these Plecoptera species. Still, we are optimistic that stoneflies are important in assessing and monitoring the quality of aquatic resources in this sparsely inhabited country. The creation of identification tools has pushed us closer to meeting the biomonitoring needs of local nomads as well as resource managers throughout the country. Our results will also be useful as taxonomic references and models of cooperation for students and biogeographers worldwide.

Nelson, **D**., University of Idaho, Moscow, USA, nels2906@vandals.uidaho.edu
Wilhelm, F. M., University of Idaho, Moscow, USA, fwilhelm@uidaho.edu

FOOD WEB STRUCTURE IN CAVE STREAMS OF SOUTHWESTERN ILLINOIS: A STABLE ISOTOPE APPROACH

Compared to surface (epigean) streams, the flow of energy and the role of organisms in underground (hypogean) streams are not well studied. Unlike epigean streams, hypogean streams are entirely dependent on the import of externally produced (allochthonous) energy due to the absence of light in caves and thus the lack of primary production via photosynthesis. To characterize the food web and identify prey and consumer organisms, we sampled representatives of all abundant invertebrate taxa and organic matter (CPOM, FPOM, and epixylon) from two cave streams in southwestern Illinois for the analysis of the natural abundance of stable isotopes (13C and 15N). We used the mixing model software IsoSource to determine the most probable food sources contributing to the diet ofinvertebrates . Results indicate that invertebrate prey are more important than organic matter sources, which is in contrast to cave systems in Greenbriar county, West Virginia, USA, where organic carbon in the form of epilithic films was a dominant form of energy. This may indicate that cave food webs are regionally unique.

Nelson, **W**. **A**., Grand Valley State University, Allendale, USA, whitneyanelson@gmail.com
Steinman, A. D., Grand Valley State University, Allendale, USA,

COMPOSITION AND TOXIC SENSITIVITY OF BENTHIC MACROINVERTEBRATE ASSEMBLAGES IN MUSKEGON LAKE, A GREAT LAKES AREA OF CONCERN

Determining benthic invertebrate growth, reproduction, and survival in response to anthropogenic stressors can provide insight into the ecological health of an ecosystem. Studies of this nature are common in lotic systems, but are less frequent in lentic systems. The current study focuses on Muskegon Lake (MI), a coastal drowned river mouth lake with a long history of anthropogenic stress and persistent sediment contamination. Benthic samples from 2003-2011 will be identified to genus (species) to determine if patterns of invertebrate density and taxonomic richness change in response to improvements in the water column. In addition, sediment toxicity will be assessed using *in situ* chambers with sediments from Muskegon Lake in an attempt to quantify the direct adverse impact of contaminated sediments on select taxa. This study will provide a linkage between restoration activities in Muskegon Lake and improvement in sediment quality by assessing the condition of the benthic community and determining if there are shifts in pollution tolerant vs. pollution sensitive taxa at Muskegon Lake sites.

Nepf, **H**. **M**., Massachusetts Institute of Technology, Cambridge, USA, hmnepf@mit.edu

FLAPPING OF UNDULATED MACROALGAE BLADES AND BOUNDARY LAYER RENEWAL

Undulated blades have more pronounced flapping that flat blades, because unsteady vortex shedding associated with individual undulations can generate unsteady pressure forces that induces flapping. Further, the boundary-layer-renewal model suggests that the flapping of macroalgae blades can enhance flux to the blade surface at low mean flow speeds, but has little impact on flux at high mean flow speeds. Taken together, these physical processes may explain the benefit of an undulated morphology in low flow conditions, providing new insight into the observation that many species of macroalgae have blades with a flat morphology in regions of high flow and blades with an undulated morphology in regions of low flow.

Neubauer, **S**. **C**., University of South Carolina, Baruch Marine Field Laboratory, Georgetown, SC, USA, scott@belle.baruch.sc.edu

ECOSYSTEM CARBON CYCLING IN A TIDAL FRESHWATER MARSH: DIFFERENTIAL RESPONSES TO CHANGING HYDROLOGY AND SALT-WATER INTRUSION

Tidal freshwater wetlands are valuable coastal ecosystems whose structure and function are tightly linked to hydrology and salinity exposure. Since June 2008, ecosystem-level fluxes of CO_2 and CH_4 have been measured from experimental plots receiving diluted seawater or additional freshwater in a *Zizaniopsis miliacea* (giant cutgrass)-dominated tidal freshwater marsh in South Carolina. The experimental manipulations had few effects on ecosystem gas fluxes during 2008. During 2009, simulated salt-water intrusion decreased gross ecosystem production (-32% relative to controls) and CO_2 and CH_4 emissions (-35 and –13%, respectively), resulting in a 21% decrease in net ecosystem production (NEP). In contrast, NEP increased by 74% in the +fresh plots, primarily due to decreased CO_2 emissions. Changes in NEP may impact the ability of marshes to keep up with rising sea levels since autochthonous organic matter can significantly contribute to soil volume. These results suggest very different fates for tidal freshwater marshes depending on the net balance between rising sea level (which will increase salt-water intrusion) and changes in river discharge (which can either offset or enhance salt-water intrusion).

Neuman, **T**. **M**., Central Michigan University, Mount Pleasant, USA, neuman.t.m@gmail.com
Woolnough, D. A., Central Michigan University, Mount Pleasant, USA, wooln1d@cmich.edu
Zanatta, D. T., Central Michigan University, Mount Pleasant, USA, zanat1d@cmich.edu

DNA BARCODING, MORPHOMETRICS, AND IDENTIFYING SPECIES OF *PYGANODON* (BIVALVIA: UNIONIDAE) IN INSULAR LAKES OF LAKE MICHIGAN ISLANDS

DNA barcoding using the mitochondrial genes NADH1 and CO1 on freshwater mussels from the genus *Pyganodon* was used to determine whether the mussels found in insular lakes of Lake Michigan Islands were a single species with highly-plastic morphologies, or if they were two or more distinct species with distinct morphologies. Because the candidate species of *Pyganodon* that post-glacially invaded these lakes – *P. grandis* and *P. lacustris* from a Mississippian refuge and *P. cataracta* and *P. fragilis* from an Atlantic Coastal refuge – are very similar morphologically, DNA sequences were used to determine which were present. The sequence data revealed definite *P. grandis* in two lakes on Beaver Island and a species of *Pyganodon* sister to *P. cataracta* and *P. fragilis* in Lake Manitou (North Manitou Island) and the two Beaver Island lakes. We believe the latter species is *P. lacustris*, as *P. grandis* and *P. lacustris* have been known to occur in sympatry. Morphologies of these species have significant overlap and accurate field identifications remain difficult. It is unknown if these species hybridize, thus further research using microsatellite genotyping is needed.

Newbold, **J**. **D**., Stroud Water Research Cener, Avondale, PA, USA, newbold@stroudcenter.org

INVERSE MODELING ANALYSIS OF ^{32}P TRACER DYNAMICS IN THE FOOD WEB OF WALKER BRANCH, TENNESSEE

With their interplay of spatial and temporal dynamics, streams are particularly good candidates for tracer analysis of food web dynamics. Phosphorus flux through the food web of Walker Branch, a first-order woodland stream in Tennessee, was inferred through inverse modeling of the dynamics of a tracer addition of ^{32}P in July 1978. The ^{32}P was traced from the water column through primary uptake by detritus-associated microbes and epilithic algae, to various macroinvertebrate groups, and their predators. These dynamics were simulated by adjusting the parameters of a linear, donor controlled food web model embedded in a coupled partial differential equation transport model. Results will be compared stoichiometrically with those of Mulholland's (2000, Ecol. Monogr.) analysis of ^{15}N dynamics in the same stream. I will highlight several basic concepts exemplified by the modeling, including: (1) the distinction between transient tracer dynamics and quasi-steady state natural element dynamics; (2) the inherent linearity of tracer dynamics within an ecosystem governed by non-linear mechanisms; and (3) the estimation of fluxes and standing stocks of natural phosphorus from the steady-state solution of the tracer model.

Newman, **M**. **M**., Auburn University, Auburn, USA, ramsemm@auburn.edu
Liles, M. R., Auburn University, Auburn, USA, lilesma@auburn.edu
Feminella, J. W., Auburn University, Auburn, USA, feminjw@auburn.edu

EFFECTS OF SEDIMENT DISTURBANCE ON BACTERIAL ASSEMBLAGES ASSOCIATED WITH LEAF BREAKDOWN IN SMALL COASTAL PLAINS STREAMS

In small heterotrophic streams, landscape disturbance can alter instream physicochemical conditions, which, in turn, can affect organic matter processing and associated microbial communities. We examined the effects of watershed-scale sediment disturbance, quantified as the percent of the watershed occurring as bare ground and road cover, on the structure of bacterial assemblages colonizing maple and oak leaf litter and litter breakdown in 6 small streams at the Fort Benning Military Installation, Georgia. Bacterial assemblages were quantified using ribosomal intergenic spacer analysis (RISA), comparing assemblage similarity between disturbed and undisturbed streams. Litter breakdown was significantly lower in disturbed (vs. undisturbed) streams for both leaf species after a 64-d incubation ($p=0.001$). Results also showed a significant interaction between disturbance and leaf species ($p=0.024$) indicating that sediment disturbance influenced the degree of difference in breakdown rate between leaf species. Litter bacterial assemblages in undisturbed streams showed higher within-stream similarity than in disturbed streams, where bacterial assemblages were more spatially variable, possibly because of more strongly contrasting physicochemical conditions. Future work will investigate the degree to which specific microbial taxa are associated with stream water quality changes to understand the potential consequence of these changes to organic matter processing.

Newman, **R**. **M**., University of Minnesota, St. Paul, USA, RNewman@umn.edu

DISTRIBUTION, VIABILITY, AND LONGEVITY OF CURLYLEAF PONDWEED TURIONS IN LAKE SEDIMENTS

Curlyleaf pondweed (*Potamogeton crispus* L.) is an invasive macrophyte in North America. It reproduces primarily via vegetative propagules called turions. To provide long-term control, it is important to know turion longevity as well as the distribution and viability of turions in lakes and within lake sediments. To determine turion longevity, mature turions were collected and buried in mesh bags in the sediment and sampled annually for viability. Buried turions were viable for at least 5 years and continued sampling will determine ultimate longevity. Sediment cores collected from 4 lakes indicate that turion densities were variable among lakes, ranging from an average of $41/m^2$ to $939/m^2$. Turion densities were highest at 1 to 2-m water depth (382 to $2003/m^2$), and were always lower at depths ≥ 3m. Most turions (50 to 75%) were in the top 5cm of sediment, but were common in the next 5cm (30%) and were found as deep as 30cm in two lakes. The buried turions were viable (generally ≥ 50% sprouted) and represent a potentially significant source of recruitment that must be considered for long-term management.

Ngai, **K**. **L**., University of Nevada Reno, Reno, USA, cngai@cabnr.unr.edu
Chandra, S., University of Nevada Reno, Reno, USA, chandra@cabnr.unr.edu
Allen, B. C., University of California Davis, Davis, USA, bcallen@ucdavis.edu

HABITAT UTILIZATION AND MIGRATION PATTERN OF NONNATIVE WARMWATER FISHES IN A LARGE OLIGOTROPHIC SUBALPINE LAKE

Information on migration pattern of nonnative species is essential for development of effective management strategies to control the spread of

these species. We employed hydroacoustic telemetry technology to monitor movements of 14 largemouth bass *Micropterus salmoides* and 7 bluegill *Lepomis macrochirus* , warmwater nonnative species between May to December 2008 from an established population in a marina (Tahoe Keys) in South Lake Tahoe CA-NV to assess their potential role in lake-wide establishment of these species. Lake-wide establishment of these nonnative predators can significantly impact the native biota of the lake. Data show that most fish departed marina proper at least once and returned around late summer. However, three bass (20%) and two (30%) bluegill demonstrated lakeward migration patterns, suggesting that the Tahoe Keys population is potentially leaving the marina and moving to other parts of the lake given suitable conditions. To prevent and control lakewide proliferation of these warmwater fishes, management efforts should be focused on the containment and reduction of marina populations while their distribution is fairly limited and their densities are still fairly low within the lake.

Ni, **W**., Zhejiang University, Hangzhou, China, nwm1225@yahoo.com.cn
Zhang, J., Zhejiang University, Hangzhou, China, zjy@zju.edu.cn

RELATIONSHIPS BETWEEN SEASONAL FACTORS, NUTRIENTS, CYANOBACTERIA, AND MICROCYSTINS IN A RESERVOIR IN CHINA

Cyanobacteria blooms and microcystins are important problems in many lakes of China. Water samples were collected at 10 locations throughout a reservoir to determine relationships among water temperature, nutrient concentrations, cyanobacteria, and microcystins. Total nitrogen (TN) was highest during the winter-spring period, and total phosphorus was highest during the summer-fall period. Algal biomass as chlorophyll a was greater than 20 mg/m^3 during the summer and less than 8 mg/m^3 during the winter. Algal species composition (measures as percent biovolume) varied from dominance by cyanobacteria from late summer and early fall to diatoms, euglenoids, and green algae during the winter and spring. A succession of cyanobacteria, *Microcystis*, *Anabaena*, and *Oscillatoria*, were observed in the reservoir from June through November. Chlorophyll a was positively related to total phosphorus and water temperature, but negatively related to total nitrogen and dissolved oxygen. Microcystin concentrations were positively related to water temperature and chlorophyll a, unrelated to total phosphorus, and negatively related to total nitrogen and dissolved oxygen. Path analysis is planned to evaluate causal relationships within environmental determinants, cyanobacteria, and microcystin concentrations within this lake.

Nichols, **S**. **J**., University of Canberra, Canberra, Australia, sue.nichols@canberra.edu.au
Robinson, W. A., Charles Sturt University, Thurgoona, Australia, wayne.robinson@csu.edu.au
Norris, R. H., University of Canberra, Canberra, Australia, richard.norris@canberra.edu.au

CLIMATE CHANGE AND 15-YEAR TRENDS IN BENTHIC MACROINVERTEBRATE ASSEMBLAGES IN AUSTRALIAN UPLAND STREAMS

Climate change is gradual and requires long-term, consistently collected data to detect biological responses. Macroinvertebrates were collected from 16 sites on 5 streams at quarterly intervals each year from 1994 to 2008 in an Australian National Park. Eleven sites were affected by ski-resorts and five were reference sites. Time-series and multivariate analyses were used to evaluate trends in 17 macroinvertebrate measures and climate data. The climate became warmer and less humid but the number of rain days increased during the study. Five to 8 sites showed significant positive trends for Caddisfly and Diptera richness, Oligochaeta abundance and total-taxon-richness and no sites showed significant negative trends for these measures. Five to 9 sites also showed significant decreasing trends for EPT and stonefly richness, and Evenness. Observed trends were not exclusive to test or reference sites. Abundance measures showed increasing variation over time with greatest variance in test sites and least variation in O/E taxa, SIGNAL-2, EPT-richness, and total-taxon-richness. Some climate variables showed weak relationships with Caddisfly and Oligochaeta abundance but local environmental conditions usually outweighed, but possibly interacted with, climate-change effects.

Niekum, **T**. **E**., Earth System Science, University of Wyoming, Laramie, USA, tniekum@uwyo.edu
Hotchkiss, E. R., Program in Ecology, Department of Zoology & Physiology, University of Wyoming, Laramie, USA, ehotchki@uwyo.edu
Hall, R. O., Department of Zoology & Physiology, University of Wyoming, Laramie, USA, bhall@uwyo.edu

THE EFFECTS OF AN INVASIVE SNAIL (*MELANOIDES TUBERCULATA*) ON NATIVE INVERTEBRATE ABUNDANCE AND DIVERSITY

Melanoides tuberculata, an exotic snail native to Asia, has invaded and established a population in Kelly Warm Spring, Grand Teton National Park, Wyoming. Invasive populations of *Melanoides* are closely linked with the aquarium trade and are limited to warm fresh waters. Benthic macroinvertebrates were sampled pre- and post-invasion from six random sites along a 500 m reach. Invertebrates found at present include: Chironomidae, *Cheumatopsyche*, *Helicopsyche*, Planorbidae, *Gyraulus parvus*, Physidae, *Fossaria*, Caenidae, *Hyalella azteca* and Oligiochaeta. Preliminary data suggests density and biomass of native invertebrates have declined since the *Melanoides* invasion after 2001. By 2007, *Melanoides* biomass was 58 g AFDM m^{-2}. By comparison, the biomass of *Hyalella* was 1 g AFDM m^{-2} in 2007 and the biomass of Chironomidae was 0.3 g AFDM m^{-2} in 2007. *Hyalella* and Chironomidae biomass decreased by approximately 6% and 31%, respectively, from 2001 to 2007. This decline in non-*Melanoides* invertebrate biomass is likely to impact all other parts of the stream food web.

Nilsson, **E**., University of Wisconsin - Madison, Madison, USA, erika.nilsson@limnol.lu.se
Solomon, C. T., University of Wisconsin - Madison, Madison, USA,
Wilson, K. A., University of Southern Maine, Gorham, USA,
Willis, T. V., University of Southern Maine, Gorham, USA,
Vander Zanden, M. J., University of Wisconsin - Madison, Madison, USA,

EFFECTS OF AN INVASIVE CRAYFISH ON BENTHIC INVERTEBRATE ABUNDANCES AND ECOSYSTEM-LEVEL TROPHIC FLOWS

The introduction of invasive species is considered one of the main threats to global biodiversity, ecosystem structure and function. In freshwaters, invasive crayfish alter macroinvertebrate community structure and destroy macrophyte beds. There is limited knowledge on how such invader driven changes affect consumers at higher trophic levels. In this study we explore how densities of invasive rusty crayfish, a benthic omnivore, affects benthic resources and the consequences for ecosystem-level trophic flows. We expected crayfish to decrease abundance of macroinvertebrates, making fish less reliant on benthic resources. However, we expected crayfish specialists (e.g. *Lepomis* and *Micropterus*) to increase their benthic dependence. Ten northern Wisconsin lakes were sampled for crayfish and macroinvertebrate abundance. Stable isotopes were used to characterize trophic pathways supporting fish in littoral food webs. We found strong negative effects of crayfish abundance on benthic invertebrates, while the effects on trophic pathways supporting fish were more subtle. Rock bass and smallmouth bass increased benthivory but there were no changes in benthic reliance for the other fish species, suggesting stability in these littoral food webs with respect to energy flow.

Nishihara, **G**. **N**., Nagasaki University, Nagasaki, Japan, greg@nagasaki-u.ac.jp
Terada, R., Kagoshima University, Kagoshima, Japan,

MARINE MACROPHYTE RICHNESS DECREASES ALONG A WAVE EXPOSURE GRADIENT IN THE EAST CHINA SEA

Waves are one of the most dominant processes influencing the coastal environment and ecosystem, and can both directly and indirectly affect coastal organisms found in these areas. In the East China Sea, large macrophytes once created vast submarine forests, which provided habitat for a large number of economically important marine organisms Therefore, the decline in these habitats has produced a flurry of research activity focusing on the restoration and the identification of causative agents. However, surprisingly little is known about how abiotic and biotic variables affect the ecology of the ecosystems in these regions. We looked at how wave exposure, based on the surf similarity number, affects the species richness of marine macrophytes collected from 210 sites along the eastern rim of the East China Sea, which covers a north-south range of 600 km. We show that the Chlorophyta, Rhodophyta, and Seagrasses decline in species richness as wave exposure increases, whereas the Phaeophyta shows an opposite trend. Furthermore, similar patterns in species richness are apparent when the macrophytes are categorized into functional form groups, where all but the thick and leathery functional forms show a decline in richness with increasing exposure.

Niyogi, **D**. **K**., Missouri University of Science and Technology, Rolla, MO, USA, niyogid@mst.edu
Hu, C. Y., Missouri University of Science and Technology, Rolla, MO, USA,
Harding, J. S., University of Canterbury, Christchurch, New Zealand, jon.harding@canterbury.ac.nz

FUNGAL COMMUNITIES IN STREAMS AFFECTED BY MINE DRAINAGE: RESPONSES TO MULTIPLE STRESSORS AND NUTRIENT SUBSIDIES

Mine drainage affects numerous streams throughout the world and imposes stress on biota from low pH, high concentrations of dissolved metals, and deposition of metal oxides. We examined fungal communities involved in leaf breakdown in streams with varying effects of acidic mine drainage in Colorado and New Zealand. Site pH ranged from circumneutral at pristine references sites to highly acidic (2.7). Acidic sites had elevated dissolved metals, and often had elevated nutrient concentrations. Microbial respiration was most closely related to the deposition of metal oxides in both areas, with a positive effect of nutrients, and was often high at acidic sites. Fungal diversity was estimated from the number of bands on denaturing gradient gels (DGGE) after amplification of fungal DNA from leaves. Fungal diversity was usually lower in acidic streams, but acidic sites in New Zealand had greater diversity than those in Colorado. This difference may be related to the stressors and subsidies at the two locations, the abundance of naturally-acidic streams in New Zealand, or a positive effect of ecosystem size.

Noe, **G**. **B**., U.S. Geological Survey, Reston, USA, gnoe@usgs.gov
Hupp, C. R., U.S. Geological Survey, Reston, USA, crhupp@usgs.gov

RETENTION AND SPIRALLING OF RIVERINE NUTRIENT AND SEDIMENT LOADS BY FLOODPLAINS

River flood pulses deliver nutrients and sediment to hydraulically connected floodplains, having large implications for watershed transport processes and floodplain productivity. However, few quantitative estimates exist for the percent retention of annual river loads of nitrogen (N), phosphorus (P), and suspended sediment by floodplains. We measured depositional fluxes of nutrients and suspended sediment onto floodplain soil surfaces of seven Coastal Plain rivers in the Chesapeake Bay watershed. For each river, the average N, P, and sediment depositional flux rates were multiplied by an estimate of floodplain area to calculate floodplain trapping rates and then compared to average river loads. Median material retention among the rivers was 24% of N (range 4-156%), 59% of P (14-604%), and 119% of suspended sediment (30-690%). Uncertainty in retention estimates derive from several aspects related to permanency and sources of deposited nutrients and sediment in floodplains. Measurement of in situ mineralization of floodplain soil nutrients in a Piedmont watershed indicates mean turnover times of 22 and 213 years for existing pools of N and P, respectively, suggesting long-term storage of flood-derived nutrients in floodplain soils.

Nogaro, **G**., Wright State University, Dayton, USA, geraldine.nogaro@wright.edu
Hammerschmidt, C. R., Wright State University, Dayton, USA, chad.hammerschmidt@wright.edu

INFLUENCE OF BIOTURBATION OF MICROBIAL PRODUCTION OF METHYLMERCURY IN MARINE SEDIMENTS

Mercury (Hg) has a complex and fascinating biogeochemical cycle, which includes the production of toxic monomethylmercury (MMHg) in aquatic sediments by anaerobic microorganisms. The role of bioturbation activities (feeding, digging of galleries, excavations, bio-irrigation) on Hg/MMHg cycling has been neglected, although bioturbation by benthic fauna are known to play a key role in many biogeochemical and microbial processes. We investigated the effects of bioturbating fauna on microbial production of MMHg in sediments sampled from the continental shelf of the northwest Atlantic Ocean in September 2009. Control (sieved) and macrofauna cores were amended with inorganic mercury isotope (200Hg) and incubated in a dark experimental chamber. The influence of ambient bioturbating macrofauna was measured on sediment MMHg production and efflux, sediment reworking, oxygen concentrations, dissolved organic carbon release, and microbial activities. Preliminary results show that bioturbating macrofauna affected biogeochemical and microbial processes in the sediment cores, which may have influenced microbial production of MMHg. Results from this work emphasize the need to enhance our knowledge and understanding of the interactions among benthic fauna, microorganisms, and geochemistry in affecting MMHg production.

North, **C**. **A**., University of Wyoming, Laramie, USA, cnorth@uwyo.edu
Lovvorn, J. R., Southern Illinois University, Carbondale, USA, lovvorn@siu.edu
Kolts, J. M., University of Wyoming, Laramie, USA, jkolts@uwyo.edu

DIETARY RESPONSE OF BENTHIC DEPOSIT-FEEDERS TO FRESH ALGAE SETTLING FROM AN ICE-EDGE SPRING BLOOM IN THE NORTHERN BERING SEA

Decreased annual sea ice cover due to climate warming is expected to lead to decreased organic matter inputs to the benthos through changes in the character of ice-associated spring blooms. Deposit-feeders may rely heavily on fresh algae deposited during the spring bloom for growth and reproduction. To determine the extent to which deposit-feeders (3 clams, a polychaete, and an ophiurid) use fresh algae, we examined diets using stable isotope, fatty acid, and gut content analyses before and after the spring bloom in May-June 2007. Gut contents indicate that ice-associated pennate diatoms and green microflagellates were heavily consumed both before and after the bloom by all 5 species. Stable isotope data suggests that some species respond more strongly to settling ice algae than others, possibly indicating differential reliance on ice algae among species. Predominance of ice algae in deposit-feeder diets suggests that continued climate warming could lead to significant reduction in food supply. Ongoing fatty acid and isotope analyses will help determine the importance of ice algae in the diets of deposit-feeders, and facilitate forecasts of future changes in benthic communities.

Northington, **R**. **M**., Virginia Tech, Blacksburg, VA, USA, rnorthin@vt.edu
Webster, J. R., Virginia Tech, Blacksburg, VA , USA, jwebster@vt.edu
Benfield, E. F., Virginia Tech, Blacksburg, VA , USA, benfield@vt.edu
Evans, D., Virginia Tech, Blacksburg, VA, USA, daniel76@vt.edu
Schoenholtz, S. H., Virginia Tech, Blacksburg, VA , USA, schoenhs@vt.edu
Timpano, A. J., Virginia Tech, Blacksburg, VA , USA, atimpano@vt.edu
Zipper, C., Virginia Tech, Blacksburg, VA , USA, czip@vt.edu

AN ASSESSMENT OF ECOSYSTEM FUNCTION IN VIRGINIA COALFIELD STREAMS

Coal production has disturbed greater than 1.5 million acres of land and affected more than 1,200 miles of headwater and low order streams in Appalachia. Restoration of impacted streams has occurred in response to increasing public concern and the expanding scale of coal-mining operations. Our primary objective in this study was to examine ecosystem structure and function in southwestern Virginia coalfield streams. Specifically, we conducted studies of habitat quality, biotic assemblages, nutrient uptake, and ecosystem metabolism in six restored and three unrestored low order streams. No significant differences were found between site types or among seasons for either structural or functional measures. Habitat quality ranged from suboptimal to optimal, while across sites, macroinvertebrates were found to range from good to severely stressed. Streams were net heterotrophic, with ammonium spiraling parameters varying widely and trending towards greater uptake in winter. These baseline data indicate that streams in this region are greatly affected by coal mining practices, potentially compromising ecosystem resilience. There is little evidence to suggest that current restoration efforts have improved these stream ecosystem structure or function.

Norton, **E**. **N**., Michigan State University, East Lansing, USA, nortone1@msu.edu
Cheruvelil, K. S., Michigan State University, East Lansing, USA, ksc@msu.edu

THE EFFECTS OF LAKE SHORELINE DEVELOPMENT ON PAINTED AND NORTHERN MAP TURTLE POPULATIONS

Turtles are important integrators of terrestrial and aquatic environments because they use both the lake and the riparian areas for habitat. As a result, turtles may be highly affected by lake shoreline development. However, no study has quantified the effects of shoreline development on turtle populations. Therefore, we studied the effects of shoreline development on painted (Chrysemys picta) and northern map (Graptemys geographica) turtle population sex ratios, age and size structure, incidence of injury, and habitat use. We used hoop traps and basking traps to capture both species in three southern Michigan inland lakes and placed radio transmitters on fifteen female northern map turtles. In addition, we quantified lake habitat features including macrophyte abundance and diversity, density of coarse woody debris, percentage of shoreline developed, and pier density. For painted turtles, higher levels of shoreline development were associated with male-skewed sex ratios, higher incidence of injury in males, and younger populations. Our results suggest that higher levels

of shoreline development could have serious implications for survivorship and reproduction in adult turtles, potentially affecting the long-term persistence of these populations.

Norton, **S. B.**, USEPA, Washington, DC, USA, norton.susan@epa.gov
Pollard, A., USEPA, Washington, DC, USA, pollard.amina@epa.gov
Suter, G. W., USEPA, Cincinnati, OH, USA, suter.glenn@epa.gov
Alexander, L., USEPA, Washington DC, USA, alexander.laurie@epa.gov
Griffith, M., USEPA, Cincinnati, OH, USA, griffith.michael@epa.gov

MOUNTAINTOP MINES AND VALLEY FILLS: DOWNSTREAM IMPACTS ON BIOTA

We will present our conclusions on the effects of mountaintop mines and valley fills (MTM-VF) on downstream biota in streams of the Central Appalachian Mountains. Our conclusions are based on a review and synthesis of evidence from the peer-reviewed literature. We examined published findings from the coalfields of the Central Appalachian Mountains, from other coal mining regions, from laboratory studies, and environmental models. We evaluated the potential effects of elevated ion, selenium and metal concentrations, habitat degradation, flow regime changes, and headwater burial. We also evaluated evidence that sediment ponds, constructed channels or wetlands mitigate any downstream impacts. We did not consider the effects of coal processing or transport, impoundment failure, truck traffic, social, cultural or aesthetic impacts. Disclaimer: The views expressed in this abstract are those of the author and do not necessarily reflect the view or policies of the U.S. Environmental Protection Agency

Norvell, **A. S.**, University of Colorado, Boulder, USA, audrey.norvell@colorado.edu
Ryan, J. N., University of Colorado, Boulder, USA, Joseph.ryan@colorado.edu
McKnight, D. M., University of Colorado, Boulder, USA, diane.mcknight@colorado.edu
Ren, J., Texas A&M University-Kingsville, Kingsville, USA,

METAL AND COLLOID TRANSPORT IN THE HYPORHEIC ZONE OF AN ACID MINE DRAINAGE-CONTAMINATED STREAM

The fate and transport of metals in streams impacted by acid mine drainage is an important component of human and ecological risk assessments for prioritizing cleanup of mining sites. In order to learn more about the processes that control metal removal in the stream, we studied the role of colloids and the exchange of stream water with the hyporheic zone in Lefthand Creek, a stream contaminated by acid mine drainage in northwestern Boulder County, Colorado. We installed a set of mini-piezometers in the streambed and sampled the hyporheic pore waters along a 90 m reach of the creek for metals, colloids, and other geochemical parameters in the water and sediments. Conservative tracers indicate rapid exchange in the upper 20-40 cm of the subsurface. Tracer dilution tests with dissolved metals and ferrihydrite colloids indicate that colloidal transport of lead and copper in the hyporheic zone is an important mechanism for metal removal in the streambed. Ferrihydrite colloids were largely removed from the stream through interaction with the upper 20 cm of the streambed.

Novak, **M.**, University of California, Santa Cruz, Santa Cruz, USA, mnovak1@ucsc.edu
Moore, J. W., University of California, Santa Cruz, Santa Cruz, USA, jwmoore@biology.ucsc.edu
Leidy, R. A., Environmental Protection Agency, San Francisco, USA, leidy.robert@epa.gov

NESTEDNESS PATTERNS REVEAL THE DUAL NATURE OF COMMUNITY DISASSEMBLY IN CALIFORNIA STREAMS

Nonrandom patterns of community disassembly exert strong control over the empirical relationship between diversity and ecosystem function. Our ability to forecast the scenarios of community disassembly would be greatly improved if the drivers of native extinction were to mirror those of non-native invasion. Here we use the nested patterns in fish community composition across 270 sites surrounding San Francisco Bay to investigate the predictability of community disassembly. Nestedness was observed not only among sites (low richness sites harbored nonrandom subsets of the species present at higher richness sites), but also among species (species observed infrequently were present at nonrandom subsets of the sites occupied by frequently occurring species) indicating considerable predictability in the ordered disassembly of fish communities. Multivariate permutation analyses assessing the independent contributions of potential abiotic drivers revealed that elevation, habitat size, conductivity, and habitat quality contributed most to overall nestedness. The distinction between native and non-native species, however, overwhelmed this effect, providing strong evidence that the processes of extinction and invasion-driven community (dis)assembly are distinct.

Novitski, **L. N.**, Michigan State University, East Lansing, USA, novitski@msu.edu
Qi, J., Michigan State University, East Lansing, USA, qi@msu.edu
Stevenson, R. J., Michigan State University , East Lansing, USA, rjstev@msu.edu

DEVELOPMENT OF REMOTE SENSING TOOLS TO MONITOR AND PREDICT HARMFUL ALGAL BLOOMS IN INLAND LAKES

Recently, scientists have used satellite imagery to help monitor harmful algal blooms (HABs) in both marine and freshwater ecosystems, including those in the Great Lakes region. By relating existing phytoplankton composition and density data from the Environmental Protection Agency's National Lake Assessment (NLA) with pixel values in Landsat 7 satellite images, we refine existing remote sensing models for cyanobacterial HABs, such as *Microcystis*, in inland lakes of the Great Lakes region. Average cyanobacterial density interpreted from images of lakes in the NLA are related by multiple regression to actual cyanobacterial density using spectral bands known to correlate with presence of a cyanobacterial pigment, phycocyanin. HAB prediction models are then calibrated and validated for use with Landsat 1-7 images. Using these remote sensing models for HABs, images from 1972 – 2010 are used to evaluate long-term trends in cyanobacterial biomass in Michigan's inland lakes to develop models relating interannual variation in weather to HABs. By using historical imagery, remote sensing provides important baseline information for improving future monitoring and predicting risk of cyanobacterial HAB events under differing global change scenarios.

Nowlin, **W. H.**, Texas State University, San Marcos, USA, wn11@txstate.edu
Pray, C. L., Texas State University, San Marcos, USA, cp1274@txstate.edu
Scott, S. E., Texas State University, San Marcos, USA, scottse3@muohio.edu
LeBoeuf, C. M., Texas State University, San Marcos, USA, cmlaquatic@gmail.com
Cohen, K. L., Texas State University, San Marcos, USA,
Zhang, Y., Texas State University, San Marcos, USA, yz11@txstate.edu

ECOSYSTEM-LEVEL IMPACTS OF INVASIVE SUCKERMOUTH CATFISH (LORICARIIDAE) ON A SPRING-INFLUENCED RIVER

Spring-influenced ecosystems are relevant systems to examine the effects of invasive species because their constant physiochemical conditions may make them highly susceptible to invasion. Suckermouth catfishes (Loricariidae) have invaded multiple spring-influenced rivers in North America and are of great concern because they alter trophic pathways and nutrient cycling. We present a results of a multi-part study in which we examined the impacts of Hypostomus spp. on the spring-fed San Marcos River, TX, USA. We assessed impacts of Hypostomus through a series of stream channel experiments and examined the influence of Hypostomus on nutrient cycling in the river through field-based nutrient excretion measurements. In stream channel experiments, Hypostomus decreased algal biomass, altered algal nutrient ratios, and increased sediment transport and OM decomposition. Among fish species in the river, Hypostomus exhibit among the highest body P content, lowest P excretion, and highest excreted N:P. Hypostomus populations in the San Marcos River represent a substantial P pool which can influence nutrient cycling. Our results indicate that Hypostomus populations can have strong influences on the trophic and nutrient dynamics of spring-fed rivers.

Nunez Milland, **D. R.**, University of South Carolina, Columbia, USA, nunez-milland@chem.sc.edu
Twining, B. S., Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, USA, btwining@bigelow.org

SINGLE-CELL MEASUREMENTS OF METAL QUOTAS IN CHARLES RIVER PHYTOPLANKTON USING SYNCHROTRON X-RAY FLUORESCENCE

The elemental composition of phytoplankton is of interest because of their role in the biogeochemical cycles of carbon and other bioactive elements. Phytoplankton also can serve as the point of introduction for metal contaminants into aquatic food webs. Single-cell analysis of phytoplankton elemental composition enables determinations free of interferences from abiotic material and other (non-target) cells present in natural particle assemblages.

Synchrotron x-ray fluorescence (SXRF) enables quantitative and qualitative analysis with high spatial resolution (< 1 µm) and high elemental sensitivity on a single cell basis. Centric diatoms collected from the lower Charles River in Boston, MA, were analyzed using SXRF. Despite high concentrations of suspended materials and adsorbed abiotic particles, manganese, iron, cobalt, nickel, copper and zinc were quantified in individual cells. Cellular metal quotas were found to be 10^{-15} – 10^{-18} mol/cell, while the biomass elements P and S were measured at levels of approximately 10^{-15} mol/cell. These are some of the first measurements of metal contents in phytoplankton collected from near-shore or riverine environments, and metal quotas will be compared to data from cultured and open ocean species.

Nunokawa, **M.**, Senshu University, Hokkaido College, Bibai, Japan, nunokawa@senshu-hc.ac.jp

Kikuchi, S., Yamagata University, Turuoka, Japan, kikku@tds1.tr.yamagata-u.ac.jp

Sakurai , M., Shin Engineering Consultants Co., Ltd., Sapporo, Japan, sakurai@shin-eng.co.jp

Itaya, T., Shin Engineering Consultants Co., Ltd., Sapporo, Japan, itaya@shin-eng.co.jp

DOES PROVIDING SLITS IN THE DAM ALTER THE MACROINVERTEBRATES ASSEMBLAGES ?

Many dams often have been established in the area where sediment supply is high in Japan. These dams have fulfilled a function of sediment disaster prevention. Although most of dams are small, many dams affect stream ecosystems. Providing slits in a dam will allow the downstream movement of sediment and would be leading to long-term aquatic habitat improvements. We hypothesize that macroinvertebrates assemblage will respond to providing slits in the dam thorough changes in substrate environment. We collected data of the macroinvertebrates assemblage and habitat variables in the Nunobe stream above and below the dam, and compared the data before and after the dam modification. We examined the effects of slitting the dam on the macroinvertebrates assemblage. Only fine gravel percentage increased below dam after providing slits in the check dam. The aquatic assemblage slightly changed below the dam after the dam modification. Our results indicate that effects of providing slits in the dam on macroinvertebrate assemblages were limited since larger substrate still could not move after dam cutting.

O'Brien, **J. M.**, University of Canterbury, Christchurch, New Zealand, jon.obrien@canterbury.ac.nz

Hamilton, S. K., W.K. Kellogg Biological Station, Michigan State University, Hickory Corners, USA, hamilton@kbs.msu.edu

Kinsman, L. E., W.K. Kellogg Biological Station, Michigan State University, Hickory Corners, USA, kinsmanl@msu.edu

Lennon, J. T., W.K. Kellogg Biological Station, Michigan State University, Hickory Corners, USA, lennonja@msu.edu

Ostrom, N., Michigan State University, East Lansing, USA, ostromn@msu.edu

MECHANISMS OF N RETENTION AND EXPORT IN A THROUGH-FLOW WETLAND: A PULSED ^{15}N ADDITION APPROACH

Through-flow wetlands can have a considerable influence on nitrogen (N) concentrations in stream networks. Spatial and temporal variability of biotic N transformations within wetlands can regulate the magnitude of N retention or export. We used pulsed additions of ^{15}N-nitrate and ^{15}N-ammonium to quantify N transformations in a small through-flow wetland. Denitrification was estimated using an open-system N2:Ar ratio approach. There was a 10% net decline in nitrate concentrations between the wetland inflow and outflow, resulting from high rates of uptake and little replacement of nitrate by nitrification. Denitrification estimates were variable, but may have been sufficient to account for nitrate loss. Ammonium concentrations oscillated in a diurnal cycle and inversely tracked dissolved oxygen concentrations. The mechanism behind the ammonium export was diffusion of ammonium out of the sediments, which was mitigated during the day by autotrophic uptake, resulting in a pattern of lower ammonium concentrations during the day than at night. Nitrate retention in the wetland was sufficient to compensate for ammonium export, suggesting that the wetland is an overall sink for N in through-flowing waters.

Obryk, **M.**, University of Illinois at Chicago, Chicago, USA, mobryk2@uic.edu

Doran, P., University of Illinois at Chicago, Chicago, USA, pdoran@uic.edu

Priscu, J., Montana State University, Bozeman, USA, jpriscu@montana.edu

MOORED AND ROBOTICALLY-DRIVEN SENSORS IN THE PERENNIALLY ICE-COVERED LAKES OF THE MCMURDO DRY VALLEYS

Several perennially frozen lakes in ice-free region of the McMcMurdo Dry Valleys, Antarctica have been studied under the Long Term Ecological Research (LTER) project since 1993. Throughout the years, long-term sensor deployment has been implemented, providing a long-term temporal dataset. Currently, four lakes have year-round stage, ablation, surface PAR, and underwater PAR sensors deployed. The extreme environment and logistical constraints of the study site requires an innovative approach for robust systems. Challenges and issues of the instruments deployment and maintenance, such as sensor biofouling, will be discussed, followed by examples of long-term data observation and newly formulated hypothesis based on it. In addition, a brief overview of the Environmentally Non-Disturbing Under-ice Robotic Antarctic Explorer (ENDURANCE) project will be presented. The autonomous underwater vehicle (AUV) was deployed in Lake Bonney, Antarctica and have measured temperature, conductivity, PAR, chlorophyll-a, pH, and redox of the entire lake yielding unprecedented spatial and temporal data.

Ocasio-Torres, **M. E.**, University of Puerto Rico, Rio Piedras, Puerto Rico, mariaocasiotorres@gmail.com

Sabat, A. M., University of Puerto Rico, Rio Piedras, Puerto Rico, amsabat@gmail.com

Giray, T., University of Puerto Rico, Rio Piedras, Puerto Rico, tgiray2@yahoo.com

LONG ROSTRUM AS A DEFENSE MECHANISM FOR XIPHOCARIS ELONGATA

Amphidromous shrimp Xiphocaris elongata possess a short rostrum in headwater streams where predatory fishes cannot access, but have a long rostrum below waterfalls where predators are present (Covich et al. 2009). The objective of our investigation was to examine if the long rostrum exhibited by some X. elongata reduces their susceptibility to predation by catadromous fish Agonostomus monticola. We videotaped attacks by six A. monticola individuals on long and short rostrum shrimps. Tests consisted of two 15 minutes trials every other day for a total of 5 test days in which we fed the fish one shrimp with long rostrum and one shrimp with short rostrum simultaneously. Long rostrum shrimps were attacked significantly more than short rostrum individuals ($p=0.001$) for the same amount of consumptions. Long rostrum shrimps were also rejected significantly more than short rostrum individuals ($p=0.001$). A. monticola attacked first shrimp with short rostrum ($p<0.0001$). Handling time was significantly higher in long rostrum shrimps than short rostrum shrimps ($p=0.005$). This study suggests that long rostrum is an effective anti-predatory strategy in X. elongata.

Ochs, **C. A.**, University of Mississippi, University, USA, byochs@olemiss.edu

Pongruktham, O., University of Mississippi, University, USA, opongrkt@olemiss.edu

DARKNESS AT THE BREAK OF NOON: A MODEL FOR ALGAL NET PRODUCTION IN THE LOWER MISSISSIPPI RIVER

The importance of autochthonous production in large, turbid floodplain rivers in the temperate zone is unclear and controversial as there have been few detailed studies. We examined temporal patterns in suspended algal biomass and production in the main channel of the Lower Mississippi River. From samples collected during all seasons over 3 years (n = 52), we derived photosynthesis-irradiance curves to estimate values of algal photosynthetic parameters. From values of these parameters, average river depth, light environment, temperature, algal biomass, and estimated respiration rates, we modeled areal NPP. During the study period, algal biomass varied between about 3-24 micrograms chlorophyll/liter, and largely consisted of diatoms. NPP was negative from spring to mid-summer, when the river was high and turbid. In contrast, during the low-water period of late-summer and fall, when the suspended sediment load was reduced, NPP became positive, with a maximum rate of 1.7 grams C produced/square meter/day. These results indicate that the temporal pattern in LMR autochthonous production is directly related to seasonal variation in terrestrial inputs of water and soil particles.

ODaniel, **S**. **J**., CTUIR, Pendleton, USA, sodaniel@ctuir.com
Lambert, M. B., CTUIR, Pendleton, USA, mikelambert@ctuir.com
Webster, J. G., CTUIR, Pendleton, USA, jameswebster@ctuir.com
Volkman, J., CTUIR, Pendleton, USA, jedvolkman@ctuir.com

CLASSIFICATION OF PHYSICAL HABITAT FOR PACIFIC SALMON IN SEMI-ARID BASINS OF WASHINGTON AND OREGON

Currently, significant efforts are aimed at improving freshwater habitats that Pacific Salmon require for spawning and rearing. In order to inform fisheries management, we measure geologic, hydrologic, geomorphic variables that influences channel morphology across the Umatilla and Walla Walla River watersheds. We calculate several DEM derived measures (channel slope, SD channel slope, sinuosity, floodplain width, valley slope, wavelength of the channel belt and ratio of channel segment length to floodplain width) to produce both standard and statistically derived stream classifications. To estimate bed grain size, we used morphologic measurements from 10 meter DEMs and the Shields equation (Buffington et al. 2004). These watersheds are characterized by a long, low gradient, mainstem stream profiles with relatively steep tributaries. Simple logistic regression was used to compare geomorphic attributes and limiting life stages (egg and juvenile at life stages) for Oncorhynchus mykiss and Oncorhynchus tshawytscha. Widely available spatial datasets allow one to apply models over large areas to produce rapid, comparable stream habitat assessments.

Oelsner, **G**. **P**., U.S. Environmental Protection Agency, Corvallis, USA, oelsner.gretchen@epa.gov
Stoddard, J. L., U.S. Environmental Protection Agency, Corvallis, USA, stoddard.john@epa.gov

LONG TERM RESPONSE OF ACID-SENSITIVE VERMONT LAKES TO SULFATE DEPOSITION

Atmospheric deposition of sulfur can negatively affect the health of lakes and streams, particularly in poorly buffered catchments. In response to the Clean Air Act Amendments, wet deposition of sulfate decreased more than 35% in Vermont between 1990 and 2008. However, most of the sulfate deposition decrease occurred in the early 1990s. While sulfate concentrations in precipitation have continuously decreased, recent increases in precipitation have resulted in relatively consistent sulfate deposition loads in the past decade. Lake chemistry data collected as part of the U.S. EPA's Long Term Monitoring Program indicate that in 11 acid-sensitive Vermont lakes sulfate concentrations have decreased continuously since the mid-1980s, despite the relatively minor changes in sulfate deposition in the last decade. Due to synchronous decreases in base cation concentrations, ANC has not increased significantly in many of the lakes. Precipitation variability can explain 20 to 40% of the sulfate concentration variability in most of the lakes. Additionally, lake sulfate concentrations are likely mediated by sulfate retention in the soil. These results suggest that climate and hydrology variability can affect atmospheric deposition and lake chemistry.

Okuda, **N**., Center for Ecological Research, Kyoto University, Otsu, Japan, nokuda@ecology.kyoto-u.ac.jp
Sakai, Y., Center for Ecological Research, Kyoto University, Otsu, Japan, ysakai@ecology.kyoto-u.ac.jp
Kumagai, M., Lake Biwa Environmental Research Institute, Otsu, Japan, kumagai-m@lberi.jp

COMPLEX GLOBAL WARMING EFFECTS ON A LACUSTRINE FISH COUPLING BETWEEN PELAGIC, PROFUNDAL AND LITTORAL HABITATS

In spite of concern that climate changes can lead to mass extinction of aquatic organisms, there are few empirical researches to explore how such changes affect their population dynamics. Here we demonstrate that global warming can cause their population collapses in Lake Biwa harboring over 2800 species. A pelagic goby endemic to this lake has unique migratory habits, i.e., diurnal vertical migration for feeding and seasonal horizontal migration for breeding, resulting in coupling between pelagic, profundal and littoral habitats. In relation to climatic and non-climatic factors affecting its population dynamics, we tested six hypotheses: 1) profundal hypoxia, 2) decreased pelagic productivity, 3) reproductive phenology disturbance, 4) temperature-dependent reproductive competition, 5) temperature-independent food competition, and 6) temperature-independent predation. Based on analyses of long-term archival data and specimens, we judged that the hypotheses 1, 3 and 4 were most likely, suggesting that 5 and 6 could be resultant of its population collapse due to climatic factors. In conclusion, the climate effects on lacustrine organisms are not a simple thermal matter but a consequence of complex interactions between limnophysical, physiological and ecological processes.

Olafsson, **J**. **S**., INSTITUTE OF FRESHWATER FISHERIES, REYKJAVIK, Iceland, jsol@veidimal.is
Demars, B., The Macaulay Land Use Research Institute, Aberdeen, United Kingdom, B.Demars@macaulay.ac.uk
Friberg, N., National Ecological Research Institute, Silkeborg, Denmark, nfr@dmu.dk
Gislason, G. M., University of Iceland, Reykjavik, Iceland, gmg@hi.is
Gudmundsdottir, R., University of Iceland, Reykjavik, Iceland, rakelgud@hi.is
Hannesdottir, E. R., Univerity of Iceland, Reykjavik, Iceland, erh@hi.is
Woodward, G., Queen Mary University of London, London, United Kingdom, g.woodward@qmul.ac.uk

GEOTHERMALLY AFFECTED SPRING-FED ECOSYSTEMS AS A MODEL FOR ECOLOGICAL EXPERIMENTS

Due to its volcanic activity, Iceland has a vast number of geothermally affected ecosystems. Some of these systems encompass warm spring-fed streams. The great majority of these streams are affected by a high ion concentration, which usually characterize geothermal fluids. The water of some of them has the same or similar chemical composition as a nearby cold spring-fed system, with pH 7-8. In some areas there are clusters of such spring-fed systems of similar size but with variable temperature regimes. This gives an exceptional opportunity for ecological experiments with replicated set-ups i.e. for testing effects of global warming on freshwater ecosystems. The Hengill geothermal area, SW Iceland, has got all these features. We have therefore chosen it for testing ecological hypothesis regarding the possible impact from global warming on such ecosystems. Sudden and significant changes can be seen in the succession of primary producers and delayed influence on the macro-fauna. Furthermore, the whole stream metabolism was assessed, where ecosystem respiration, gross primary production and net ecosystem production response to temperature were measured.

Olson, **J**. **R**., Utah State University, Logan, USA, john.olson@usu.edu
Hawkins, C. P., Utah State University, Logan, USA, chuck.hawkins@usu.edu

PREDICTING NATURAL, SITE-SPECIFIC NUTRIENT CONCENTRATIONS IN WESTERN USA STREAMS

Stream nutrient standards should ideally be based on the natural potential of individual sites. However, determining site potentials is difficult because we lack data characterizing major natural processes controlling nutrient concentrations within and across regions. Therefore criteria are typically derived from the range of nutrient concentrations observed among reference-quality sites within a region, resulting in imprecise standards caused by within-region heterogeneity. We developed Multiple Linear Regression and Random Forest models to estimate natural, base-flow concentrations of total phosphorus (TP) and total nitrogen (TN) concentrations from data collected at over 700 reference sites across the western USA. Of the candidate predictor variables we examined (rock physiochemical properties, climate, topography, atmospheric deposition, hydrology, vegetation, and soils), rock %P and precipitation were most useful in predicting TP. Precipitation, soil K-factor, vegetation, and N deposition were most useful in predicting TN. Our models performed well enough (TP RMSE = 12 µg/L over a range of 0.4-290 µg/L and TN RMSE = 48 µg/L over a range of 5-900 µg/L) to allow establishment of more precise and defensible nutrient criteria and support site-specific TMDL development.

Olson, **R**. **J**., Inter-American Tropical Tuna Commission, La Jolla, CA, USA, rolson@iattc.org

APEX PREDATION IN THE EASTERN TROPICAL PACIFIC: LESSONS FROM FISH AND FISHERIES

A single-species approach to tuna fisheries management considers the tunas as apex predators, with no explicit consideration of inter-annual changes in the abundance of their predators. A recent comprehensive evaluation of multispecies diet data showed that sharks and billfishes are important predators of yellowfin and skipjack tuna in the Pacific Ocean, and the true apex predators could potentially play an important role in regulating the tuna populations. However, stomach contents are variable, and trophic structure is best determined by biochemical indicators that integrate feeding over recent months. Stable nitrogen isotopes of yellowfin tuna compared to isotope values

near the base of the food web and amino-acid specific isotope analysis confirmed the status of yellowfin as a secondary predator in the ETP, and also revealed a trophic structure heretofore unknown from stomach contents. Ecological implications of decreasing shark and increasing squid populations are examined using a mass balance food web model.

Olszewski, **M**. **M**., Loyola University Chicago, Chicago, USA, molszew@gmail.com
Geddes, P., Northeastern Illinois University, Chicago, USA, p-geddes@neiu.edu
Larkin, D., Chicago Botanic Garden, Chicago, USA, dlarkin@chicagobotanic.org
Lishawa, S., Loyola University Chicago, Chicago, USA, slishawa@gmail.com
Mitchell, M. E., Loyola University Chicago, Chicago, USA, mmitchell4@luc.edu
Tuchman, N., Loyola University Chicago, Chicago, USA, ntuchma@luc.edu

EFFECTS OF INVASIVE PLANT TYPHA X GLAUCA ON WETLAND DENITRIFICATION AND EMISSION OF NITROUS OXIDE

Denitrification (DN), a critical wetland ecosystem function requires specific soil conditions: anoxia, and the availability of nitrate (NO_3^-) and organic carbon. The invasive plant *Typha x glauca* has been associated with increased soil NO_3, organic matter and also with greater soil aeration, which may result in incomplete reduction of NO_3^- to N_2 and increased flux of N_2O, a potent green house gas. To test these interactions, two experiments were conducted: 1) DN activity of soil cores collected along a gradient of *Typha* densities from Lake Michigan coastal wetlands was analyzed using acetylene inhibition and helium assays; and 2) $^{15}NO_3^-$ was traced through the DN process in controlled microcosms with wetland soils at a range of redox levels. Results from the acetylene inhibition assay were inconclusive as to whether *Typha* affected DN quality, likely resulting from uneven distribution of site specific water levels. Helium assay samples are currently being analyzed. Results from the ^{15}N study revealed a strong positive relationship between soil aeration and relative N_2O emissions. This suggests, *Typha* mediated increases in soil aeration, may result in increased N_2O emissions.

Opsahl, **S**. **P**., Jones Research Center, Newton, USA, sopsahl@jonesctr.org
McEntire, J. M., Jones Research Center, Newton, USA, mcentirj@gmail.com
Covich, A. P., Odum School of Ecology, Athens, USA, alanc@uga.edu

INTERNAL CYCLING OF NUTRIENTS AND DISSOLVED ORGANIC CARBON IN A SUBTROPICAL RESERVOIR: IMPLICATIONS FOR WATERSHED DELIVERY TO THE NORTHERN GULF OF MEXICO

Lake Seminole forms at the confluence of the Chattahoochee and Flint River watersheds and serves as source water for the Apalachicola River/Bay system. Over an annual cycle, we observed elevated nitrate concentrations in the Flint River basin during base flow reflecting large scale groundwater contributions of excess nitrate. Dissolved organic carbon (DOC) transported within the Flint River basin was diluted by groundwater during low flows and was elevated during high flows due to flushing of regional wetlands. Conversely, DOC pulses in the Chattahoochee River were diminished suggesting that increased water residence time in multiple upstream reservoirs dampened storm-driven DOC pulses. Influxes of nitrate and phosphate to Lake Seminole usually exceeded export to the Apalachicola River and the reservoir retained as much as 88% of the NO3- load and 90% of the PO4- load. In contrast, Lake Seminole frequently appeared to be a source for DOC. These findings carry broad implications for nutrient and DOC delivery into Apalachicola Bay and highlight the important roles performed by inland waters.

Ordóñez, **V**., Laboratorio de Ecología Acuática, Universidad San Francisco de Quito, Quito, Ecuador, sire_ordonez@hotmail.com
Encalada, A., Laboratorio de Ecología Acuática, Universidad San Francisco de Quito , Quito, Ecuador, aencalada@usfq.edu.ec
Ríos, B., Departamento de Ecología, Universidad de Barcelona, Barcelona, Spain, brios@ub.edu
Prat, N., Departamento de Ecología, Universidad de Barcelona, Barcelona, Spain, nprat@ub.edu
Vimos, D., Laboratorio de Ecología Acuática, Universidad San Francisco de Quito, Quito, Ecuador, diego_v02@yahoo.com

EFFECTS OF LAND USE ON THE ECOLOGICAL INTEGRITY OF HIGH-ALTITUDE ANDEAN STREAMS IN NORTHERN ECUADOR

High altitude ecosystems provide most of the water for cities and irrigation in the Andean region. Land-use pressures in these landscapes are growing rapidly without planning. We studied the effects of land use in the ecological integrity of high-Andean streams in northeastern Ecuador to contribute to land-use management strategies. During 2009, we studied three microcatchments divided in two altitudinal ranges (2800 – 3000 m and 3500 – 4000 m). At each altitude, three land-use types and a control site were chosen. In each land-use type we choose three streams and at each one we sampled stream physicochemical and biological factors, and land-use parameters at three different scales (watershed, corridor and reach). Our preliminary results suggest strong effects of mining and urban settlements on stream invertebrate communities, as indicated by lower alfa diversity and higher density of Chironomidae and Tubificidae. Richness was higher at control sites and higher altitudes. Overall, stream ecosystem integrity was lower at mining sites. Results of this research will be used to guide land-use management strategies to conserve the integrity of high-Andean streams.

O'Reilly, **C**. **M**., Bard College, Annandale, USA, oreilly@bard.edu
Gibson, C. A., Skidmore College, Saratoga Springs, USA, cgibson@skidmore.edu
Hannigan, E., Bard College, Annandale, USA,
Miller, L., Bard College, Annandale, USA,
Rahmati, M., Bard College, Annandale, USA,

ORGANIC MATTER STOICHIOMETRY COUPLES N AND P DYNAMICS IN A HEADWATER STREAM

Linking nitrogen and phosphorus cycles is of increasing interest in ecology. We measured nitrate, ammonium, and phosphate uptake in a headwater stream in New York weekly knotweed throughout autumn. Headwater streams are heterotrophic, detritus-based systems. We found that N and P uptake were closely coupled. N and P uptake gradually changed as leaf litter inputs accumulated, with increases in NH_4^+ uptake and declines in NO_3^- and PO_4^{3-} uptake. This is likely because of increased microbial demand for NH_4^+ due to the input of leaf litter that had low N:P ratios. The stoichiometry of the organic matter was a primary factor explaining N and P uptake, with N:P of the dominant organic matter highly correlated with N:P uptake ratios. After a flood event flushed leaf litter from the stream, the nature of the relationship between N and P uptake shifted, but not the strength of the coupling.

Orihel, **D**. **M**., University of Alberta, Edmonton, Canada, orihel@ualberta.ca
Vinebrooke, R. D., University of Alberta
Proctor, H. C., University of Alberta
Wilson, L., University of Alberta
Schindler, D. W., University of Alberta

MANAGEMENT OF INTERNAL EUTROPHICATION IN SHALLOW LAKES: IS IRON TREATMENT AN EFFECTIVE REMEDIATION STRATEGY?

Reductions in external phosphorus loading have been highly effective in controlling eutrophication in some lakes, but have had surprisingly little effect in others. In many shallow lakes, phosphorus reductions have not led to improvements in water quality because of the continued release of phosphorus from lake sediments. A potential remediation technique for inhibiting internal phosphorus recycling in eutrophic waterbodies is iron treatment. Iron applications have successfully controlled internal eutrophication in a number of lakes and reservoirs, but the use of iron for remediation has a short history and the science behind this management approach is in its early stages. We are assessing the feasibility of iron treatment for controlling internal phosphorus loading in shallow prairie lakes. Our research spans several scales of inquiry, using in vitro sediment assays, in situ replicated lake mesocosm experiments, and whole dugout manipulations. In this presentation, we describe how iron treatment improved water quality in a shallow, hypereutrophic lake. We applied different amounts of iron to fifteen large in-lake mesocosms and monitored changes in water quality over 10 months. Iron treatment inhibited internal phosphorus loading, reduced the biomass of phytoplankton, caused shifts in phytoplankton species composition, and decreased levels of cyanobacterial toxins.

Orive, **E**., University of the Basque Country, Leioa, Spain, emma.orive@ehu.es
Alonso, A., University of the Basque Country, Leioa, Spain, aitor.alonso@ehu.es
Laza-Martínez, A., University of the Basque Country, Leioa, Spain, aitor.laza@ehu.es
Seoane, S., University of the Basque Country, Leioa, Spain, sergio.seoane@ehu.es

TAXA IDENTIFICATION: A DIFFICULT TASK FOR PHYTOPLANKTON MONITORING IN ESTUARINE WATERS

Phytoplankton biomass and productivity are regularly determined by standard methods which can give an accurate estimate of both attributes. However, when dealing with phytoplankton taxonomic composition many constrains are found even when using several methodological approaches jointly. In this study we compare the information on phytoplankton taxonomical composition provided by the application of different methodological approaches during ten years of phytoplankton monitoring in the Nervion River estuary (Bay of Biscay, Northern Spain). The use of optic and electron microscopy, HPLC analysis of pigments, flow citometry and several molecular methods on both natural and cultured naterial have revealed the presence of cryptic or semicryptic species and of fragile or small sized taxa which would have remained undetected with the routine monitoring of estuarine waters.

Orlofske, **J. M.**, Canadian Rivers Institute, and Dept. Biology, Univ. New Brunswick, Fredericton, Canada, j.orlofske@unb.ca

Baird, D. J., Environment Canada @ Canadian Rivers Institute, Dept. Biology, Univ. New Brunswick , Fredericton, Canada, djbaird@unb.ca

TRAITS-BASED METRICS AND NATURAL VARIABILITY IN BODY SIZE AND SHAPE IN AQUATIC INSECTS

Traits-based metrics describe community structure through characteristics of organisms instead of taxonomic lists. Traits-based metrics present an alternative approach for aquatic biomonitoring programs by incorporating functional attributes of the ecosystem, and offering greater potential to explain mechanisms of perceived environmental perturbations. We investigate natural variability in body size and body shape traits in populations of four groups of commonly-occurring larval aquatic insects (Ephemeroptera, Plecoptera, Trichoptera, and Odonata). Body size and body shape integrate an aquatic organism's adaptation to stream conditions. In November 2007, benthic macroinvertebrate samples were collected from riffle habitats in 3 stream reaches of the Renous and Dungarvon tributaries of the Miramichi River in New Brunswick, Canada. Aquatic insect specimens were identified to lowest taxonomic level, examined with a stereomicroscope and digitally photographed. Body size measurements were made using calibrated photographs and AutoMontage software. Landmarks established for each insect order were plotted on the specimen photographs and used for geometric-morphometric analysis. Trait variation was summarized for each taxon. A better understanding of natural variation in aquatic insect traits can lead to the development of more refined trait-based metrics.

Osborne, **M. J.**, University of New Mexico, Albuquerque, USA, mosborne@unm.edu

Turner, T. F., University of New Mexico, Albuquerque, USA, turnert@unm.edu

AND PARASITE DIVERSITY IN THE RIO GRANDE SILVERY MINNOWβMULTI-LOCUS MAJOR HISTOCOMPATIBILITY COMPLEX CLASS II

Genetic variation forms the basis of a species' ability to adapt and respond to changing environments. Moreover, their long-term persistence depends partially on avoiding loss of this variation. For example, genetic variation of immune genes serves as the foundation of an individual's response to disease pressures. Variation at immune genes is especially important for aquatic species, whose chemical and microbial environment is impacted heavily by humans, which may increase their risk of exposure to pathogens. We characterized diversity at the major in the Rio Grande silveryβhistocompatibility complex (MHC) Class II minnow, *Hybognathus amarus* . These data were used to examine the relationship between MHC variation and pathogen diversity. Seventy-two different MHC alleles belonging to three divergent groups were identified. The transcription of particular alleles was associated with both heavier and lighter infection by certain parasites. No association between gill parasite diversity or abundance and MHC diversity was detected, nor was there an association between pathogen diversity or abundance and the number of MHC allelic groups expressed by individuals. Parasite and bacterial species diversity and abundance also differed spatially.

Osborne-Gowey, **J.**, Conservation Biology Institute, Corvallis, USA, jeremiah@consbio.org

Strittholt, J., Conservation Biology Institute, Corvallis, USA, stritt@consbio.org

Ward, B., Conservation Biology Institute, Corvallis, USA, bcward@consbio.org

Callaway, P., Conservation Biology Institute, Corvallis, USA, phillip@consbio.org

Bergquist, J., Conservation Biology Institute, johnb@consbio.org, USA, Corvallis

Comendant, T., Conservation Biology Institute, Corvallis, USA, tosha@consbio.org

Bachelet, D., Conservation Biology Institute, Olympia, USA, dominique@consbio.org

DATA BASIN AQUATIC CONSERVATION CENTER: EXPANDING ACCESS TO AQUATIC CONSERVATION DATA, VISUALIZATION TOOLS, PEOPLE AND PRACTICAL ANSWERS

The world's aquatic resources are experiencing unprecedented pressure as aquatic habitats and organisms are experiencing widespread declines. Climate change is likely to exacerbate these threats. Scientists are generating large volumes of data that vary in quality, format, supporting documentation, and accessibility. Diverse models are being run at various temporal and spatial scales as scientists attempt to understand previous (and project future) impacts on aquatic species and their habitats. Natural resource practitioners, however, often struggle to extract relevant information. As a result, the best available science is often under-utilized. As aquatic conservation problems around the globe become more serious, scientists and practitioners need to bring strategic, science-based approaches to aquatic conservation. The Aquatic Conservation Center is being designed and built by the Conservation Biology Institute in partnership with ESRI as part of Data Basin – a new web-based conservation resource that centralizes reliable datasets and provides tools to visualize data, communicate findings, and link conservation scientists and practitioners. To illustrate its utility, we present example datasets of varying spatial scales and synthesize multiple studies to help practitioners arrive at novel solutions to aquatic threats.

Óskarsson, **H.**, Agricultural University of Iceland, Reykjavik, Iceland, hlynur@lbhi.is

Guðmundsson, J., Agricultural University of Iceland, Reykjavik, Iceland, jong@lbhi.is

ORGANIC CARBON STOCK OF PLANNED IMPOUNDMENT AREAS: A USEFUL PREDICTOR OF FUTURE RESERVOIR METHANE RELEASE?

Hydroelectric reservoirs are known to emit greenhouse gases for some years following impoundment. However, the release has been found to be highly variably depending on numerous environmental and engineering factors. Future greenhouse gas release of planned reservoirs is an important factor to consider when selecting between possible reservoir locations. Currently there are no means of predicting future gas release of individual reservoirs. Organic matter is prerequisite for the production of greenhouse gases and hence holds promise as a useful predictor of future gas release. This study examines the possibility of using organic carbon levels of planned impoundment areas as a predictor of future methane release. Here we report on the fist part of a study where we examined, under controlled laboratory conditions, the relationship between organic carbon levels of inundated soil cores and amount of methane release. First results indicate that there is a good relationship between soil organic carbon and amount of methane released under inundation. These results need to be verified in situ.

Osterback, **A. K.**, University of California Santa Cruz, Santa Cruz, USA, osterbac@biology.ucsc.edu

Frechette, D. M., Moss Landing Marine Laboratories, Moss Landing, USA, dfrechette@mlml.calstate.edu

Hayes, S. A., NOAA Southwest Fisheries Science Center, Santa Cruz, USA, Sean.Hayes@noaa.gov

Bond, M. H., University of Washington, Seattle, USA, mobond@u.washington.edu

Shaffer, S. A., San Jose State University, San Jose, USA, scott.shaffer@sjsu.edu

Moore, J. W., University of California Santa Cruz, Santa Cruz, USA, jwmoore@biology.ucsc.edu

SUBSIDIZED PREDATORS AND IMPERILED PREY: THE IMPACT OF AVIAN PREDATORS ON SALMONIDS

The impact of predators on prey species can be magnified when predators are subsidized by flow of nutrients across ecosystem boundaries, especially when subsidies increase predation on imperiled prey. For this study, we investigated the impact of predation by seabirds (primarily Western gulls) on threatened and endangered steelhead and coho salmon in central California coastal streams. Gulls are heavily subsidized by anthropogenic food resources and have experienced population increases, whereas salmonid species have declined precipitously. We quantified minimum gull predation rates by scanning nearby nesting areas for salmonid PIT tags that were regurgitated by seabirds. From 2002 to 2008, the recovery of PIT tags accounted for 0.2-2.5% of the tagged population of salmonids in each stream. Distance from stream river mouth to the seabird nesting site was inversely related to inferred predation rates. We

conducted large-scale tagging experiments to refine predation estimates and compare rates between streams. These data reveal a previously overlooked source of mortality for threatened and endangered steelhead and coho salmon, and suggest subsidized predators are contributing to salmonid declines.

Ouellet, **A**., Concordia University, Montreal, Canada, axouellet@hotmail.com
Tremblay, L., Université de Moncton, Moncton, Canada, luc.tremblay@umoncton.ca
Plouhinec, J. B., UQAM, Montreal, Canada, jbplouhinec@hotmail.com
Soumis, N., UQAM, Montreal, Canada, maitrecarbo@gmail.com
Lucotte, M. M., UQAM, Montreal, Canada, lucotte.marc_michel@uqam.ca
Gélinas, Y., Concordia University, Montreal, Canada, ygelinas@alcor.concordia.ca

DIFFERENCES IN MICROBIAL CYCLING BETWEEN LAKES AND RESERVOIRS: EVIDENCE FROM AMINO AND LIPIDIC BIOMARKERS

GHG supersaturation in lakes and reservoirs is mainly modulated by heterotrophic bacterial activity. In this study, transient disturbances (nutriments and organic matter inputs) resulting from watershed wood harvesting events were used to understand the major differences in the summer cycle of carbon between lakes and reservoirs from the boreal forest. Bulk and molecular analytical techniques (C:N ratios, $\delta^{13}C_{org}$, $\delta^{13}C_{inorg}$, amino acids and lipid biomarkers) were applied to dissolved, particulate and sedimentary OM from lake and reservoirs with a non-impacted or wood-harvested watershed. Carbon concentrations, C:N ratios and water-column profiles of $\delta^{13}C$ of dissolved inorganic and particulate carbon differ among scenarios, which suggests significant differences in the biogeochemical processes controlling carbon dynamics. This is further reinforced by the analysis of amino acids and lipid biomarkers in the same fractions, which suggest increased inputs of terrestrial dissolved organic matter in perturbed water bodies. These inputs stimulate bacterial growth and result in increased dissolved CO_2 concentrations. A complete lipid biomarker dataset will be presented, which unambiguously emphasizes the importance of allochthonous carbon and heterotrophic bacterial activity in the dynamics of carbon in these systems.

Overstrom-Coleman, **M**., Dartmouth College, Hanover, USA, maxwell.overstrom-coleman@dartmouth.edu

IMPACT OF KELP-DERIVED PARTICULATE ORGANIC MATTER ON INVERTEBRATE COMMUNITIES

Kelp-derived productivity drives the diversity and dynamics of kelp forest systems. Most kelp forest food web studies have focused on direct kelp-grazer interactions, yet drift kelp, particulate organic matter (POM) and dissolved organic matter (DOM) are hypothesized to be important, if not primary, energy sources in kelp forest food webs. This study tested the hypothesis that plankton-derived POM was significantly enriched by kelp-derived POM within kelp systems. POM concentrations were significantly and consistently higher inside of the kelp bed relative to outside. Peak POM concentrations coincided with heavier Delta-13C signatures in POM suggesting enrichment was driven by kelp-derived POM production. Invertebrate tissues collected from with in the kelp bed exhibited significantly heavier Delta-13C signatures than invertebrate tissues collected outside the boundary of the kelp bed. Plankton-derived productivity is the dominant foundational food source of many marine ecosystems, however in the nearshore environment of central California the availability and consumption of macrophyte-based primary productivity is of such magnitude to be ecologically significant.

Oviedo-Vargas, **D**., Indiana University, Bloomington, IN, USA, dioviedo@indiana.edu
Johnson, L. T., Indiana University, Bloomington, IN, USA, latjohn@indiana.edu
Royer, T. V., Indiana University, Bloomington, IN, USA, troyer@indiana.edu
Leff, L. G., Kent State University, Kent, OH, USA,

CHARACTERIZATION OF DISSOLVED ORGANIC CARBON SOURCES IN AN AGRICULTURAL STREAM IN CENTRAL INDIANA

Dissolved organic carbon (DOC) plays many roles in freshwater systems including a strong interaction with other nutrient cycles. However, DOC dynamics in stream ecosystems are not fully understood because of the chemical complexity and multiple origins of DOC. We examined potential sources (upstream and lateral inputs, algal exudates, photodissolution) and sinks (downstream exports, community respiration) of DOC in an agricultural stream in central Indiana. The results suggest a 2.5% increase in DOC over the 100m reach, indicating the existence of autochthonous sources of DOC. We determined that algal exudates could account for as much as 13% of the total inputs while photodissolution likely accounted for only 1%. Fluorescence index (FI) values ranged from 1.8 to 2.0 suggesting the majority of DOC in the stream was microbially derived. DOC bioavailability was 25%, indicating the DOC was also relatively labile. In forested streams, DOC is primarily terrestrial in origin; however our results suggest a high proportion of autochthonous origins in agricultural streams. Therefore, DOC dynamics represent another example of the altered biogeochemical cycles that characterize agricultural streams.

Owen, **R**., Scottish Environment Protection Agency, Aberdeen, United Kingdom, roger.owen@sepa.org.uk
Pardo, I., Universidad de Vigo, Vigo, Spain, ipardo@uvigo.es

THE EUROPEAN REFERENCE CONDITION CONCEPT: A SCIENTIFIC AND TECHNICAL APPROACH TO IDENTIFY MINIMALLY IMPACTED AQUATIC ECOSYSTEMS

We describe the approach used to set widely-applicable criteria for the identification of sites in reference conditions that have been agreed and applied at EU level. This work was part of the Water Framework Directive intercalibration exercise for ecological classification of Central and Baltic European rivers. The Central-Baltic geographic intercalibration group included 17 European countries, stretching from Ireland in the West to Estonia in the East and took the lead in method development for rivers intercalibration. The aim was to develop objective, transferable criteria for reference conditions, akin to the "minimally disturbed condition" (MDC), i.e. allowing a minimal level of anthropogenic impairment based on abiotic characteristics rather than on properties of the biota. A protocol was developed for the consistent application of agreed quantitative and qualitative pressure thresholds to identify candidate water bodies as reference rivers. Alternative methods for the establishment of the upper threshold of biological classification systems included modeling of the reference condition, and the use of biological benchmarks of known level of abiotic disturbance. These criteria are undergoing further refinement for the second round of EU intercalibration.

Owens, **D**. **C**., University of Nebraska, Lincoln, NE, USA, davidchristopherowens@yahoo.com
Thomas, S. A., University of Nebraska, Lincoln, NE, USA, sthomas5@unlnotes.unl.edu
Heatherly, T. N., University of Nebraska, Lincoln, NE, USA, heatherly75@yahoo.com
Flecker, A. S., Cornell University, Ithaca, NY, USA, asf3@cornell.edu

SEASONAL VARIATION IN TERRESTRIAL INSECT SUBSIDIES TO TROPICAL STREAMS AND IMPLICATIONS FOR RIVULUS DIET

Invertebrate prey moves across the aquatic-terrestrial boundary and subsidizes both stream and riparian ecosystems. In temperate streams, fish respond to seasonal variation in the supply of terrestrial insects by shifting their diet between aquatic and terrestrial invertebrates as their relative abundance changes. We investigated whether seasonality in the tropics (wet-dry season transitions) similarly influences terrestrial invertebrate delivery to streams and whether fish diets track these changes. We examined this question by measuring terrestrial invertebrate fall-in, benthic and drifting invertebrates, and fish gut contents in the wet and dry season in three streams draining Trinidad's Northern Range. Input rates of terrestrial invertebrates increased ~20% in the wet season compared to the dry season and varied with canopy cover and daily precipitation rates. In contrast, benthic invertebrate abundance declined 6-fold between dry and wet seasons. Preliminary evaluation of invertebrate drift and Rivulus hartii diets suggests seasonal shifts in the relative importance of terrestrial invertebrates in stream food webs. However, these seasonal shifts appear to be driven by large changes in benthic invertebrate biomass rather than variation in terrestrial subsidies.

Yadamsuren, O., Clemson University, Clemson, USA, oyadams@clemson.edu
Gelhaus, J. K., Academy of Natural Sciences, Philadelphia, USA, gelhaus@ansp.org
Podenas, S., Vilnius University, Vilnius, Lithuania, sigitas.podenas@gf.vu.lt
Bazartseren, B., National University of Mongolia, Ulaanbaatar, Mongolia, boldgiv@biology.num.edu.mn
Hayford, B., Wayne State College, Wayne, USA, bhayford@gmail.com

TRENDS IN DIVERSITY OF CRANE FLIES (DIPTERA: TIPULOIDAE) IN LAKE HOVSGOL REGION, MONGOLIA

Adult crane flies were sampled in six stream valleys of the eastern shore of Lake Hovsgol, Mongolia by various qualitative and semi-quantitative methods during 2002-2005 as part of the Hovsgol GEF project. A total of 119 species was found

during the study period, with 47 species newly recorded for the Lake Hovsgol watershed in the following subfamilies: Tipulinae - 23 spp.; Limoniinae – 17; Choineinae – 6; and Limnophilinae – 1. Species composition was compared between this study and a previous study in the same region (Gelhaus and Podenas, 2006) making a combined total of 135 species known for the Lake Hovsgol region. A total of 17 species were unique for the earlier study and 49 species unique for this study. Species acummulation analysis was conducted on the data and based on Chao 1 diversity estimates it was concluded that sampling efforts for the study were enough to discover the most of diversity of Tipuloidea in the region. Keywords: Tipuloidea, diversity, Hovsgol region.

OZ, **B.**, UNIVERSITY OF NOVA GORICA, NOVA GORICA, Slovenia, basakozz@gmail.com

BRANCELJ, A., NATIONAL INSTITUTE OF BIOLOGY, LJUBLJANA, Slovenia, Anton.Brancelj@nib.si

DIFFERENCES IN MACROINVERTEBRATE COMMUNITIES OF SPRINGS IN THE ALPINE REGION OF SLOVENIA (EUROPE) RELATED TO HYDROGEOLOGY

Three mountain ranges in the Alpine region of Slovenia (the Julian Alps, the Karavanke and the Kamnisko-Savinjske Alps) are different in terms of geology, hydrology and climate. The whole area is characterised with abundant subterranean aquifers interconnected with surface in a form of karstic springs. Twelve springs in three Alpine regions were selected for studies of faunal composition between high and low discharge seasons in 2009. Springs are located in an area of c. 1600 km2 between 500 and 2000m of the altitude where physical and chemical variables and biological samples were collected. Selected taxonomic groups, as Gastropoda, Hydrachnida, Amphipoda and larvae of Ephemeroptera, Plecoptera, Diptera and Trichoptera were determined to the lowest possible taxonomic level. The differences in macroinvertebrate community structure were significantly pointed out also differences and influences between three hydrogeological systems. Practical multivariate analysis and diversity indices with Sorenson's similarity index were applied to indicate the most significant interactions of spring communities with their ecological requirements.

Ozersky, **T.**, University of Waterloo, Waterloo, Canada, tozersky@gmail.com

Barton, D. R., University of Waterloo, Waterloo, Canada, drbarton@sciborg.uwaterloo.ca

Evans, D. O., Ontario Ministry of Natural Resources, Peterborough, Canada, david.evans@ontario.ca

THIRTEEN YEARS OF *DREISSENA*: CHANGES TO INVERTEBRATE COMMUNITY STRUCTURE AND ENERGY FLOW IN THE LITTORAL ZONE OF A LARGE LAKE

Invasive dreissenid mussels are ecosystem engineers capable of modifying numerous aspects of aquatic environments. Relatively few studies have investigated the long-term effects of dreissenid colonization on invertebrate communities inhabiting rocky nearshore habitats. Still fewer studies have examined dreissenid-mediated changes to energy flow patterns in benthic communities. We use pre- and post-dreissenid quantitative invertebrate data to describe changes to the numerical abundance and community composition of nearshore benthos at four sampling locations and three different depths in Lake Simcoe, Ontario. Isotope analysis of components of the benthic food web is used to infer changes to energy flow patterns that followed the dreissenid invasion of the lake. Our results show large increases in the abundance of almost all benthic organisms and increased proportional abundance of Amphipoda and Isopoda following dreissenid establishment. Stable isotope analysis shows considerable change in the source of carbon driving the post-dreissenid littoral benthic food web, with dreissenid feces and pseudofeces likely serving as an important food resource. Overall, our results show enormous change to the ecology of the nearshore benthic community with important implications for higher trophic levels.

Pace, **M. L.**, University of Virginia, Charlottesville, USA, pacem@virginia.edu

Strayer, D. L., Cary Institute of Ecosystem Studies, Millbrook, USA, strayerd@caryinstitute.org

Fischer , D., Cary Institute of Ecosystem Studies, Millbrook, , fischerd@caryinstitute.org

Malcom, H., Cary Institute of Ecosystem Studies, Millbrook, USA, malcomh@caryinstitute.org

HOW THE ZEBRA MUSSEL LOST ITS GRIP: RECOVERY OF ZOOPLANKTON IN THE HUDSON RIVER

We have studied an invasion of zebra mussels (Dreissena.polymorpha) into the Hudson River (New York, USA) over a 22 year period inclusive of five years of pre-invasion observations. Zebra mussels caused changes in the abundance, distribution, biomass and productivity of many groups of organisms including zooplankton. However, over the last few years zooplankton, but not phytoplankton, have recovered to pre-invasion abundance and biomass. Average zooplankton biomass prior to the invasion was 35 micrograms C per liter. In the post-invasion years of 1992-2004 average biomass was 18 micrograms C per liter about 50% of the pre-invasion level. For the years 2005-2008 average zooplankton biomass was 39 micrograms C per liter similar to pre-invasion levels While zebra mussels are still present and abundant in the Hudson, their impact on zooplankton biomass has disappeared. This change is consistent with an increased mortality of larger zebra mussels that has altered the size structure and filter feeding impact of the population.

Packman, A., Northwestern University, Evanston, USA, a.packman@northwestern.edu

Zhang, W., Northwestern Unviersity, Evanston, USA,

Lee, J., Northwestern University, Evanston, USA,

RELATIONSHIPS BETWEEN ENVIRONMENTAL CONDITIONS AND MIRCOBIAL PROCESSES MEDIATED BY HYDRODYNAMIC TRANSPORT CONDITIONS

Microbes are ubiquitous in aquatic and sedimentary systems, and their community metabolism drives numerous biogeochemical cycles. In energetic shallow-water environments such as rivers, microbes persist primarily in surface-attached communities (biofilms). Recent advances in analytical methods provide highly detailed information on biofilm structure and architecture, as well as flow patterns and chemical gradients around and within biofilms. We are employing non-invasive, high-resolution methods to investigate the coupling between local environmental conditions and biofilm heterogeneity in novel flow cells. Biofilms develop into highly structured ecosystems because of internal gradients that arise from the competition between solute delivery from the surrounding fluid and cellular metabolism. Flow-biofilm interactions play a key role in this process by controlling transport of oxygen, carbon, and nutrients into and within the biofilm, and also by shaping biofilm morphology through erosion and sloughing. Competition between substrate delivery and shear-induced erosion causes dramatically different patterns to develop under flow gradients of differing magnitude. Further, colonization of surfaces by strongly adherent organisms enables weakly adherent organisms to persist under high-flow conditions where they would otherwise be removed by erosion.

Paffenhofer, **G. A.**, Skidaway Institute of Oceanography, Savannah, USA, gustav.paffenhofer@skio.usg.edu

HOW DID WE GET TO STUDYING PELAGIC TUNICATES, AND HOW DID WE ADVANCE?

When Shelbourne (1962) and Ryland (1966) revealed that the appendicularian Oikopleura dioica was the main food of larvae of plaice and sand-eel in the southern North Sea during late winter and early spring, major interest emerged in processes of that food species. Laboratory studies, simulating in situ conditions, showed that growth and reproduction rates of O. dioica were sufficiently high to cover the food requirements of plaice larvae at environmental temperatures and food levels (Paffenhöfer 1976). The extraordinary fast zooid growth rates and short generation times of the neritic salp Thalia democratica were described by Heron (1972). It represented the beginning of about 35 years of field and laboratory studies on Thaliacea (doliolids and salps) on the U.S. SE shelf (e.g. Atkinson et al. 1978, Pomeroy and Deibel 1980, Deibel 1985, Gibson and Paffenhöfer 2000, Deibel and Paffenhöfer 2009). Success of these studies partly hinged on type of sampling, and experimental conditions which closely resembled those in the ocean. We will describe and evaluate these approaches in detail. Questions are welcome during the presentation!

Palkovacs, **E. P.**, Duke University Marine Laboratory, Beaufort, NC, USA, eric.palkovacs@duke.edu

Post, D. M., Yale University, New Haven, CT, USA, david.post@yale.edu

THE ALEWIFE AS A DOMINANT PLANKTIVORE: BROOKS AND DODSON REVISITED

Predators can structure prey communities by selectively consuming favored prey. This basic insight traces its beginnings in large part to the seminal work of John

Brooks and Stanley Dodson on alewife-zooplankton interactions in Connecticut lakes. Brooks and Dodson (1965) is a classic because it was among the first studies to conclusively demonstrate that predation can structure ecological communities. Forty years after Brooks and Dodson, we returned to examine the zooplankton and phytoplankton communities of Connecticut lakes. Brooks and Dodson's lakes either lacked alewives or contained landlocked alewives. To this we added a third lake type – lakes containing anadromous alewives. Anadromous alewives are seasonally present in freshwater lakes. As a result, the zooplankton and phytoplankton communities in anadromous lakes toggle between the landlocked and no alewife states. In addition, anadromous and landlocked alewives show evolutionary divergence in foraging traits, with important consequences for mid-summer zooplankton and phytoplankton communities. Our results build on the original conclusions of Brooks and Dodson by showing that phenotypic variation within dominant predator species can have profound impacts on ecological communities.

Papoulias, **D**. **M**., US Geological Survey, Columbia Environmental Research Center, Columbia, USA, dpapoulias@usgs.gov

Annis, M. L., US Geological Survey, Columbia Environmental Research Center, Columbia, USA, mannis@usgs.gov

Davis, A., , Albuquerque, USA, a.davis@comcast.net

Lusk, J. D., US Fish and Wildlife Service, Albuquerque, USA, joel_lusk@fws.gov

Zabotkina, E., Russian Academy of Science, Institute for Biology of Inland Waters, Borok, Russian Federation, zabel@ibiw.yaroslavl.ru

Nazarova, E., Russian Academy of Science, Institute for Biology of Inland Waters, Borok, Russian Federation, katarinum@mail.run

Tillitt, D. E., US Geological Survey, Columbia Environmental Research Center, Columbia, USA, dtillitt@usgs.gov

HEALTH AND HISTOPATHOLOGICAL EVALUATION OF RIO GRANDE SILVERY MINNOW FROM THE RIO GRANDE, NEW MEXICO

The decline of the Rio Grande silvery minnow (RGSM) is associated with physical and hydrologic changes in the Rio Grande. Decreasing water quality and contaminants may also be factors. This study was designed to evaluate RGSM health in relation to water quality and other environmental stressors in the middle Rio Grande. Health indicators including somatic indices, hematology, and gross and histological observations were used at several locations seasonally. Our results indicate that between Bernalillo and Bosque del Apache NWR RGSM are experiencing chronic stress. RGSM collected in the summer tended to be less healthy indicated by: increased macrophage aggregates and granulomas, lowered liver glycogen, and increased spleen size. Whereas RGSM from all sites showed impairment, health indicators such as Health Assessment Index, Splenosomatic Index, and percentage of fish with 2 or more pathologies showed an upstream to downstream trend. It appears that the stress is likely related to poor water and sediment quality (ammonia, metals, bacteria, and possibly PAHs). These results are in agreement and consistent with the known impacts of urban effluents, stormwater runoff, and agricultural return waters.

Pardi, **R**. **R**., William Paterson University, Wayne, New Jersey, USA, pardir@wpunj.edu

Sebetich, M., William Paterson University, Wayne, New Jersey, USA, sebetichm@wpunj.edu

Socha, C., William Paterson University, Wayne, New Jersey, USA, sochac@student.wpunj.edu

NUTRIENT CYCLING AND THE ASSIMILATIVE CAPACITY OF AN EXURBAN STREAM – BELCHER CREEK, PASSAIC COUNTY, NJ

Belcher Creek is the principal tributary to Greenwood Lake, flowing north within the Township of West Milford into the Lake which straddles the New Jersey/New York border. Greenwood Lake is, in turn, the headwater for much of the potable water supply system for lower Passaic County. Greenwood Lake itself has been showing signs of increasing eutrophication and significant efforts have and are being made to control excessive aquatic plant growth. An intensive study was conducted during the summer of 2009 of habitat, water quality and quantity within Belcher Creek. The goal of this study was to assess the impact of nutrient loading on the stream. This watershed is unique in having several, small waste-water treatment plants rather than one central facility. We found that under the current conditions, and, during the exceptionally wet summer of 2009, the Creek was able to maintain acceptable habitat and water quality along much of the stream's length. However, continued development within West Milford Township, particularly reductions in wetland acreage and open space, could potentially tip the current precarious state of the stream's water quality.

PARK, **G**. **S**., ANYANG UNIVERSITY, INCHEON, Republic Of Korea, GSPARK@ANYANG.AC.KR

IMPROVING MANAGEMENT OF CRITICAL HABITATS AROUND THE YELLOW SEA

Ganghwa Southern Tidal Flat (GSTF) is important for migratory birds and feeding grounds for estuarine fishes. The study is aimed to establish new management plans and identify the possible amendment of laws/regulations for the habitat management. Ecological status was estimated in terms of the water/sediment quality, and pollution loadings. We identified nutrient pollution, marine litter and the planned construction of two tidal power plants as the most imminent and concerned environmental issues associated with the habitat quality. Nutrient pollution was severe, with particularly high nitrogen concentration. Pollution load data showed that most of the nutrient apparently was being introduced via runoff from Han River representing 95% of COD, TN and TP. Marine litter was an increasingly recognized stress on ascetics of coasts and in its ecological impact on aquatic organisms given its durability. The proposed construction of two tidal power plants could be destructive to the already stressed fragile ecosystem. We proposed bottom-up and top-down approaches and identified key organizations for the implementation of management plans. General acceptance of the plan by the local people is essential for the implementation. Possible solution is a gradual increase in public awareness, education and training for the local people to make them understand the importance of ecological roles and services of the habitat. Supported by UNDP/YSLME Project and MLTM.

Paul, **M**. **J**., Tetra Tech, Inc., Owings Mills, USA, Michael.Paul@tetratech.com

TIED UP IN KNOTS: CIRCULARITY AND DEVELOPING BIOLOGICAL CRITERIA FOR STREAMS AND RIVERS

Benthic ecologists have led the development of biocriteria for assessing attainment of aquatic life use in streams and rivers. This work has benefitted from our expertise in invertebrate/vertebrate ecology, statistics, and landscape ecology. It is also grounded in the reference site concept. Our scientific reasoning, however, may have clouded our thinking with regards to developing sound assessment models for meeting society's expectations for aquatic life. Society sets biological expectations in biological terms. I present an argument that models for reference condition must explicitly consider biology in their definition, otherwise we put our faith in satellites, habitat assessments, and water quality grab samples to define biological goals. By defining reference conditions in non-biological terms, we at best set a low bar for biological condition and, at worst, completely miss the mark. I provide examples of where this mark is being missed and also present several models for how we might move forward using existing tools, such as O/E models and the biological condition gradient approach, simply by rethinking how we define reference conditions.

Pavel, **C**. **A**., Savannah State University, Savannah, USA, cpavel@student.savannahstate.edu

Walters, T. L., Skidaway Institute of Oceanography, Savannah, USA, tina.walters@skio.usg.edu

Peck, M. E., Skidaway Institute of Oceanography, Savannah, USA, megan.peck@skio.usg.edu

Frazier, L. M., Skidaway Institute of Oceanography, Savannah, USA, lagina.frazier@skio.usg.edu

Paffenhofer, G. A., Skidaway Institute of Oceanography, Savannah, USA, gustav.paffenhofer@skio.usg.edu

Frischer, M. E., Skidaway Institute of Oceanography, Savannah, USA, marc.frischer@skio.usg.edu

A MOLECULAR BASED METHOD FOR THE ANALYSIS OF DOLIOLID FEEDING RATES

Gelatinous zooplankton play a crucial role in marine planktonic food webs yet because of difficulties encountered while studying them in situ relatively little is known about their ecology, including their diet or in situ rates of feeding. In this study we developed a differential length amplification quantitative PCR (dla-qPCR) assay to quantify consumption of specific plankton prey based on DNA markers by the pelagic tunicate Dolioletta gegenbauri. D. gegenbauri is a swarm producing species commonly occurring on western boundary subtropical continental shelves. This approach has previously been applied successfully to quantify gut content in copepods based on prey DNA signatures which can be rapidly degraded by digestion. Multiple PCR primer sets were designed to amplify 18S rRNA gene fragments ranging in size from 60bp to 573bp

allowing for correction of the digestion of prey DNA by the doliolid. Assays were developed, optimized, and validated for three representative prey species, Thalassiosira weissflogii, Isochrysis spp., and Rhizoselenia spp.. These assays are being applied to complement classical culture-based feeding studies allowing us to quantify gut content and infer feeding rates in D. gegenbauri.

Payn, **R**. **A**., Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT, USA, rpayn@montana.edu
Poole, G. C., Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT, USA, gpoole@montana.edu
Helton, A. M., Odum School of Ecology, University of Georgia, Athens, GA, USA, amhelton@uga.edu

MODELING INTERACTIONS BETWEEN SURFACE AND SUBSURFACE TEMPERATURE DYNAMICS IN FLOODPLAINS

Surface and subsurface water temperature dynamics are highly interdependent in river systems with complex floodplains. Mechanistic simulation of water temperature within floodplains must therefore represent the entire valley floor hydrosystem, which includes integrated, three-dimensional simulation of both surface and hyporheic flow. We have defined the fundamental mechanisms of energy balance and heat transfer within an object-oriented model of surface and subsurface flow through low-relief landscapes (WREN - Water Resource Exchange Network). Here we report sensitivity analyses of the resulting model using three-dimensional simulations of flow through a main-channel/spring-channel complex, an alluvial feature that commonly drives extensive surface-subsurface exchange in anabranched, gravel-bedded rivers. Results demonstrate how interactions of surface and subsurface flow generate spatial and temporal variability in both surface and subsurface water temperatures. Our effort contributes tools that will allow comparisons between modeled and observed temperature distributions within floodplains. These comparisons will be used to test integrated hypotheses or compare competing hypotheses that describe the controls of river temperature.

Paytan, **A**., UCSC, Santa Cruz, USA, apaytan@ucsc.edu
Black, F., UCSC, Santa Cruz, USA, fblack@ucsc.edu
Ganguli, P., UCSC, Santa Cruz, USA, pganguli@ucsc.edu
Knee, K., UCSC, Santa Cruz, USA, klknee@stanford.edu
Desieyes, N., Stanford, Stanford, USA, Desieyes@stanford.edu
Gray, E., UCSC, Santa Cruz, USA, eltgray@ucsc.edu
Conaway, C., USGS, Santa Cruz, USA, cconaway@usgs.gov
Flegal, R., UCSC, Santa Cruz, USA, raflegal@ucsc.edu
Swarzenski, P., USGS, Santa Cruz, USA, pswarzenski@usgs.gov

SUBMARINE GROUNDWATER DISCHARGE OF TOTAL MERCURY AND MONOMETHYLMERCURY TO COASTAL WATERS

Fluxes of total mercury (HgT) and monomethylmercury (MMHg) associated with submarine groundwater discharge (SGD) were studied in California and Hawaii by combining measurements of HgT and MMHg in nearshore groundwater with Ra and Rn as tracers of groundwater inputs. Fluxes of HgT via SGD reached up to 400 nmol day-1 per m of shoreline, while MMHg fluxes via SGD reached up to 20 nmol day-1 per m of shoreline. The MMHg fluxes were similar in magnitude to reported estuarine sediment MMHg fluxes. Temporal variability in flux within and among sites was detected. Multiple linear regression analysis identified significant ($p < 0.05$) positive correlations between dissolved groundwater HgT, NH4+, and SiO2, and between dissolved groundwater concentrations of MMHg and those of HgT and NH4+. This work demonstrates that SGD constitutes an important transport mechanism of both HgT and MMHg to coastal waters along the Pacific coast. Tidal fluid exchange in wetlands / salt marshes and subsequent drainage provides favorable conditions for Hg methylation and transport. This process is likely important for other estuarine biogeochemical budgets and should be further investigated.

Pearlstine, L. G., Everglades National Park, Homestead, USA, leonard_pearlstine@nps.gov
Pearlstine, E. V., University of Florida, Belle Glade, USA, epearls@ufl.edu
Aumen, **N**. **G**., Everglades National Park, Boynton Beach, USA, nick_aumen@nps.gov

ECOLOGICAL CONSEQUENCES AND MANAGEMENT IMPLICATIONS OF CLIMATE CHANGE FOR THE EVERGLADES (FLORIDA, USA)

Florida's Everglades (USA) faces aquatic ecosystem impacts from climate change and associated sea level rise. The diverse aquatic habitats support a rich assemblage of wildlife, including 36 vertebrates and 26 plant species federally listed as endangered, threatened or candidate species. Anticipated changes for south Florida include more droughts and higher temperatures, and increased intense storms. Hydrologic regimes, temperature, and CO_2 correlate strongly with aquatic invertebrate community structure, coral and fish abundance and diversity, and higher tropic level responses. Greater variability in extreme climatic events can destabilize aquatic communities. Climate change precipitation regimes may alter N:P ratios that influence periphyton community composition. Sea level rise may be 0.8 to 2 m over the next century in a landscape that only rises 5 cm per km from Florida Bay inland. In addition to habitat loss, saltwater inundation of peat in Everglades freshwater wetlands may increase carbon emissions by release of sequestered carbon. Identifying species and habitats most at risk and potential for increasing habitat and landscape resilience to climate change will be critical for maintaining a diverse and productive Everglades.

Pease, **A**. **A**., Texas A&M University, College Station, USA, aapease@tamu.edu
Rodiles-Hernandez, R., El Colegio de la Frontera Sur, San Cristobal de las Casas, Mexico,
Gonzalez-Diaz, A., El Colegio de la Frontera Sur, San Cristobal de las Casas, Mexico,
Winemiller, K. O., Texas A&M University, College Station, USA,

FUNCTIONAL STRUCTURE OF STREAM FISH COMMUNITIES ALONG ENVIRONMENTAL GRADIENTS IN THE RIO GRIJALVA BASIN, MEXICO

Relationships between environmental variables at multiple spatial scales and the functional structure of stream fish communities were examined along a longitudinal gradient in the Rio Grijalva basin in Chiapas and Tabasco, Mexico. We measured morphological traits with known functional relationships to feeding, locomotion, and habitat use in fishes from a variety of stream types, from high-elevation tributaries to lowland streams in the coastal plains. Functional trait diversity was highest in lowland communities, where habitats are more stable and high productivity and spatial heterogeneity provide for a broad prey resource base. This diversity decreased in communities further upstream in the basin, where the flow regime is harsher and fewer favorable habitat types are available for fishes or their prey resources. In large tropical river basins, few studies have examined changes in fish assemblage structure at the watershed scale, and little is known about how functional community structure is related to environmental variables in these systems. Knowledge of functional trait responses across environmental gradients may be applied across geographical scales, and it provides vital information for conservation and management.

Peckarsky, **B**. **L**., University of Wisconsin Madison, Madison, USA, peckarsky@wisc.edu
McIntosh, A. R., University of Canterbury, Christchurch, New Zealand, angus.mcintosh@canterbury.ac.nz
Alvarez, M., University of Vigo, Vigo, Spain, maruxa@uvigo.es
Moslemi, J. M., Cornell University, Ithaca, USA, jmm257@cornell.edu
Brown, W. S., Rocky Mountain Biological Lab, Crested Butte, USA, wsbrown@frontier.net
Penton, M. A., Rocky Mountain Biological Lab, Crested Butte, USA, malgaep@gmail.com
Horn, S. C., Rocky Mountain Biological Lab, Crested Butte, USA, stevehorn1@gmail.com
McHugh, K., University of Canterbury, Christchurch, New Zealand, iamkatiemchugh@gmail.com

HOMAGE TO STAN DODSON: SIMPLE EXPERIMENTS REVEAL COMPLEX INTERACTIONS IN STREAMS

One of the most important lessons we have learned from Stan Dodson is that simple methods are always best, even when asking complex questions. Unraveling the complexities of species interactions within food webs of Rocky Mountain streams has proven to be extraordinarily challenging. Stan Dodson embraced such challenges as solving the puzzles of counterintuitive data and unexpected outcomes. We, as his students and disciples, strive to carry on his passion for using simple experiments to learn more about nature by discovering the mechanisms that explain unexpected observations. We present the results of innovative experiments carried out in outdoor microcosms and mesocosms with natural stream water and in replicated streams to help explain why under

natural stream conditions we do not consistently observe a behavioral trophic cascade, whereby top predators (brook trout) suppress the foraging behavior of mayfly prey, releasing periphyton from grazing pressure. The answers lie in the influence of nutrient limitation and hydrologic disturbance, both of which cause variation in the cascading effects of predators on basal resources in streams.

Pecor, **K. W.**, The College of New Jersey, Ewing, USA, pecor@tcnj.edu
Deering, C. M., The College of New Jersey, Ewing, USA,
Firnberg, M. T., The College of New Jersey, Ewing, USA,
Pastino, A. K., The College of New Jersey, Ewing, USA,
Wolfson, S. J., The College of New Jersey, Ewing, USA,

THE USE OF CONSPECIFIC AND HETEROSPECIFIC ALARM CUES BY VIRILE CRAYFISH (*ORCONECTES VIRILIS*) FROM AN EXOTIC POPULATION

The successful establishment of a population of introduced animals is dependent upon a number of variables, including the ability to respond adaptively to novel stimuli indicating predation risk. Previous studies have suggested that exotic crayfish have an advantage over native species, in that the former respond to alarm cues released from both injured conspecifics and injured heterospecifics and the latter typically respond only to injured conspecifics. This pattern could be a result of learning in the new environment or a predisposition of certain species to respond to a broader range of alarm stimuli. We tested between these possibilities using individuals from an exotic population of the virile crayfish (*Orconectes virilis*). The crayfish responded similarly to alarm cues from conspecifics, sympatric heterospecifics, and novel heterospecifics. The results suggest that these animals enter a new habitat with the ability to respond adaptively to a wide range of predation risk cues, but more work is needed to conclusively make this assertion.

Pedro, A., University of Évora, Évora, Portugal, anapedro@uevora.pt
Morais, M., University of Évora, Évora, Portugal, mmorais@uevora.pt
Rosado, J., University of Évora, Évora, Portugal, jrosado@uevora.pt
Lillebø, **A. I.**, University of Aveiro, Aveiro, Portugal, lillebo@ua.pt

INTER-ANNUAL VARIATION OF HYDROLOGICAL FEATURES IN A MEDITERRANEAN TEMPORARY STREAM (PARDIELA STREAM, GUADIANA BASIN, PORTUGAL)

Most of the streams in the Mediterranean region are temporary. They are physically, chemically and biologically shaped by sequential predictable seasonal events of flooding and drying over an annual cycle, with a transition from lotic conditions to shallow lentic conditions. When stream starts to flow, after the first flood event (usually in October), all the organic and inorganic materials, stored in the riverbed and catchment area are washed downstream in large quantities. Pardiela is a fourth-order Mediterranean stream, located in the southern Portugal (Guadiana basin). The drying and rewetting cycle was studied during the last five years. 2005/2006 and 2007/2008 were classified as dry years, contrasting with 2006/2007 and 2009/2010. During this period, inter-annual variability was studied in terms of first flood intensity, beginning date, discharge and lotic period duration (contraction/expansion dynamics). Results reflect the inter-annual variability of organic matter and nutrients transported into downstream reservoirs

Peipoch , **M.**, Centre d'Estudis Avançats de Blanes, Blanes (Girona), Spain, mpeipoch@ceab.csic.es
Martí, E., Centre d'Estudis Avançats de Blanes, Blanes (Girona), Spain, eugenia@ceab.csic.es
Gacia, E., Centre d'Estudis Avançats de Blanes, Blanes (Girona), Spain, gacia@ceab.csic.es

VARIABILITY IN ^{15}N NATURAL ABUNDANCE OF DISSOLVED INORGANIC NITROGEN AND PRIMARY UPTAKE COMPARTMENTS IN STREAMS: A META-ANALYSIS APPROACH

In this study, we conducted a meta-analysis to examine variability in ^{15}N natural abundance of dissolved inorganic nitrogen (DIN) and primary uptake compartments (PUC) in streams, and how they are affected by land-use activity. We based the study on a literature review of ^{15}N studies published since 1989 from which we compiled ^{15}N values for DIN and PUC from >100 streams. We observed a lack of ^{15}N-NH_4 data, despite this is the preferred N-source for PUC. ^{15}N-NO_3 values ranged from 2.5‰ to 19.3‰, and were higher in human-altered streams. ^{15}N signatures of PUC varied widely (-3.9‰ - 18.1‰) both within and among compartments. However, average values for each compartment and variability among compartments were lower in forested than in human-altered streams. These results indicate that ^{15}N signature of PUC can trace human-derived N alterations. Finally, biofilm was the compartment showing closest ^{15}N values to those of NO_3, regardless of stream type. Since these compartments are at the interface between DIN sources and consumers, this information can provide insights to better understand of stream N dynamics and trophic food webs.

Pelletier, **L.**, Université du Québec à Montréal, Montréal, Canada, pelletier.luc@uqam.ca
Garneau, M., Université du Québec à Montréal, Montréal, Canada, garneau.michelle@uqam.ca
Ullah, S., Lancaster University, Lancaster Environment Center, Lancaster, United Kingdom, s.ullah3@lancaster.ac.uk

INVESTIGATING PRE-IMPOUNDMENT TERRESTRIAL CARBON STOCKS AND FLUXES IN THE EASTMAIN-1 RESERVOIR AREA, JAMES BAY, QUEBEC, CANADA

In 2005, the Eastmain-1 project was initiated to measure net greenhouse gas emissions from a hydro-electric reservoir by comparing watershed level greenhouse gas fluxes before and after the reservoir creation, considering the different boreal ecosystems present (forest, wetlands, Lakes and rivers). Between 2005 and 2009, pre-impoundment terrestrial carbon stocks and greenhouse gas fluxes were measured through several field campaigns over peatlands and the different forest types. Long term carbon accumulation was measured from several peat and forest soil cores covering the spatial variability found in the region and ground penetrating radar was used to measure sediment accumulation in peatlands. More than 7000 greenhouse gas fluxes were measured using static chambers on peatland and forest soils covering the spatial and temporal variability found in these ecosystems. The fluxes were then compared to eddy covariance measurements made in the same ecosystems. The carbon stock and fluxes were extrapolated based on ecosystem coverage to achieve a pre -impoundment carbon budget for net greenhouse gas emissions calculation from hydro-electric reservoir.

Penaluna, **B. E.**, Oregon State University, Corvallis, OR, USA, brooke.penaluna@oregonstate.edu
Dunham, J. B., USGS, Corvallis, OR, USA, jdunham@usgs.gov

THE IMPORTANCE OF IN-STREAM COVER TO CUTTHROAT TROUT EMIGRATION

An extensive amount of literature exists which examines the consequences of historical forest harvest practices on stream ecosystems, including fishes. However, the importance of certain aspects of physical habitat structure to fish is not well understood. Physical habitat structure in the form of in-stream cover is influenced by the riparian substrate, stream substrate and stream flow, which are factors that are impacted by forest harvest. Our objective was to provide a rigorous manipulative study to initially address the importance of in-stream cover to fish and not to strictly mimic every possible scenario in nature. In our study, we examined the effect of high and low levels of in-stream cover on the number of wild resident adult cutthroat trout emigrants. Our study was a comparison study with manipulation at a large-scale in a semi-natural outdoor setting for 28 days in September and October 2009. We found that there were more cutthroat trout emigrants in low cover treatments than in high cover treatments. Our study indicates that in-stream cover is important to retaining fishes in stream sections. This suggests that maintaining or adding in-stream cover habitat will be critical to maintaining cutthroat trout numbers during and after forest harvest practices.

Penczykowski, **R. M.**, Georgia Institute of Technology, Atlanta, USA, rachelp@gatech.edu
Hall, S. R., Indiana University, Bloomington, USA, sprhall@indiana.edu
Duffy, M. A., Georgia Institute of Technology, Atlanta, USA, duffy@gatech.edu

CONSEQUENCES OF VARIATION IN DISEASE RESISTANCE: IS THERE A WITHIN-SPECIES DILUTION EFFECT?

The "dilution effect" hypothesis posits that consumption of infective parasites by unsuitable host species may decrease infection prevalence in suitable host species. Does the dilution effect also occur within species? We tested for a dilution effect between genotypes of *Daphnia dentifera* hosts with a

yeast parasite. *D. dentifera* ingest infective parasite spores while feeding, and genotypes differ in their infection resistance. We administered spores to different proportions of highly susceptible and relatively resistant genotypes, with equal densities of *D. dentifera* across treatments, for two different pairs of host genotypes. As expected, treatments containing only susceptible (resistant) genotypes had the highest (lowest) infection prevalence. A non-linear relationship between the proportion resistant genotype and infection prevalence would indicate a dilution effect. This relationship was linear for one pair of host genotypes, and only weakly non-linear for the other pair, which suggests that resistant genotypes may not protect susceptible genotypes from infection in this system. Additional experiments explored whether variation in *D. dentifera* feeding rates among treatments helped explain the lack of a within-species dilution effect.

Penick, **M. D.**, Western Kentucky University, Bowling Green, USA, mary.penick@wku.edu
Meier, A. J., Western Kentucky University, Bowling Green, USA, albert.meier@wku.edu
Grubbs, S. A., Western Kentucky University, Bowling Green, USA, scott.grubbs@wku.edu

WHY IS THE GREEN RIVER STILL GREEN? ALGAL BIOMASS ACCRUAL IN RELATION TO NUTRIENT AVAILABILITY IN THE UPPER GREEN RIVER, KENTUCKY

Nutrient limitation centers mainly on lack of nitrogen (N) or phosphorus (P) relative to cellular growth needs, affecting primary productivity and algal community structure. During summer baseflow conditions we assessed relationships between ambient algal biomass and nutrient levels, and conducted experimental nutrient limitation assays on periphytic algae along a longitudinal weak to extensive karst (= limestone) bedrock gradient in the Green River, Kentucky. Sestonic and filamentous biomass (= chlorophyll a) levels increased monthly along the longitudinal gradient. In contrast, periphyton biomass levels increased minimally monthly yet displayed no longitudinal pattern. Nitrate and soluble reactive phosphorus levels exhibited distinct longitudinal increases, whereas total phosphorous displayed minimal change and ammonia levels decreased in the downstream direction. Total nitrogen (TN) levels spiked longitudinally but decreased sharply in the well-developed downstream karst sites. Results from the nutrient limitation assays revealed that the highest periphyton levels were with N + P treatments at the most downstream sites. Overall, in Kentucky's Green River algal growth appears to be mainly P-limited but likely also by TN availability during late summer.

Perez-Fuentetaja, **A.**, SUNY College at Buffalo, Buffalo, NY, USA, perezfa@buffalostate.edu
Pennuto, C., SUNY College at Buffalo, Buffalo, NY, USA, pennutcm@buffalostate.edu
Karatayev, A., SUNY College at Buffalo, Buffalo, NY, USA, karataay@buffalostate.edu
Burlakova, L., SUNY College at Buffalo, Buffalo, NY, USA, burlakle@buffalostate.edu
Conroy, J., Ohio State University, Columbus, OH, USA, conroy.27@osu.edu
Kramer, J., Heidelberg University, Tiffin, OH, USA, jkramer@heidelberg.edu
Bade, D., Kent State University, Kent, OH, USA, dbade@kent.edu
Matisoff, G., Case Western Reserve , Cleveland, OH, USA, gerald.matisoff@case.edu

BIOLOGICAL INFLUENCE ON THE NEARSHORE AND OFFSHORE NUTRIENT DYNAMICS OF LAKE ERIE

We compared phosphorus (P) fate and biological production in June/July and Sept. in transects from nearshore (depths 2, 5, 10 m) to offshore (20 m) in the Eastern (Cattaragus Creek, NY) and Central (Grand River, OH) basins of Lake Erie and in the Sandusky Subbasin (west-central basin). Sediment P content was lower in the Cattaragus and Sandusky transects (4 mg/g) and higher at Grand (8 mg/g). In the benthic environment, *Cladophora* mats were present in the Cattaragus and Grand sites (8 mg/g each). The largest P content was in benthic organisms at 5 and 10 m, with *Dreissena bugensis* having the largest contribution (Cattaragus 105 mg/g, Grand 80 mg/g and Sandusky 95 mg/g). In the pelagia, zooplankton densities were higher at 10 and 20 m and differed among lake basins. Cladoceran densities were similar in early summer at the three locations (10-40 ind/L) but were markedly high in Sept. in Sandusky (bosminids 76 ind/L). Veliger densities were very high in Cattaragus and Sandusky in Sept. (2,000 ind/L) at 5 m, comprising a significant amount of the zooplankton.

Pérez-Martínez, **C.**, University of Granada, Granada, Spain, cperezm@ugr.s
Jiménez-Liébanas, L., University of Granada, Granada, Spain, laurajl@ugr.es
Conde-Porcuna, J., University of Granada, Granada, Spain, jmconde@ugr.es
Ramos-Rodríguez, E., University of Granada, Granada, Spain, elo@ugr.es
Moreno-Linares, E., University of Granada, Granada, Spain, emiliojml@ugr.es

SUBFOSSIL CLADOCERAN AS INDICATORS OF PALEO-ECOLOGICAL CHANGES IN A HIGH MOUNTAIN LAKE OVER THE LAST 200 YEARS

A sediment core from Río Seco Lake, a high mountain lake located in Sierra Nevada Mountains (SE Spain), spanning the last 200 yr, was dated by radionuclide 137-Cs and 210-Pb and analyzed for subfossil Cladocera, LOI content and fossil pigments. We have identified twenty different species, belonging mainly to Bosminidae, Daphnidae and Chydoridae families. Some of these species show significant density changes along the profile. During the 20th century both planktonic and benthic Cladocera communities show a period of low density around the middle of this century, following by an important density increase from the 1980s until the present time. Additionally, the period of low Cladocera density correlates with a period of high LOI values and pigment concentration. These results could be related to air temperature and rainfall changes affecting the ice-free period of Río Seco Lake and, consequently, the growth period of the different trophic level organisms. So, the development of Cladoceran species populations is more affected by a short growth period than that of the algal species populations.

PEREZ-REYES, **O.**, Watershed Sciences Department and The Ecology Center, Utah State University, LOGAN, UTAH, USA, macrobrachium@yahoo.com
CROWL, T. A., Watershed Sciences Department and The Ecology Center, Utah State University, LOGAN, UTAH, USA, facrowl@gmail.com

HOW ARE DECAPOD POPULATIONS INFLUENCED BY URBANIZATION?

Many tropical streams have been altered by water diversions, channel modification, introduced species, and water quality degradation. In Puerto Rico, watersheds range relatively pristine to highly degraded, and offer an opportunity to examine the impacts of human disturbances on native stream communities. Populations of native decapods, water temperature, pH, and DO were studied in 3 sites encompassing urban, suburban and pristine streams. Fourteen decapod taxa were recorded from the 3 streams. The abundance of species and community structure showed variations across the urban to pristine gradient. Macrobrachium faustinum, Xiphocaris elongata and Palaemon pandaliformis were the most tolerant species reported at impacted sections of the streams. The most pristine rivers had a greater number of species present. In addition, the numbers of species were distributed more equitably among the river sections. Higher temperatures and lower Dissolved Oxygen values were observed at urban sites compared to the suburban and natural sections of rivers. The variations in decapod communities among watersheds correlated with the degradation of the physical-chemical environments, clearing of the riparian zones, and the introduction of exotic fauna to those portions of the rivers.

Perkin, **E. K.**, Leibniz-Institute of Freshwater Ecology and Inland Fisheries/Free University Berlin, Berlin, Germany, liz.perkin@igb-berlin.de
Hölker, F., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, hoelker@igb-berlin.de
Wolter, C., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, wolter@igb-berlin.de
Sadler, J. P., University of Birmingham, Birmingham, United Kingdom, J.P.Sadler@bham.ac.uk
Richardson, J. S., University of British Columbia, Vancouver, Canada, john.richardson@ubc.ca
Tockner, K., Leibniz-Institute of Freshwater Ecology and Inland Fisheries/Free University Berlin, Berlin, Germany, tockner@igb-berlin.de

EFFECTS OF ARTIFICIAL LIGHT AT NIGHT ON AQUATIC AND RIPARIAN ECOSYSTEMS

Terrestrial ecologists have already found evidence that migrations, feeding, and other important ecological functions are disrupted by artificial light at night. However, there has been very little experimental or quantitative work done on this issue; particularly in aquatic ecosystems. First, we present key questions about the ways in which artificial light at night may impact aquatic systems, leading to a forward-looking research framework. Our questions are: will artificial light at night i) alter the interaction between terrestrial and aquatic food webs? ii) change either the alpha or beta diversity within aquatic and riparian

habitats? and iii) change effective population sizes of some aquatic and riparian species? Second, we present preliminary data from an experiment to test the effects of artificial lighting on macroinvertebrate drift.

Perkin, **J**. **S**., Kansas State University, Manhattan, USA, JPerkin@ksu.edu
Gido, K. B., Kansas State University, Manhattan, USA, Kgido@ksu.edu

EFFECTS OF FRAGMENTATION ON FISH DISTRIBUTION AND COMMUNITY STRUCTURE IN GREAT PLAINS PRAIRIE STREAM NETWORKS

Fish community structure within stream networks varies according to spatial positioning, network architecture, stream size, and a suite of local biotic and abiotic factors. Recent work suggests local assemblage composition within dendritic stream networks is largely influenced by species-specific movement patterns from adjacent, interconnected streams (or branches in a strictly dendritic context). However, riverscape fragmentation caused by barrier construction disrupts fish movement in these networks and contributes to altered species distributions and community structure within fragmented reaches. Here we consider how species distributions and community composition vary in stream fragments at multiple spatial scales throughout the central Great Plains. Preliminary results suggest fragmentation correlated with declines and extirpations of species with specific life history requirements (e.g., plains minnow; Classification Tree Analysis, Cohen's Kappa = 0.875, $P < 0.01$), and in some cases extirpations occurred within relatively short stream fragments (i.e., <200km for plains minnow). Results from this study suggest comparing species distributions or community composition across a scale-dependent gradient of fragmentation is useful in identifying thresholds in distributional or compositional change as well as prioritizing barrier removal or remediation.

Perry, **J**. **E**., Virginia Institute of Marine Science, Gloucester Point, USA, jperry@vims.edu
DeBerry, D., College of William and Mary, Williamsburg, USA, ddeberry@vhb.com
Sutter, L. A., Virginia Institute of Marine Science, Gloucester Point, USA, lsutter@vims.edu
Ferner, S., San Francisco Bay National Estuarine Research Reserve, San Francisco State University, Tiburon, USA, daviess@sfsu.edu

DECADAL AND INTER-ANNUAL VARIABILITY WITHIN THE VEGETATION COMMUNITY OF A TIDAL FRESHWATER MARSH

Historic vegetation surveys of a tidal freshwater marsh in Virginia have suggested a shift to an oligohaline marsh. We re-sampled the marsh in 2003 and 2004 to determine if the shift towards salt-tolerant species continued. Importance-values were calculated for plant species in 76 1m x 1m plots throughout the growing season. Dominance of salt-tolerant perennial species within the vegetation community increased from 1974 to 2003, while perennial species more sensitive to salt stress decreased. However, a reversal of those trends occurred between 2003 and 2004. Analysis of salinity data suggested that observed increase in salt-tolerant species from 1974 to 2003 may have been indicative of high salinity events in years preceding the second and third studies (1983 and 2002). However, Canonical Correspondence Analysis indicated that shifts in the vegetation community were most strongly correlated with spring salinities measured prior to the growing season; with the preceding years' salinity values showing a smaller, but still perceptible, effect. The increase in importance-values by freshwater species in 2004 suggested that marsh vegetation is able to oscillate between a salt-state and fresh-state.

Péru, **N**., University of Lyon, Villeurbanne, France, nicolas.peru@univ-lyon1.fr
Dolédec, S., University of Lyon, Villeurbanne, France, sylvain@biomserv.univ-lyon1.fr

USING FUZZY SET THEORY FOR COMPUTING ABUNDANCE IN MULTIPLE-TRAIT BASED APPROACHES

Rooted in the habitat templet theory, multiple-trait based (MTB) assessments rely on predicting ecological responses to selection induced by environmental conditions. MTB approach result in functional community descriptions that can be compared among regions differing in their taxonomic composition and have large-scale applicability. Such functional community descriptions are usually obtained from a trait-by-species array that is weighted by the relative abundance of species collected in sites. However, understanding why a species has a particular abundance is yet a matter of debate (McGill 2006, Science, 314, 770-771). We propose a method, which aims at redefining the abundance of species according to knowledge about their distribution area. The method derived from fuzzy set theory (Zadeh 1965, Information and control, 8,338-353) takes into account the biological properties of species (i.e. a predator would never reach those abundances of its preys). We apply the method to discriminate between clean and impacted river sites according to trait attributes of invertebrate communities. We show a greater separation of sites from a method based on membership functions in comparison to relative abundance.

Peter, **S**., ETH and Eawag, Zürich, Switzerland, speter@env.ethz.ch
Rechsteiner, R., ETH, Zürich, Switzerland, rromana@student.ethz.ch
Lehmann, M. F., University of Basel, Basel, Switzerland, moritz.lehmann@unibas.ch
Tockner, K., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Switzerland, tockner@igb-berlin.de
Wehrli, B., ETH and Eawag, Zürich, Switzerland, Bernhard.Wehrli@eawag.ch
Durisch-Kaiser, E., ETH and Eawag, Zürich, Switzerland, edith.durisch-kaiser@env.ethz.ch

SPATIO-TEMPORAL CONTROLS OF NITRATE REMOVAL IN A RESTORED RIPARIAN GROUNDWATER SYSTEM

The effect of environmental heterogeneity, hydrological connectivity and flood disturbances on subsurface nitrate removal was investigated in a floodplain of the River Thur, Switzerland. Related to discharge and seasons, water samples were collected along hyporheic connectivity in different functional process zones (FPZs). Nitrate dynamics were determined by its dual stable N and O isotopic signature and the abundance of functional genes in denitrification. The organic carbon (OC) was characterized by its stable C isotopic ratio, polydispersity, and the yield of low-molecular weight organic acids and hydrolysable amino acids. The results showed that where willow dominated the vegetation, functional gene abundance was permanently increased and substantial losses of nitrate and an enrichment of ^{15}N and ^{18}O in the residual nitrate occurred post flooding. Willows exhibit high below-ground OC-dynamics. Hence, during flooding re-dissolution and vertical mixing of root-derived and bioavailable OC fuelled denitrification in groundwater in this FPZ. This study showed that a complex interplay of different control mechanisms may direct the spatio-temporal formation of denitrification hot spots in riparian groundwater systems.

Peterson, **C**. **G**., Loyola University Chicago, Chicago, USA, cpeters@luc.edu
Daley, A. D., Loyola University Chcago, Chicago, USA,
Hell, S. M., Loyola Unversity Chicago, Chicago, USA,
Kalscheur, K. N., Northwestern University, Evanston, USA,
Sullivan, M., Loyola University Chicago, Chicago, USA,
Kufta, S. L., Loyola University Chicago, Chicago, USA,
Gray, K. A., Northwestern University, Evanston, USA, k-gray@northwestern.edu
Kelly, J. J., Loyola University Chicago, Chicago, , jkelly7@luc.edu

DEVELOPMENT OF BENTHIC MICRO-ALGAL AND DENITRIFYING-BACTERIAL COMMUNITY STRUCTURE DURING BIOFILM ESTABLISHMENT IN STREAMS OF CONTRASTING ATTRIBUTES.

We tracked successional changes in composition of microalgal and denitrifying bacterial consortia during establishment (3-28 d) of epilithic biofilms at two stream sites, one downstream of a wastewater treatment plant (WTP) and the other within a restored channel running through former agricultural land converted to prairie (RP). One objective was to determine if/when changes in algae species composition influence the taxonomic structure and function of denitrifier assemblages. Patterns of succession differed markedly between the two sites in both identity of dominant algal taxa and taxonomic content of the consortia of denitrifiers, and the rate at which taxonomic changes occurred. Successional changes, in both algae and denitrifiers, were more rapid and directional at RP compared to WTP. Moreover, succession rates of algal and denitrifier communities were coupled at RP, but showed no significant relationship at WTP. Denitrification potential and organic 'signatures' of 28-day old biofilms were highly variable and did not differ between sites. Our results suggest that the strength of algal/bacterial interactions differs among systems, which may influence bacterially mediated ecosystem functions.

Peterson, **R**. **N**., Coastal Carolina University, Conway, USA, rpeters2@coastal.edu
Burnett, W. C., Florida State University, Tallahassee, USA, wburnett@fsu.edu

ASSESSING THE IMPACT OF A VARYING END-MEMBER WHEN EMPLOYING A RADON TIME-SERIES BOX MODEL FOR SGD QUANTIFICATION

Radon-222 has become a widely used tracer of submarine groundwater discharge (SGD). Non-steady-state box models using time-series radon records are an effective approach to quantifying SGD rates, though some characteristic uncertainties are involved in these calculations. Perhaps the greatest uncertainty is associated with determining an appropriate groundwater end-member radon activity to use in the model calculations. Various authors report the spatial variability of measured groundwater radon concentration, but fewer report the temporal variability. Coastal aquifers can experience drastic changes in groundwater radon activity over tidal time scales due to saline water intrusion and subsequent discharge. We examine here the dependence of the 'radon flux model' and its derived SGD estimates using a variable, rather than a constant end-member. Empirical data sets are tested using both a record of varying groundwater radon concentration and a constant end-member based on an average value. Since the box model response to a varying end-member yields a greater range in estimated SGD rate, we recommend that temporal fluctuations in the associated groundwater radon be considered when possible.

Peterson, **S**. **D**., Southern Illinois University/ Department of Zoology and Center for Ecology, Carbondale, IL, USA, pete13@siu.edu

Rugenski, A. T., Southern Illinois University/ Department of Zoology and Center for Ecology, Carbondale,IL, USA, arugenski@yahoo.com

Colon-Gaud, J. C., University of Puerto Rico- Rio Piedras/ Institute for Tropical Ecosystem Studies, San Juan, Puerto Rico, checo@siu.edu

Whiles, M. R., Southern Illinois University/ Department of Zoology and Center for Ecology, Carbondale,IL, USA, mwhiles@zoology.siu.edu

Kilham, S. S., Drexel University/ Department of Biology, Philadelphia, PA, USA, kilhams@drexel.edu

Lips, K. R., University of Maryland/ Department of Biology, College Park, MD, USA, klips@umd.edu

Pringle, C. M., University of Georgia/ Institute of Ecology, Athens, GA, USA, cpringle@uga.edu

INFLUENCES OF CATASTROPHIC AMPHIBIAN DECLINES ON STORAGE AND EXPORT OF FINE PARTICULATE ORGANIC MATTER IN NEOTROPICAL HEADWATER STREAMS

Larval amphibians can be important in tropical streams because their feeding and egestion can enhance food availability to other consumers. As part of the Tropical Amphibian Declines in Streams (TADS) project, we are examining the long-term ecological consequences of stream-breeding amphibian extirpations in the Panamanian Highlands. We sampled fine (<1mm, >250µm) and very fine (<250µm) benthic organic matter and organic seston (<754µm) for multiple years in streams at El Cope, where a recent amphibian decline occurred, and Fortuna, which declined over a decade ago. In El Cope streams, post-decline benthic organic matter standing stocks remained similar to pre-decline (74.5 and 73.4 gAFDM/m2, respectively). Organic seston C/N in Fortuna streams averaged 10.4, while El Cope increased from 9.0 (pre-decline) to 10.6 (post-decline). At El Cope, base flow organic seston concentrations decreased from 2.7mg L^{-1} (pre-decline) to 1.4mg L^{-1} (post-decline). Increased C/N and lower concentrations of seston indicate that amphibian declines alter the quantity and quality of organic materials exported from tropical headwater streams, but may not affect benthic organic matter standing stocks, at least within the time frames we examined.

Pettit, N. E., University of Western Australia/TRaCK, Perth, Australia, nepettit@cyllene.uwa.edu.au

Jardine, T. D., Griffith University/TRaCK, Brisbane, Australia, t.jardine@gu.edu.au

Warfe, D. M., Charles Darwin University/TRaCK, Darwin , Australia, danielle.warfe@cdu.edu.au

Douglas, **M**. **M**., Charles Darwin University/TRaCK, Darwin, Australia, michael.douglas@cdu.edu.au

Hamilton, S. K., Michigan State University/TRaCK, Hickory Corners, USA, hamilton@kbs.msu.edu

Bunne, S. E., Griffith University/TRaCK, Brisbane, Australia, s.bunn@gu.edu.au

Davies, P. M., University of Western Australia/TRaCK, Albany, Australia, pdavies@cyllene.uwa.edu.au

KEY DRIVERS OF RIVER AND WETLAND FOOD WEBS IN AUSTRALIA'S WET-DRY TROPICS.

Douglas et al (2005) proposed five general principles to characterise aquatic food webs in northern Australia: (i) Seasonal hydrology is a strong driver of ecosystem processes and food web structure,(ii) Hydrological connectivity is largely intact and underpins important terrestrial-aquatic food-web subsidies, (iii) River and wetland food webs are strongly dependent on algal production, (iv) Omnivory is widespread and food chains are short, and (v)A few common macroconsumer species have a strong influence on benthic food webs. Recent stable isotope surveys of food sources and consumers across the region tested support for these principles. Three were generally supported: (i) Food sources varied between wet and dry seasons, (ii) Consumer-resource coupling was weaker at sites with greater hydrological connection, and (iii) Food webs were generally dependent on algal production. However, food chain lengths were similar to those in temperate systems. Although isotope surveys showed that consumer diversity was high, other experimental evidence suggests that some common macroconsumers do indeed exert strong control on benthic food webs. Seasonal hydrology and hydrological connectivity appear key drivers of aquatic food webs in northern Australia.

Petty, **J**. **T**., West Virginia University, Morgantown, WV, USA, jtpetty@mail.wvu.edu

Ziemkiewicz, P. F., West Virginia University, Morgantown, WV, USA,

Strager, M. P., West Virginia University, Morgantown, WV, USA,

Merriam, E. R., West Virginia University, Morgantown, WV, USA,

TOWARDS MANAGING IMPACTS IN ACTIVELY DEVELOPING WATERSHEDS: CAN WE LEARN ANYTHING FROM MOUNTAINTOP REMOVAL MINING?

Mountaintop removal / Valley fill mining (MTR/VF) may be one of the most pressing environmental issues confronting our nation. We will present results of recent studies on the localized and watershed scale impacts of mining on aquatic resources in West Virginia. Specifically, we will address: 1- aquatic ecosystem functions on reclaimed surface mines; 2- the interaction of mining related impacts with other stressors; 3- the influence of coal geology and mine geography; 4- how numerous localized impacts accumulate to produce watershed scale impairment; and 5- the management of impacts at a stream segment versus a whole watershed scale. Our results suggests that current approaches to managing impacts in the central Appalachians is not sustainable and that the problems are very similar to those of actively urbanizing watersheds. Our results, however, do not suggest that the problems are intractable. Instead, we encourage watershed scale management of mining related impacts rather than piecemeal management at the stream segment scale. We demonstrate how this can be done in Pigeon Creek, a tributary of the Tug Fork in southern West Virginia, and argue that such an approach could be successful throughout the MTR/VF region and may provide hope for managing urbanizing watersheds as well.

Peura, **S**., University of Jyväskylä, Jyväskylä, Finland, sari.peura@jyu.fi

Tiirola, M., University of Jyväskylä, Jyväskylä, Finland, marja.a.tiirola@jyu.fi

Nykänen, H., University of Jyväskylä, Jyväskylä, Finland, hannu.nykanen@jyu.fi

Bertilsson, S., Uppsala University, Uppsala, Sweden, stebe@ebc.uu.se

Jones, R. I., University of Jyväskylä, Jyväskylä, Finland, roger.i.jones@jyu.fi

INTERACTIVE EFFECTS OF INCREASED DOC AND INORGANIC NUTRIENTS ON BACTERIAL COMMUNITY COMPOSITION IN A HUMIC LAKE STUDIED WITH 454 PYROSEQUENCING

Climate change is predicted to increase rainfall leading to elevated dissolved organic carbon (DOC) discharge to boreal lakes. As a simulation of this effect we are conducting a whole-lake experiment in which the DOC concentration in a small humic lake is raised by 2 mg l^{-1} to the concentration corresponding to that expected from climate change effects. In the experiment, we added DOC as cane sugar, which has higher 13/12C ratio than the natural DOC and enables us to trace the carbon transfer via bacteria to higher trophic levels. In addition, three bag experiments were made in 2009 to test the interactions of increased DOC, nitrogen and phosphorus on the seasonal succession of the bacterial community. Bacterial community composition was analyzed using 454-pyrosequencing and microbial profiling. As a result we have a comprehensive library of bacterial DNA-sequences revealing nutrient-induced changes in the bacterial community composition. Both methods confirm nutrient as well as season-related changes, the most marked changes being in the amounts of *Actinobacteria* and *Proteobacteria*.

Phillips, **I**. **D**., Saskatchewan Watershed Authority, Saskatoon, Canada, iain.phillips@swa.ca

Parker, D., AquaTax Consulting, Saskatoon, Canada, dale.parker@sasktel.net

Wissel, B., University of Regina, Regina, Canada, bjoern.wissel@uregina.ca

LIFE HISTORY AND DIET OF SKWALA PARALLELA (PLECOPTERA: PERLODIDAE) AND ZAPADA CINCTIPES (PLECOPTERA: NEMOURIDAE) IN A PRAIRIE HEADWATER STREAM.

Stoneflies are uncommon in Canadian prairie streams and understanding the habitat requirements supporting their presence is an important prerequisite to expecting their occurrence in benthic invertebrate bioassessment programs. Further, as Northern Great Plains lotic ecosystems are characterized by assemblages tolerant of wide variation in environmental characteristics, understanding the habitat requirements necessary to support pollution sensitive taxa such as stoneflies will only enhance the accuracy and extrapolation of bioassessments. In this current work we describe the life history and diet of two NGPs stoneflies based on two years of temperature regime, nymphal development, gut analysis and stable isotopes. We establish both species as univoltine in this extent of their range. In addition, we elucidate their food web position and diet as generally omnivorous, although selective in their predation of other macroinvertebrates in their aquatic communities. The forage assemblage typifying the diet of these stoneflies is common across NGP watersheds they are absent from, and we present the habitat conditions necessary to support these sensitive taxa in the developed agricultural regions neighboring their current distribution.

Piehler, **M**. **F**., UNC Chapel Hill Inst. Marine Sciences, Morehead City, USA, piehler@unc.edu

Christian, R. R., East Carolina University, Greenville, USA,

Smyth, A. R., UNC Chapel Hill Inst. Marine Sciences, Morehead City, USA, arsmyth@email.unc.edu

Stephenson, L. M., UNC Chapel Hill, Chapel Hill, USA, lmstephe@email.unc.edu

McCarthy, M. J., Université du Québec à Montréal, Montréal, Canada, markm@mail.utexas.edu

Gardner, W. S., UT Marine Science Institute, Port Aransas, USA, wayne.gardner@mail.utexas.edu

SHALLOW LAKES MEET FACEBOOK: VISUALIZING SHALLOW LAKE NITROGEN CYCLING USING SOCIAL NETWORK ANALYSIS

Nitrogen availability has been demonstrated to be a limiting factor in many shallow lakes. Identity of dominant primary producers in shallow lakes affects lake function. Multiple nitrogen transformations in a shallow lake with both algal and plant dominated basins were quantified. We hypothesized that nitrogen cycling in the algal dominated basin would be regulated by water-column processes and in the plant dominated basin would be regulated by sediment-water exchanges. Denitrification, dissimilatory nitrate reduction to ammonium, nitrogen fixation, ammonium mineralization and sediment fluxes of dissolved nitrogen constituents were quantified. Results indicated that water-column process rates were higher in the algal dominated basin. Social network analysis was used to visualize the nitrogen cycles. Transformations of nitrogen were perceived analogous to interactions of a social network. This novel application of social network analysis provided qualitative and quantitative contrasts in nitrogen cycling in algal and plant dominated shallow lakes. This approach has value to explore material cycling in a range of systems.

Piggott, **J**. **J**., University of Otago, Dunedin, New Zealand, jeremy.piggott@otago.ac.nz

Townsend, C. R., University of Otago, Dunedin, New Zealand, colin.townsend@otago.ac.nz

Matthaei, C. D., University of Otago, Dunedin, New Zealand, christoph.matthaei@otago.ac.nz

HOT, RICH AND DIRTY: MULTIPLE STRESSOR EFFECTS IN A STREAM CHANNEL EXPERIMENT

Agriculture affects streams worldwide through nutrient enrichment, increased fine sediment input and, where riparian vegetation has been removed, raised water temperatures. Global warming will also cause stream temperatures to rise. We manipulated all three stressors simultaneously in streamside channels and determined the individual and combined effects on benthic invertebrates, algal community composition and leaf decay. Each stressor had strong individual effects, but in combination often produced synergistic or antagonistic outcomes. For example, EPT density (mayflies, stoneflies and caddis flies) increased with nutrient enrichment and decreased with sediment addition but the latter effect was weaker at intermediate nutrient levels. Further, increasing temperature reduced EPT density, but only at intermediate nutrient levels. Similarly, algal biomass increased with nutrient enrichment and warmer water, but this effect was strongest when no sediment was added. If managers consider the effects of individual stressors in isolation, their assessment of risk may be erroneous. The fact that temperature had both individual effects on ecological response parameters, and interacted with nutrients and sediment, highlights how global warming may change stream structure and function in a complex manner.

Pilgrim, E. M., U.S. Environmental Protection Agency, Cincinnati, USA, pilgrim.erik@epa.gov

Jackson, **S**. **A**., U.S. Environmental Protection Agency, Cincinnati, USA, jackson.suzanne@epa.gov

UNUSUALLY HIGH GENETIC DIVERSITY IN COI SEQUENCES IN CHIMARRA OBSCURA (TRICHOPTERA: PHILOPOTAMIDAE)

Chimarra obscura (Walker 1852) is a philopotamid caddisfly found throughout much of North America. Using the COI DNA barcode locus, we have found unexpectedly high amounts of genetic diversity and distances within C. obscura. Of the ~150 specimens sampled, we have found over 50 COI haplotypes. Minimum spanning network analysis of these haplotypes reveals two distinct clades, one common (130+ specimens) and one rare (10+ specimens). These two major clades are separated by genetic distances of 7-8%. Within the large common clade are three smaller clades that are separated by genetic distances of 1-2%. We discuss whether these distances represent unusually high intraspecies genetic variation or if this data suggests cryptic diversity within C. obscura.

Pillsbury, **R**. **W**., University of Wisconsin, Oshkosh, Oshkosh, USA, pillsbur@uwosh.edu

O'Brian, M., University of Wisconsin, Oshkosh, Oshkosh, USA, obriem77@uwosh.edu

CAN ALGAL COMMUNITY COMPOSITION WITHIN DETACHED, NUISANCE *CLADOPHORA* MATS HELP DETERMINE THE SOURCE AND SIZE OF FUTURE, BEACH-CLOSING EVENTS?

The nuisance alga *Cladophora* can forms large, detached mats along shorelines. This is an increasing problem for homeowners and beach managers on the Great Lakes. During the summers of 2007-2009, composite samples of these mats were collected from various swimming beaches in Door county, Wisconsin (Lake Michigan, USA). All samples were preserved and examined under a light microscope to determine the composition and morphological characteristics of the filamentous algae. Relative abundances of the attached diatom species were also determined. We found that these "*Cladophora* mats" were often dominated by other filamentous genera. Algal mats from even nearby beaches could be distinguished by *Cladophora* cell morphology, the relative abundance of other filamentous algae, and the associated epiphyte community. This unique combination of mat characteristics may enable the identification of the off shore sources of these beach-closing occurrences. This knowledge could broaden the management options for recreational beaches.

Pinho, **L**., Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, luanaqp@yahoo.com.br

Marotta, H., Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, luanaqp@yahoo.com.br

Gudasz, C., Uppsala University, Uppsala, Romania, cristian.gudasz@ebc.uu.se

Bastviken, D., Linköping University, Linköping, Sweden, david.bastviken@liu.se

Tranvik, L., Uppsala University, Uppsala, Sweden, Lars.Tranvik@ebc.uu.se

Enrich-Prast, A., Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, aenrichprast@gmail.com

WHAT CONTROLS GLOBAL ANAEROBIC ORGANIC CARBON MINERALIZATION IN LAKE SEDIMENTS?

Lake sediments represent an important storage of organic carbon. The stability of this storage depends on within-sediment mineralization rates. Observations that boreal sediments typically store more organic carbon on an areal basis than tropical sediments is typically explained by differences in temperature, but is this true and to what extent can other factors affect mineralization rates? We made a microcosm experiment comparing anaerobic organic mineralization at different temperatures simultaneously in sediments from a broad range of different lake types in Boreal and Amazon regions. Mineralization rates in both Boreal and Amazon lake sediments showed an exponential temperature response from 4 to 40 ° C and relationships with other sediment or lake variables such as organic matter content, C:N ratio, alkalinity are revealed. Hence this study provides insights in the control of sediment metabolism across two lake rich biomes aiming at a global perspective.

Pinto, **P**., Water Lab. ICAAM, University of Évora, Évora, Portugal, ppinto@uevora.pt

Paquete, R., Engenieing High School University of Algarve, Faro, Portugal,

Fernandes, A. E., Regional Forest Authority of Algarve, Faro, Portugal,

Morais, M. M., Water Lab. ICAAM, University of Évora, Évora, Portugal,

Robinson, C. T., Aquatic Ecology, EAWAG, Zurich, Switzerland,

LONG-TERM SEASONAL EFFECTS OF WILDFIRES ON FUNCTIONAL PARAMETERS OF TWO MEDITERRANEAN STREAMS FROM SOUTHERN PORTUGAL

Long-term effects of wildfires (after four years) on stream functional parameters of two Mediterranean streams were evaluated. Four sites were selected on a flat valley stream and three sites on one with a more v-shape valley. Type of cork trees, wildfire severity, post-fire recovery, geomorphologic features and dominant vegetation (riparian and terrestrial), were evaluated on respective drainage areas. This evaluation was done on set of transepts perpendicular to the streams, from the margin until to the top of the slope. At each site, in-stream organic matter, sediment respiration ratios and type of charcoal were evaluated, during spring and autumn. Charcoal was more abundant at flat valley shape sites than at the V shape ones. Stream functional parameters and charcoal in sediment streams were more related to geomorphologic features during spring, while during autumn a strongest relationship with wildfire characteristics was observed (mantel correlations). This suggests that during autumn, after the first rainfalls, terrestrial sediments from burnt areas is carried out to the stream, influencing river functional parameters, but during spring, after the winter washing effect, influence of wildfires is negligible.

Piper, **L**. **R**., Montana State University, Bozeman, USA, leslie.piper@msu.montana.edu

Cross, W. F., Montana State University, Bozeman, USA, wyatt.cross@montana.edu

McGlynn, B. L., Montana State University, Bozeman, USA, bmcglynn@montana.edu

STREAM ISOTOPIC AND STOICHIOMETRIC RESPONSE TO SPATIALLY-VARIABLE NITROGEN LOADING IN A RAPIDLY DEVELOPING MOUNTAIN WATERSHED

Stream ecosystems reflect and respond to changes in watershed land use and associated nutrient loading. Food webs can be particularly useful sentinels of such change, as their elemental stoichiometry and isotopic composition integrate altered watershed conditions in both time and space. Ongoing and spatially-variable development within the West Fork watershed of the Gallatin River in southwestern Montana provides a valuable opportunity to examine this relationship between development and stream ecosystems across a broad range of anthropogenic impact. In August 2009, we quantified elemental stoichiometry (C:N:P ratios) of streamwater, epilithon, and invertebrate primary consumers at 31 stream reaches. We also measured the $\delta^{15}N$ of these food web components to assess the relative importance of wastewater contributions to the nitrogen pool at each reach. Initial results indicate that these two metrics shift in parallel, with reduced C:nutrient ratios and enriched $\delta^{15}N$ signals reflecting more extensive upslope development. Our future research will assess the consequences of these human-induced stoichiometric shifts on nutrient retention and cycling across the West Fork watershed.

Plouhinec, **J**. **B**., Université du Québec à Montréal, Montréal, Canada, jbplouhinec@hotmail.com

Lucotte, M., Université du Québec à Montréal, Montréal, Canada, lucotte.marc_michel@uqam.ca

Ouellet, A., Concordia University, Montréal, Canada, axouellet@hotmail.com

Gélinas, Y., Concordia University, Montréal, Canada, ygelinas@alcor.concordia.ca

PHOTOCHEMICAL CONTRIBUTION TO CO_2 DIFFUSIVE FLUXES IN PERTURBED LAKES AND OLD RESERVOIRS OF THE BOREAL REGION IN QUEBEC: A LIGNIN BIOMARKER APPROACH

In order to evaluate the role of the nature of organic matter on CO_2 production by photochemistry in both natural lakes and lakes perturbed by logging as well as old reservoirs of the boreal region, we measured the photoproduction rate of water samples. Water samples were irradiated after filtration under 0,2µm, and subsequently analyzed for their CO_2 production. Mean energy normalized for the spectral energy exposed to samples was determined to evaluate the photoreactivity of DOM and POM under similar exposure conditions. In complement, organic matter samples had been concentrated via reverse osmosis. We then characterized the origin of DOM and POM present in the water column with lignin biomarkers. Our results confirmed that the photomineralization increased significantly with DOM and POM concentrations. Moreover, our lignin biomarkers increased significantly with CO_2 generation. It thus appears that allochthonous organic matter strongly influences CO_2 photoproduction, which in turn seems independent of the quality of organic matter. Finally, we evaluated the Photochemical Contribution to CO_2 diffusive Fluxes (PCF_{CO2}) between 14% and 32% depending on the degree of perturbation of the aquatic system.

Poff, **N**. **L**., Colorado State University, Fort Collins, CO, USA, poff@lamar.colostate.edu

Pyne, M. I., Colorado State University, Fort Collins, CO, USA, mpyne@lamar.colostate.edu

Bledsoe, B. P., Colorado State University, Fort Collins, CO, USA, brian.bledsoe@colostate.edu

Cuhaciyan, C. O., CBEC, Eco-Engineering, Inc., Eagle, ID, USA, riverdoctor@gmail.com

Carlisle, D. M., U.S. Geological Survey, Reston, VA, USA, dcarlisle@usgs.gov

USING SPECIES TRAITS AND MULTI-SCALED ENVIRONMENTAL VARIABLES TO EXPLORE VULNERABILITY OF BENTHIC COMMUNITIES TO CLIMATE CHANGE

We assessed potential benthic community response to anthropogenic climate change by characterizing macroinvertebrate communities at 279 EMAP reference sites in 12 western US states in terms of 7 species traits that are responsive to temperature and streamflow conditions. For each site we derived 55 environmental metrics describing contemporary climatic, hydrologic and non-climatic habitat features, at catchment to local scales. The full environmental variable set explained 65% of the variation in the trait-based community composition across the sites, with catchment-scale climatic and hydrologic variables accounting for 19%. Using CART and random forests, we illustrate how geographic distribution of trait-based community types is explained by multi-scaled climatic and non-climatic variables. We explored vulnerability of benthic communities to climate change by superimposing regional-scale projections of late 21st Century temperature and runoff change on the spatial distribution of thermally- and runoff-sensitive assemblages. These results suggest that western EMAP reference sites will be differentially affected by future climate change based on geographic location and contemporary trait-based composition, and that non-climatic environmental factors may ameliorate or exacerbate local responses to projected changes in temperature and runoff.

Pohl, **A**. **L**., Miami University, Oxford, USA, pohlal@muohio.edu

Lang, B. K., New Mexico Department of Game & Fish, Santa Fe, USA, brian.lang@state.nm.us

Sei, M., Miami University, Oxford, USA, seim@muohio.edu

Berg, D. J., Miami University, Hamilton, USA, bergdj@muohio.edu

AMINO ACID TRANSLATION OF THE COI BARCODING GENE INCREASES RESOLUTION OF CONSERVATION UNITS AMONG FLATWORM POPULATIONS

DNA barcoding using sequences of the mitochondrial COI gene is widely used as a rapid screening tool for assigning individuals to putative species, and describing functional conservation units. Benthic invertebrates are poorly characterized and morphologically ambiguous; barcoding has revealed high levels of endemism and numerous cryptic species among such organisms in desert springs. Application of the typical DNA barcoding methodology on individuals sampled from nine flatworm populations in the genus *Dugesia* from springs in the northern Chihuahuan Desert revealed saturation of the third codon position, resulting in an inability to resolve differences among populations. By aligning the protein translations of our nucleotide sequences, we were able to discover a pattern of isolation-by-distance among populations consistent with the low dispersal abilities of flatworms, and with DNA barcoding results for populations of amphipods from the same spring systems. We conclude that nucleotide-based DNA barcoding may not be optimal in systems where populations have been isolated for long periods of time. Our results suggest that an extra "step" in DNA barcoding guidelines (examination of protein translations) may increase the utility of this approach.

Politano, K. K., University of Maryland Center for Environmental Science, Solomons, USA, politano@cbl.umces.edu
Politano, V. A., University of Maryland, College Park, USA, vin2242@umd.edu
Jacoby, C. A., University of Florida, Gainesville, USA, cajacoby@ufl.edu
Frazer, **T. K.**, University of Florida, Gainesville, USA, frazer@ufl.edu

OXYGEN MEDIATED GRAZING IMPACTS IN FLORIDA SPRINGS

The Ichetucknee River and other spring-dominated streams in Florida are fed primarily by groundwater emanating from the most productive karst aquifer in the world. In these discharges, DO concentrations can be quite low or nearly anoxic. Consequently, grazers may be markedly less abundant in and around vents. Fewer grazers translate into reduced grazing pressure on periphyton growing on SAV. In fact, reduced grazer abundances near spring vents may enable periphyton to proliferate leading to a decline in production of SAV and deterioration of trophic webs in many Florida springs. Increased nutrient loads may exacerbate this situation. In the Ichetucknee, surveys documented significantly greater numbers of a primary grazer, *Elimia floridensis*, in the main river compared to few live snails in feeder springs. Experiments in the main river showed that *E. floridensis* significantly slowed periphyton accumulation on artificial substrates relative to controls without snails. Within feeder springs, snails suffered nearly 50% mortality and did not affect periphyton significantly. These findings provide new insights into the ecology of Florida's springs and demonstrate the potential importance of top-down control of periphyton growth.

Pollard, **P. C.**, Australian Rivers Institute, Griffith University, Nathan campus, Australia, p.pollard@griffith.edu.au

CLOSING THE GLOBAL CARBON CYCLE: TERRESTRIAL PLANT PRODUCTION LOST TO AQUATIC MICROBIAL RESPIRATION

Currently rainforests are viewed as carbon sinks, where more carbon is fixed than is respired. However, evidence is building to suggest that this is not the case. Forests may not be the Climate Change "get out jail free" — card we all want. I spent 6 months in Central America and in the protected temperate boreal forests of Massachusetts (USA) measuring aquatic microbial respiration. After making over 300 direct measurements of the rate that freshwater microbes use dissolved oxygen, I was able to compare aquatic microbial respiration with the gross primary forest production in their respective watersheds. Forest Production was estimated from tree leaf production and also from Eddy Flux Towers (less plant respiration) that were collected over several years by other researchers. Here I will show aquatic microbial respiration in freshwater can return large amounts of the organic carbon from temperate boreal and tropical forests to the atmosphere as CO2. As global temperatures rise forest respiration is increasing, but much plant production also appears to be lost to microbial respiration in the nearest water body.

Polson, **C. M.**, Australian Rivers Institute, Griffith University, Nathan, Australia, c.polson@griffith.edu.au
Pollard, P. C., Australian Rivers Institute, Griffith University, Nathan, Australia, p.pollard@griffith.edu.au
Galbraith, L. M., Australian Rivers Institute, Griffith University, Nathan, Australia, l.galbraith@griffith.edu.au

FLUORESCENCE SPECTROSCOPY EXCITATION-EMISSION MATRICES (EEM) AS A METHOD TO QUANTIFY BACTERIAL AND VIRAL ABUNDANCE

Quantifying aquatic viruses using epifluorescence microscopy and SYBR staining has come to a standstill with the end of the production of Anodisc (0.02µm) filters. While flow cytometry is an alternative, not everyone has this expensive equipment and it requires considerable expertise, attention to detail and consistency across operators and environments. To quantify the number of bacteria and viruses in a range of natural waters from sub-tropical Australia we used a scanning fluorescence spectrophotometer, in conjunction with a DNA and RNA stain (SYBR Gold) to produce fluorescence excitation-emission matrices (EEM). We corrected for dissolved humic substances in water samples that sometimes changed the position and shape of the DNA/RNA SYBR spectral peak. Bacterial and viral abundance were determined using this EEM method across a range of environments and they correspond with abundance determined using the traditional method of SYBR staining of bacteria and viruses collected on (our last remaining) Anodisc filters and counted using epifluorescence microscopy.

Pongruktham, **O.**, The University of Mississippi, University, USA, opongrkt@olemiss.edu
Ochs, C. A., The University of Mississippi, University, USA, byochs@olemiss.edu

EFFECTS OF HYDROLOGICAL CONNECTIVITY ON PHYSICOCHEMICAL PROPERTIES AND PHYTOPLANKTON BIOMASS AND PRODUCTION IN FLOODPLAIN LAKES OF THE LOWER MISSISSIPPI RIVER

We examined the relationship of hydrological connectivity between the main channel of the Lower Mississippi River (LMR) and several floodplain lakes on chemical properties, and biomass and production of lake phytoplankton communities. Between Nov 07 and Sep 09, samples were collected from the main river channel and three oxbow lakes having different degrees of hydrological connection to the river. During this period, the hydrological dynamics of the LMR changed dramatically, with a fluctuation of river stage of up to 12 meters. As river water flowed into the lakes during high river stage, the lakes experienced elevated turbidity and NO3 concentration, and had relatively low chlorophyll concentrations and pH. As the lakes disconnected, water turbidity decreased while NO3 remained high. This resulted in a rapid increase in phytoplankton biomass and production, contributing to high dissolved oxygen and pH, but a rapid decrease in NO3 concentration. The dramatic seasonal and spatial variations in lake phytoplankton community properties were strongly linked to the degree of connection with the main channel.

Pool, **T. K.**, University of Washington, Seattle, USA, tpool@uw.edu
Olden, J. D., University of Washington, Seattle, , Olden@uw.edu

TAXONOMIC AND FUNCTIONAL HOMOGENIZATION OF FISHES IN THE LOWER COLORADO RIVER BASIN

Exploring the mechanisms that preserve or erode the regional distinctiveness of biotas is a primary focus in the field of conservation ecology. The burgeoning study of biotic homogenization describes how invasions and extinction events can increase the similarity of two or more biotas over a specified time interval. In the present study we employ both a taxonomic and functional approach to explore the temporal dynamics of biotic homogenization and the relative role of human-related environmental variables influencing the process. Our results reveal the taxonomic homogenization process for fish fauna in the LCRB is characterized by a period of differentiation followed by homogenization at the watershed scale. Shifts in the trait similarity between fish communities mimicked the temporal pattern of taxonomic homogenization. Furthermore, we show that the decadal influence of dam instillation, population density, and agricultural development positively correlates with both the taxonomic and functional homogenization of fish faunas in the LCRB. Our study highlights that biotic homogenization is both temporally dynamic and spatially sensitive influenced by human associated landscape environmental drivers.

Poole, **G. C.**, Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT, USA, gpoole@montana.edu
Izurieta, C., Department of Computer Science, Montana State University, Bozeman, MT, USA, clemente.izurieta@cs.montana.edu
Payn, R. A., Fluvial Landscape Lab, Dept of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT, USA, robpayn@gmail.com
Helton, A. M., Odum School of Ecology, University of Georgia, Athens, GA, USA, amhelton@uga.edu
Bernhardt, E. S., Nicholas School of the Environment and Earth Sciences, Duke University, Durhan, NH, USA, emily.bernhardt@duke.edu
Wright, M. S., Flathead Lake Biological Station, The University of Montana, Polson, MT, USA, meredith.wright@flbs.umt.edu
Burgin, A. J., Dept of Earth and Environmental Sciences, Wright State University, Dayton, OH, USA, burginam@gmail.com
Stanford, J. A., Flathead Lake Biological Station, The University of Montana, Polson, MT, USA, jack.stanford@flbs.umt.edu

SYSTEM-LEVEL HYPOTHESIS TESTING: A NOVEL APPROACH TO DEVELOPING PARSIMONIOUS MODELS OF COMPLEX ECOSYSTEM DYNAMICS

Parsimonious conceptualizations of interactions among ecosystem components (e.g., channels, floodplains, and aquifers) and currencies (e.g., water, heat, carbon, nutrients) are important to advancing aquatic science. Competing conceptual models can represent alternate *system-level hypotheses* (SLHs) that

should be rigorously tested, falsified, and refined. However, rigorous SLH testing requires formalization of corresponding simulation models that provide a rapid means of: 1) strategically adding and removing model complexity to create model variants, and 2) managing and analyzing predictions from model variants that may falsify and subsequently allow refinement of SLHs. We are developing Network Exchange Objects (NEO), a software framework to support iterative design of ecosystem models via SLH testing. NEO allows components of models (equations) to be coded individually and organized into nested hierarchies of algorithms. At run time, algorithms can be recombined at any level of the hierarchy to create model variants and thus test alternate SLHs. Ultimately, NEO facilitates evaluation and blending of model algorithms (e.g., alternate representations of water movement, nutrient dynamics, and carbon fixation) to represent ecosystem processes with an appropriate balance among model complexity, realism, and generality

Porcal, **P**., Trent University, Peterborough, Canada, petrporcal@trentu.ca
Dillon, P. J., Trent University, Peterborough, Canada,
Molot, L. A., York University, Toronto, Canada,

PHOTOCHEMICAL PRODUCTION AND DECOMPOSITION OF PARTICULATE ORGANIC MATTER IN FRESHWATER STREAMS AND LAKES

Terrestrial dissolved organic matter (DOM) freshly released to surface waters undergoes photochemical transformation forming particulate organic matter (POC). Laboratory experiments with stream water were conducted to determine the kinetics of POC formation during exposure to artificial solar radiation. The results showed that the decrease in DOM concentration was accompanied initially by increasing and later by decreasing POC concentration. The observed changes in POC concentration fit the kinetics of an intermediate in consecutive reactions. The process of photochemical formation of POC is enhanced in waters with higher concentration of organically bound metals, such as iron and aluminum, that are photochemically-released from organic complexes and that coagulate and co-precipitate DOM, increasing the efficiency of POC production. This mechanism is an important part of the organic carbon cycle in temperate stream and lake waters with higher concentration of DOM and affects the fate of organically-bound metals.

Poret-Peterson, **A**. **T**., Arizona State University School of Earth and Space Exploration, Tempe, USA, aporetpe@asu.edu
Schwegel, R., Arizona State University School of Earth and Space Exploration, Tempe, USA,
Knowlton, M. K., Arizona State University School of Life Sciences, Tempe, USA,
Elser, J. J., Arizona State University School of Life Sciences, Tempe, USA,
Shock, E. L., Arizona State University School of Earth and Space Exploration , Tempe, USA,
Anbar, A. D., Arizona State University School of Earth and Space Exploration, Tempe, USA,

DENITRIFICATION IN GEOTHERMAL SPRINGS: A GENE PERSPECTIVE

Hydrothermal springs of Yellowstone National Park (YNP), with their diverse geochemical properties encompassing gradients of pH, temperature, oxygen levels, and nutrient concentrations, provide excellent aquatic environments to study nitrogen (N) cycling at high temperatures. N cycle processes that have been investigated in hydrothermal systems include dinitrogen fixation and, to a lesser extent nitrification. Prior research in these areas has extended the upper temperature limits for both processes to above 80ºC. Denitrification at elevated temperatures, on the other hand, has received comparatively little attention. Here, we examine denitrification in sediments collected from an array of hot springs located in YNP using functional gene markers for enzymes that catalyze each step of this microbial respiratory process. We have retrieved genes encoding the membrane-bound nitrate reductase (*narG*), cytochrome cd1 nitrite reductase (*nirS*), and nitric oxide reductase ((*norB*). Our results support the potential for denitrification at temperatures up to 85ºC. We also use comparative sequence and phylogenetic analyses to describe the diversity of these genes and correlate our findings with geochemical characteristics of hot springs.

Porst, **G**., Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany, porst@igb-berlin.de
Hilt, S., Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany, hilt@igb-berlin.de
Hupfer, M., Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany, hupfer@igb-berlin.de
Kasprzak, P., Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany, daphnia@igb-berlin.de
Kirillin, G., Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany, Kirillin@igb-berlin.de
Kleeberg, A., Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany, kleeberg@igb-berlin.de
Mischke, U., Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany, mischke@igb-berlin.de
Roithmeier, O., Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany, olivia.roithmeier@pik-potsdam.de
Venohr, M., Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany, m.venohr@igb-berlin.de
Vohland, K., Berlin Museum of Natural History, Leibniz Institute for Research on Evolution and Biodiversity, Berlin, Germany, Katrin.Vohland@mfn-berlin.de

TOWARDS A SUSTAINABLE MANAGEMENT OF GLACIAL LAKES IN NORTH-EASTERN GERMANY IN THE CONTEXT OF CLIMATE CHANGE

Inland waters provide valuable ecological, economical and social services that support biodiversity and human needs. These are threatened by global climate change. Current scenarios for east-central Europe predict increases in temperature and evaporation, which will be paralleled by a distinct precipitation decrease during summer months. This will presumably affect several thousand lakes in the large north-east German lake district severely. Effects driven by climate change include direct and indirect consequences, such as shortened ice-cover periods, increasing water temperatures and seasonal water level fluctuations, changes in hypolimnic nutrient and dissolved oxygen concentrations, earlier onset of thermal stratification, changes in epilimnic water quality, alterations in species composition, abundances and phenology, and their geographical ranges. In this review we develop an integrative view on the various impacts of climate change on lakes with special emphasis on the north-east German lake district, which includes the lakes identified most vulnerable to climate change in Germany. Climate change produces a cascading effect on the multiple linkages between key variables of lake ecosystems, which will be represented in a hierarchical impact spectrum.

Porter, **E**. **T**., Washington College, Chestertown , USA, eporter2@washcoll.edu
Mason, R. P., University of Connecticut, Groton, USA, robert.mason@uconn.edu
Sanford, L. P., Horn Point Laboratory, Cambridge, USA, lsanford@hpl.umces.edu

EFFECT OF TIDAL RESUSPENSION ON BENTHIC-PELAGIC COUPLING IN AN EXPERIMENTAL ECOSYSTEM STUDY

To test the effect of sediment resuspension on the nutrient- and ecosystem dynamics we performed a 4-week experiment in three 1000-L Shear-Turbulence-Resuspension-Mesocosm resuspension (R) tanks and three 1000-L non-resuspension (NR) tanks with similar water column turbulence intensities (~ 1 cm s^{-1}), energy dissipation rates (~ 0.08 cm^2 s^{-3}), and tidal cycles (4-h-mixing-on, and 2-h-off), and different levels of bottom shear stress. Tidal_resuspension in the R tanks resulted in 120-220 mg L-1 total suspended solids concentrations when mixing was on, decreasing to 10-20 mg L-1 when mixing was off. Particulate nitrogen, phosphorus, and carbon concentrations, as well as dissolved inorganic nitrogen, nitrate+nitrite, and phosphate levels were higher in the R tanks. Phytoplankton biomass was also higher in the R tanks, though light was limiting. Tidal_resuspension affected water column algal and zooplankton community composition and induced a brown tide, *Aureococcus anophagefferens*, bloom. In the R tanks, processes were shifted from the benthos to the water column. Regular tidal_resuspension profoundly affected ecosystem structure and function, often through indirect linkages, sometimes reversing effects. Resuspension is a key variable in ecosystem studies.

Post, **A**. **F**., Marine Biology Lab, Woods Hole, USA, apost@mbl.edu
Penno, S., Hebrew University, Jerusalem, Israel, sigrid.penno@mail.huji.ac.il
Kamennaya, N., Hebrew University, Jerusalem, Israel, pingninka@gmail.com

CYANOBACTERIAL DIVERSITY AND NICHE ADAPTATION IN MARINE ENVIRONMENTS

Forging a linkage between species (genotype) and functional diversity (ecotype) is one of the great challenges in the ecology of marine microbes. We employ the N-regulatory gene ntcA as marker for phylogenetic analyses and the NtcA regulon as indicator of functional diversity in marine cyanobacteria. We show distinct Prochlorococcus ntcA clades in different ocean basins with novel clades for the Tropical Indian and Southern Oceans. Based on phylogeny and GC content this latter clade was tentatively identified as a novel clade of low light adapted Prochlorococcus. Members of the novel clade showed a dS/dN ratio of 3.46 (25-52 for other clades), suggestive of a strong purifying selection. Prochlorococcus presence in Antarctic waters was confirmed from ITS sequences and a SOLiD metagenome analysis that contained 480,689 bp (0.11% of total) with >90% identity to Prochlorococcus genomes, mostly to rRNA operons. On the assumption that gene composition of the NtcA-regulon reflects the N-nutritional complexity in their immediate environment, we analyze the context of a 60 kB genomic region that encodes the main N-acquisition modules in Prochlorococcus and Synechococcus. We will present data on NtcA regulon composition from genome comparisons and metagenome analyses. Clade specific differences in nitrate, urea and cyanate utilization illustrate the constraints of ecotype definition based on (still) low numbers of genome sequences for culture representatives of the various clades.

Post, **D**. **M**., Yale University, New Havne, USA, david.post@yale.edu

ECOSYSTEM SIZE AND FOOD CHAIN LENGTH

Food chain length, a measure of the vertical structure of food webs, is a fundamental characteristic of ecological communities. Until recently, only limited progress had been made in understanding what determines the variation in food chain length. Here I will discuss the rapidly growing evidence that ecosystem size explains a considerable amount of the variation in food chain length using data from lakes, islands, and streams. I will present the structural mechanism that must underlay this variation in food chain length, and I will draw from empirical observations and theory to address the mechanisms that potentially link ecosystem size to variation in food chain length. Finally, I will address how ecosystem size is likely to interact with other potential drivers of food chain length such as disturbance and resource availability.

Post, **D**. **M**., Yale University, New Haven, CT, USA, david.post@yale.edu

CONNECTIVITY, FLOW VARIATION, EVOLUTION AND FOOD WEB STRUCTURE

Aquatic ecologists are increasingly interested in how flow variation within and spatial connectivity among aquatic ecosystem because of their potential to influence food web structure. Here I draw from work on lotic and lentic ecosystems to understand how flow variation and connectivity influence fundamental characteristics of food webs and the evolution of critical members of food webs. First, I outline how watershed area and lotic network structure influence flow variation in lotic systems, and how that flow variation can affect food chain length ¬ a fundamental property of food webs. Then I discuss how changes in connectivity have influenced the evolution of alewife, a keystone fish species in lakes across Eastern North America, and how that evolution interacts with connectivity to alter the role of alewives in lake food webs. Both of these examples highlight how geomorphic network structure strongly shapes the structure and dynamics of aquatic food webs.

Post, **J**. **R**., University of Calgary, Calgary, Canada, jrpost@ucalgary.ca

RISK OF FISHERY COLLAPSE AMPLIFIED BY NON-LINEAR PROCESSES AT LOW POPULATION DENSITY

Understanding the dynamics of populations at low density is a fundamental requirement in designing effective management strategies for harvested populations. Yet identifying and quantifying low density processes in nature is challenging due to sparse and variable data typical of low density populations. Two key processes in harvest dynamics involve the compensatory ability of natural populations to offset harvest mortality and the density-dependent depensatory behavior of harvesters. Here we show through analysis of a comprehensive database for freshwater fisheries that these processes are strongly non-linear, leading to important deviations from predictions made by classical harvest dynamics models. We demonstrate that the interactive dynamics of these two competing processes lead to higher minimum density thresholds for persistence and to enhanced risk of population collapse for the majority of populations. The precautionary principle suggests that these nonlinear processes be incorporated into future assessments of harvest strategies and conservation thresholds to avoid fishery collapse.

Postaski, **L**. **L**., College of William & Mary, Williamsburg, USA, llpostaski@wm.edu
Capelli, G. M., College of William & Mary, Williamsburg, USA, gmcape@wm.edu

OBSERVATIONS ON THE DISTRIBUTION, ECOLOGY, AND LIFE HISTORY OF THE FRESHWATER AMPHIPODS GAMMARUS PSEUDOLIMNAEUS AND GAMMARUS FASCIATUS IN SE VIRGINIA

The freshwater amphipods Gammarus pseudolimnaeus and Gammarus fasciatus are broadly sympatric in SE Virginia. G. pseudolimnaeus is far disjunct from its previously-described range in Great Lakes drainages; our documentation includes comparison of morphological traits between such populations, and the establishment of successful mate-guarding between interpopulation individuals. G. pseudolimnaeus is restricted to lotic habitats, usually small high-quality first order streams. G. fasciatus occurs in lakes and streams that are typically significantly degraded; it does not occur with G. pseudolimnaeus in protected habitat. We hypothesize that G. pseudolimnaeus outcompetes G. fasciatus in such areas, but cannot tolerate the higher temperature/lower oxygen conditions where G. fasciatus occurs. G. pseudolimnaeus reproduces year-round, with adults and juveniles of all size classes continuously present. G. fasciatus reproduces primarily from February through June; adults then die, and by late summer the population consists solely of very small (< 2 mm length) individuals buried in the substrate. Immature individuals begin emerging in fall. We hypothesize that this life cycle is highly disadvantageous in the presence of G. pseudolimnaeus, perhaps accounting in part for the observed distribution pattern.

Poulton, **B**. **C**., U.S. Geological Survey, Columbia, USA, bpoulton@usgs.gov
Graham, J. L., U.S. Geological Survey, Lawrence, USA, jlgraham@usgs.gov
Rasmussen, T. J., U.S. Geological Survey, Lawrence, USA, rasmuss@usgs.gov

DEVELOPMENT OF METRIC MODELS FOR PREDICTING BIOLOGICAL CONDITION IN THE UPPER BLUE RIVER WATERSHED, KANSAS AND MISSOURI, USA

The Blue River watershed (725 square km) is located in the Kansas City metropolitan area. Land use is typically rural in headwaters and extensively urbanized in lower reaches. Previous bioassessments documented a longitudinal decline in stream quality corresponding with increased urbanization and nutrients. Along a 10-km reach that includes a wastewater discharge, we examined responses of 34 macroinvertebrate metrics to determine the best suite of indicators for discriminating differences in stream quality among sites, and to develop multi-metric models for predicting changes in biological condition. Multiple regressions identified several significant three-, four-, and five- metric models for spring (r-square = 0.92 - 0.99) and late summer (r-square = 0.89 - 0.99). Metric redundancy and representation of metric categories were considered during model selection. The best model for spring (r-square = 0.92) included Kansas biotic index (KBI), EPT richness, Shannon diversity index (SDI), and scraper/filtering collector ratio (ScFcR). Similarly, the best model for late summer (r-square = 0.92) included KBI, SDI, ScFcR, and clinger richness. Metrics included in other significant models were macroinvertebrate biotic index, Diptera richness, and percent (%) filterers.

Pounder , **C**. **A**., Caribbean Institute of Meterology , St James, Barbados, cpounder@cimh.edu.bb
Hutchinson, T., Coastal Zone Management Unit, St Michael, Barbados, thutchinson@coastal.gov.bb
Farrell, D., Caribbean Institute of Meterology and Hydrology, St James, Barbados, dfarrell@cimh.edu.bb
Inniss, L. V., Coastal Zone Management Unit, St Michael, Barbados, linniss@coastal.gov.bb
Cable, J. E., Louisiana State University, Baton Rouge, USA, jcable@lsu.edu
Martin, J. B., University of Florida, Gainesville, USA, jbmartin@ufl.edu

GROUNDWATER INPUTS TO A MANGROVE AND SEDGE WETLAND, GRAEME HALL, SOUTHERN BARBADOS

A water balance study of Graeme Hall Natural Heritage Conservation Area was undertaken to determine the groundwater inputs to this mangrove and sedge wetland. This area represents the last pristine wetland on the island country of Barbados and is a critical habitat for wading and nesting birds. The mangrove wetland occurs at the base of a series of uplifted carbonate marine terraces just inland of Worthing Beach, and agricultural fields are developed on the terraces uphill from this wetland. We placed pressure and temperature transducers in four existing wells along the upslope terrace gradient to monitor the groundwater movement through time and space. In addition, two leveloggers were placed in the wetland water bodies (a lake and adjacent spring-fed pond). Precipitation data was obtained from the nearby airport and evaporation data was estimated by the Caribbean Institute of Meteorology and Hydrology. Preliminary estimates indicate some tidal modulation appears in groundwater measurements and recharge to groundwater on the upslope terraces is key to maintaining a freshwater wetland at Graeme Hall.

Povinec, **P**. **P**., Comenius University of Bratislava, Bratislava, Slovak Republic, povinec@fmph.uniba.sk
Bokuniewicz, H., Stony Brook University, Stony Brook, USA,
Burnett, W. C., Florida State University, Tallahassee, USA,
Charette, M., Woods Hole Oceanographic Institution, Woods Hole, USA,
Groening, M., International Atomic Energy Agency, Vienna, Austria,
Ishitoibi, T., Research Institute for Humanity and Nature, Kyoto, Japan,
Kontar, E., Shirshov Institute of Oceanology, Moscow, Russian Federation,
Marie, D. E., Mauritius Oceanography Institute, Quatre Borne, Mauritius,
Moore, W. S., University of South Carolina, Columbia, USA,
Oberdorfer, J. A., San Jose State University, San Jose, USA,

SUBMARINE GROUNDWATER DISCHARGE STUDIES USING ISOTOPIC TRACERS AND NUTRIENTS: MAURITIUS ISLAND CASE

Submarine groundwater discharge (SGD) measurements using benthic chambers on the floor of a shallow lagoon on the west coast of Mauritius Island (Flic-en-Flac), as well as analyses of radioactive (3H, 222Rn, 223Ra, 224Ra, 228Ra) and stable (2H, 18O) isotopes and nutrients are presented. The results show significant discharge of groundwater into the Flic-en-Flac Lagoon with discharge rates over 490 cm/day from the fractured-rock aquifer. The multiple deployment of automated seepage meters captured the spatial and temporal variability of SGD with average seepage rate of 10 cm/day. Large SGD variations were seen over distances of a few meters, which were attributed to the spatial variations to the geomorphologic features. Low enrichments in radium isotopes reflect the low abundance of U and Th in the basalt that makes up the island. The stable isotopic composition of submarine waters was characterized by significant variability and heavy isotope enrichment with a varying contribution of groundwater in submarine waters. The integrated SGD estimated from transect carried out parallel to the shoreline was 35 m3/m day, which was in a reasonable agreement with results obtained from radon in situ measurements.

Power, **M**. **E**., University of California, Berkeley, Berkeley, USA, mepower@berkeley.edu

ECOSYSTEM SIZE: MAPPING DOMAINS RELEVANT TO THE DYNAMICS OF FOOD WEBS

We know too little about the spatial and temporal contexts of food webs to forecast how they will respond to environmental change. Robert Holt proposed "spatially splayed food webs" as conceptualizations that depict not only trophic interactions, but also the "domains relevant to the population dynamics" of organisms. Interacting web members may derive their energy and constituent molecules from different environmental source areas ("resource sheds"). Better knowledge of consumers' resource sheds would help us predict the population and food web consequences of spatially explicit environmental change. Organisms can also block resource fluxes to other consumers. Mapping out these "resource shadows" would help us understand consequences of species invasions or losses. Some resource fluxes and species interactions are delimited by physical habitat boundaries (e.g. drainage divides, air-water or water-sediment interfaces), but many are not, as ecological interactions across edges are often intense. Predicting how freshwater organisms and ecosystems will respond as humans shrink and fragment their habitats will depend in part on elucidating the space-time domains that determine the complex relationships between diet and dynamics in food webs.

Powers, **S**. **M**., University of Wisconsin Madison, Madison, USA, smpowers@wisc.edu
Stanley, E. H., University of Wisconsin Madison, Madison, USA, ehstanley@wisc.edu

STREAM AND WETLAND NITRATE UPTAKE ACROSS EXTREMES IN CHANNEL FORM

Two dominant factors, water residence time (WRT) and nutrient inputs (loading), dictate much of the variation in aquatic nutrient budgets. This knowledge suggests that for a given loading, variation nutrient use efficiency (uptake; T^-1 or L T^-1) across systems should be small regardless of differences in WRT or size. However, the potential evenness of uptake is not well tested, largely due to insufficient study of high WRT wetlands and reservoirs where unique hydrogeomorphic conditions can affect uptake. We examined evenness of nitrate uptake across ponded and free-flowing reaches arranged consecutively, which offered large hydrogeomorphic contrasts but common loading. For a nearly 10-fold range of water velocity (including extreme lows down to 0.03 m s^-1), whole stream uptake at 20 ug L-1 enrichment had a narrow range (0.5x10^-4 to 2.0x10^-4 s^-1). Transient storage uptake varied widely, but was occasionally very important (>80% of total nitrate removed). We currently lack a strong basis for predicting inter-system differences in uptake per unit loading. However, because uptake differences were not large, our study lends credence to network models that assume uniform uptake across systems.

Prairie, **Y**. **T**., UQAM, Montreal, Canada, prairie.yves@uqam.ca
del Giorgio, P. A., UQAM, Montreal, Canada, del_giorgio.paul@uqam.ca

METHANE MICROBUBBLE EVASION FROM BOREAL AQUATIC ECOSYSTEMS

The potential importance of methane microbubble evasion from freshwater systems was examined by comparing the gas exchange velocities derived from carbon dioxide and methane fluxes in a set of diverse systems and environmental conditions. In over 90% of about 200 measurements, methane exhibited higher evasion rates than strictly diffusive processes would suggest. The flux associated with microbubble evasion was closely related and directly proportional to the degree of methane supersaturation relative to the atmosphere. On average, microbubbles contributed about half of the total methane efflux from the systems and could be modeled as an additive gas piston velocity of about 2.1 m d-1, on average. Our results suggest that methane evasion rates based only on measured partial pressures and exchange velocities characteristic of diffusive processes will grossly underestimate methane loss from these boreal ecosystems.

Prater, **C**., University of Arkansas, Fayetteville, USA, cxp014@uark.edu
Evans-White, M. A., University of Arkansas, Fayetteville, USA, mevanswh@uark.edu

NUTRIENT CONTENT OF DETRITUS AND MACROINVERTEBRATES ACROSS A PHOSPHORUS GRADIENT IN OZARK HIGHLAND HEADWATER STREAMS

Increasing P concentrations may favor macroinvertebrate species with high P demands over those with lower demands by increasing the P content of food resources. Phosphorus (P) is often the most limiting nutrient in streams, especially when the prominent food source is detritus, which has high Carbon (C):P ratios. We predicted that stream total phosphorus (TP), leaf %P, and macroinvertebrate %P would be positively correlated. Stream water, macroinvertebrates, and leaf litter samples were collected across streams along a TP gradient (range: 8 - 41 µg P/L). All macroinvertebrates were identified to genera except Chironomidae. A significant correlation was found between TP and leaf P (R^2 0.627, P 0.034); however, no significant correlations were found between TP and invertebrate P (P 0.98) or between leaf and invertebrate P (P 0.35). Shredding macroinvertebrate insect richness was low, (range: 1-3 taxa per site) and most streams had TP concentrations below those reported to saturate leaf %P and to cause significant changes in macroinvertebrate richness and stoichiometry. Future sampling efforts will focus on including streams with higher TP concentrations and will track abundance and biomass.

Premke, **K.**, University of Konstanz, Limnology, Konstanz, Germany, katrin.premke@ebc.uu.se

Hesselschwerdt, J., University of Konstanz, Limnology, Konstanz, Germany, john.hesselschwerdt@uni-konstanz.de

Gessler, A., Institute for Landscape Matter Dynamics (ZALF), Müncheberg, Germany, gessler@zalf.de

Wantzen, K. M., Karlsruhe Institute of Technology , Institute for Water and River Basin Management, Karlsruhe, Germany, matthias.wantzen@uni-konstanz.de

INFLUENCES OF ALLOCHTHONOUS DISSOLVED ORGANIC CARBON AND WARMING ON GROWTH AND INTERACTIONS OF LEAF LITTER COMMUNITIES

Enhanced concentrations of dissolved organic carbon (DOC) together with warming are expected to change the productivity, interactions and structure of benthic habitats in lakes. We tested the effect of DOC subsidy (enriched in d13C) at low and high temperatures on microbial leaf litter communities. We found fungal growth in all treatments but higher biomass at lower temperature. DOC supply did not influenced fungal growth. While both factors did not affect the carbon sources used by fungi, thus leaf carbon was estimated to cover up to 81% of the carbon used for fungal biomass incorporation. In contrast, bacterial growth rate were positively affected by temperature and DOC supply. Furthermore, we could find an antagonist effect from bacteria on fungi at high temperatures and a reverse effect from fungi on bacteria at low temperatures and suggest this reciprocal antagonism to be an important controlling factor during warming for growth of microbial degraders. This data suggest that litter associated microbial communities may be sensitive to extra DOC supply and warming. Increase in both may lead to strong changes in interactions between those two major microbial groups during litter decomposition.

Prentice, **M. J.**, Australian Rivers Institute, Griffith University, Brisbane, Australia, m.prentice@griffith.edu.au

Burford, M. A., Australian Rivers Institute, Griffith University, Brisbane, Australia, m.burford@griffith.edu.au

O'Brien, K. R., School of Chemical Engineering, The University of Queensland, Brisbane, Australia, k.obrien@uq.edu.au

RELATIVE IMPORTANCE OF ORGANIC AND INORGANIC PHOSPHORUS UTILIZATION BY PHYTOPLANKTON IN A SUBTROPICAL RESERVOIR

Cycling of phosphorus by the phytoplankton and bacterioplankton in the surface waters of a phosphorus-depleted subtropical reservoir was investigated. Phytoplankton dissolved inorganic phosphorus (DIP) uptake and regeneration rates were measured monthly between February 2009 and January 2010 in Lake Wivenhoe, Australia. The ability of phytoplankton to utilize dissolved organic phosphorous (DOP) was determined from the alkaline phosphatase activity over the same period. A critical threshold of 0.005 mg L^{-1} of DIP was found, below which alkaline phosphatase production was initiated, and phytoplankton DIP uptake rates were elevated. Alkaline phosphatase activity was also highly dependent on temperature. Hence in summer months, when surface DIP concentrations were generally below detection limits, utilization of DOP represents a considerable source of phosphorus for the phytoplankton in the surface waters of this subtropical reservoir. Conversely in winter months when DIP concentrations were elevated due to increased lake mixing, alkaline phosphatase activity and therefore DOP utilization was virtually non-existent.

Price, **K. J.**, The Pennsylvania State University , University Park, USA, kjp201@psu.edu

Carrick, H. J., The Pennsylvania State University , University Park, , hjc11@psu.edu

EFFECTS OF IN SITU PHOSPHORUS ENRICHMENTS ON THE UPTAKE CAPACITY OF STREAM BIOFILMS

Elevated phosphorus (P) concentrations in streams are frequently linked with eutrophication and diminished water quality. Stream biofilms appear to play an important role in P assimilation; however, little work has addressed how increasing P loadings can affect assimilative abilities. We evaluated P uptake kinetics of benthic biofilms along a stream productivity gradient. Point-source nutrient loadings were approximated using an in situ enrichment system (ISES), which consisted of vials spiked with increasing concentrations of KH_2PO_4 (n=60). Vials were capped with disks that were removed with attached biofilms after three weeks of incubation in streams. After, a series of short-term radiotracer ($H_3{}^{33}PO_4$) experiments were conducted to measure biofilm uptake. As anticipated, uptake vs. loading showed a hyperbolic decay. ISES experiments demonstrated that in situ enrichment of biofilms satisfies some P demand, as higher P treatments had lower uptake rates. Biofilms in less productive streams showed comparatively higher uptake rates, indicating that these communities may be more physiologically poised to respond to P loads (e.g. ISES). Biofilms in more productive streams are likely P-saturated (high internal pools) with lower demand for added P.

Priscu, **J. C.**, Montana State university, Bozeman, USA, jpriscu@montana.edu

THE GOLDMAN LEGACY: THE IMPORTANCE OF LONG-TERM PHYTOPLANKTON PRODUCTIVITY DATA

Charles Goldman's contributions to limnology are numerous, but perhaps his most important are the long-term records of primary productivity on Castle Lake (50 years) and Lake Tahoe (43 years). These collections were initiated with the idea that temporal data would provide scientists and lake managers with an important base to assess eutrophication and set water quality policy. More recently, these long-term records have been used to show the limnological response to climate change. Of interest is the fact that Goldman was one of the first limnologists to measure primary production (1961) and examine nutrient deficiency in the lakes of the McMurdo Dry Valleys, Antarctica. As a former Goldman student, I have continued these measurements on Antarctic lakes through the McMurdo LTER program. The 20 years of productivity data on these polar lakes have been to show that they are sentinels of climate change on our planet. Without the insights provided by Goldman, we would not have the long-term productivity studies on Antarctic lakes and the world would be a sadder place.

Prochaska, **E. A.**, Central Michigan University, Mt. Pleasant, USA, proch1ea@cmich.edu

Woolnough, D. A., Central Michigan University, Mt. Pleasant, USA, wooln1d@cmich.edu

SHORT TERM MOVEMENT PATTERNS AND MORTALITY RATES OF FRESHWATER MUSSELS AFTER RELOCATION

Freshwater mussels are relocated for a variety of reasons including conservation, management, and construction. This study considers the weekly movement and mortality rates of mussels relocated from Ross Lake to the Cedar River during a dam repair in Beaverton, Michigan. *Pyganodon grandis* and *Fusconaia flava* were the two most abundant species during the initial relocation and were used for this study. Individuals of each of the target species were placed in two different substrate types: gravel (n=100 per species) and sand (n=100 per species) in upstream and downstream locations of the Cedar River. Movement was recorded weekly for two months after relocation. Data showed that there was a significant difference (p=0.008) between the movement of the two species; *P. grandis*, on average, moved 0.54 m/day more than *F. flava*. Zebra mussels were initially found on many of the individuals in this study and were considered as a stress factor throughout this study. Management implications for dealing with species differences, mortality, and zebra mussels during dam repair will be discussed.

Proia Lorenzo, **L. P.**, Institute of Aquatic Ecology, University of Girona, Girona, Spain, lorenzo.proia@udg.edu

Osorio, V., Department of Environmental Chemistry, IDAEA, CSIC,, Barcelona, Spain, votqam@cid.csic.es

Lupini, G., Water Research Institute,IRSA-CNR, Monterotondo St. (RM), Italy, lupini@irsa.cnr.it

Soley, S., Institute of Aquatic Ecology, University of Girona, Girona, Spain, susanna_soley_prieto@hotmail.com

Di Maio, M., Water Research Institute,IRSA-CNR, Monterotondo St. (RM), Italy, mariarita.dimaio@hotmail.it

Barceló, D., Department of Environmental Chemistry, IDAEA, CSIC/Catalan Institute for Water Research (ICRA), Barcelona, Spain, dbcqam@cid.csic.es

Fazi, S., Water Research Institute,IRSA-CNR, Monterotondo St. (RM), Italy, fazi@irsa.cnr.it

Perez, S., Department of Environmental Chemistry, IDAEA, CSIC, Barcelona, Spain, spsqam@cid.csic.es

Romanì, A., Institute of Aquatic Ecology, University of Girona, Girona, Spain, anna.romani@udg.edu

Sabater, S., Institute of Aquatic Ecology, University of Girona/Catalan Institute for Water Research, ICRA

MICROBIAL BIOFILM RESPONSE TO TRANSLOCATION ALONG A POLLUTION GRADIENT IN A HIGHLY IMPACTED RIVER.

Effects of pollution on microbenthic biofilms were assessed in a highly impacted river (Llobregat River, Barcelona). Microbial biofilm structure-function was experimentally related to water quality by translocation along a pollution gradient under controlled conditions. Biofilms grew with water from 3 differently impacted sites were sampled 6 times during 41 days. Moreover, after 25 days, replicates were translocated from less to more polluted waters and 3 samplings were performed. Different mixtures of new emerging compounds (pharmaceuticals) and priority pollutants were detected in different sites. Biofilms developed differently in function of site: the most polluted site resulted in the highest autotrophic biomass and the lowest live/dead bacteria ratio. Bacterial community differed in terms of dominance of the main groups of proteobacteria (α- β- γ-). Autotrophs of translocated biofilms increased their fluorescence, and decreased their photosynthetic capacity and efficiency. In translocated biofilms bacterial mortality increased and bacterial community changed with an increase of β- and a decrease of α- γ- proteobacteria. Cytophaga-Flavobacteria and Actinobacteria did not show major changes in abundance. Slight changes were observed on heterotrophic metabolism and biofilm phosphorus uptake efficiency

Przeszlowska, **A.**, USFS Pacific Northwest Research Station, Olympia, USA, aprzeszlowska@fs.fed.us

Wondzell, S. M., USFS Pacific Northwest Research Station, Olympia, USA, swondzell@fs.fed.us

Bisson, P. A., USFS Pacific Northwest Research Station, Olympia, USA, pbisson@fs.fed.us

Hemstrom, M. A., USFS Pacific Northwest Research Station, Portland, USA, mhemstrom@fs.fed.us

A STREAM NETWORK APPROACH FOR PREDICTING RIPARIAN VEGETATION DYNAMICS AND SALMONID HABITAT QUALITY.

Understanding land-use and ecosystem change at the watershed scale is crucial for decision makers who manage riparian and aquatic habitats, especially those managing for threatened or endangered species. We use a state-and-transition framework to model the effects of various management and restoration practices on conditions of riparian forests, channel morphology, and salmonid habitats across stream networks. State classes in our models are defined by channel morphology and riparian vegetation. Transitions are defined by plant succession, natural disturbances, management and restoration practices. Habitat suitability rankings for anadromous salmonids are derived from channel and vegetation attributes associated with each state in the models. We present results from the upper Middle Fork John Day River watershed in eastern Oregon (824 km^2): 1) current riparian and aquatic conditions relative to historic range of variability, and 2) likely trajectories under expected land-use and restoration practices. These models link biological and physical dynamics within stream networks and offer the potential to project changes in habitat conditions under alternative management scenarios at sub-basin to regional scales, in order to better implement cost-effective restoration programs.

Pulkkinen, **K.**, University of Jyväskylä, Jyväskylä, Finland, katja.a.pulkkinen@jyu.fi

Wojewodzic, M., University of Oslo, Oslo, Norway, marcin.wojewodzic@bio.uio.no

Hessen, D. O., University of Oslo, Oslo, Norway, d.o.hessen@bio.uio.no

NUTRIENT LIMITATION INCREASES THE EFFECT OF PARASITE INFECTION ON *DAPHNIA* POPULATION DYNAMICS

Nutrient deficiency has been shown to affect growth and population dynamics of consumers in aquatic environments. Parasites can be seen as consumers which compete for resources with their host. Under nutrient limitation, parasites could further depress host growth and reproduction, and conversely nutrient limitation of hosts could also decrease the growth of parasites. We studied the effect of phosphorus (P) - limitation and parasites on population dynamics of *Daphnia magna*. After 32 days the densities were lower for populations infected with a microsporidian *Glugoides intestinalis* than for controls for both feeding treatments with P-rich or P-poor algae. In P-rich treatment the dry weights did not differ between the infected and uninfected populations, but in P-poor treatment the dry weight of the infected populations was less than half of that of control populations. Surprisingly, the spore load of infected females was significantly higher in the P-poor treatments than in the P-rich treatments, pointing to a complex role of reciprocal P-limitation in host and parasite. These interactions would be relevant for understanding host-parasite dynamics under varying degrees of nutrient limitation.

Pyne, **M. I.**, Colorado State University, Fort Collins, USA, mattpyne@hotmail.com

Poff, N. L., Colorado State University, Fort Collins, USA, poff@lamar.colostate.edu

TESTING A PRIORI CONCEPTS OF ENVIRONMENTAL-TRAIT RELATIOSHIPS

Reclassifying a community from taxonomic designations into functional trait categories allows for mechanistically linking environmental selective forces and community composition. However, such redefining generates inter-correlated multivariate response variables (multiple trait states) that often respond to many inter-correlated environmental factors. These complex relationships within and between the explanatory and response variables can lead to vague interpretations and weak mechanistic links. Previous authors in stream traits literature have advocated using only a priori definitions of environment-trait responses, built on sound ecological theory, to avoid some of the pitfalls of these complex datasets. They have also argued that theoretically sound a priori selection of traits and trait combinations should have stronger environment-trait relationships. But do they? We test the strength of a priori trait-environment relationships against null models assembled from randomly selected trait states and combinations along with taxa and environmental variables collected for 279 sites in the western EMAP database. While many a priori predictions result in strong relationships, other unexpected trait-environment pairings occurred. We explore possible reasons for these relationships, including the influence of other correlated traits and dominant taxa.

Pyron, **M.**, Ball State University, Muncie, USA, mpyron@bsu.edu

Goforth, R., Purdue University, Lafayette, USA, rgoforth@purdue.edu

Morlock, S., United States Geological Survey, Indianapolis, USA, smorlock@usgs.gov

Kim, M., United States Geological Survey, Indianapolis, USA, mkim@usgs.gov

Beugly, J., Purdue University, Lafayette, USA, jsbeugly@bsu.edu

MODELING FISH ASSEMBLAGES OF LARGE RIVERS: A GIS APPROACH USING BATHYMETRY, WATER VELOCITY, SEDIMENT, AND WOODY DEBRIS

Fish preferences for specific habitats have been documented for multiple ecosystems including rivers. However, the use of a Geographic Information System (GIS) to analyze and view fish distributions and habitat parameters provides numerous advantages over previous analyses. We collected channel bathymetry, water velocity, and streambed composition using an Acoustic Doppler Current Profiler (ADCP) deployed from a USGS boat and interfaced with a Differential Global Positioning System (DGPS) receiver, for a 10-km study reach of the Wabash River in Lafayette, Indiana. Within one week of collecting habitat data we used three boat electrofishers to simultaneously collect fishes through the same reach. Individual fish were assigned latitude-longitude coordinates when they were captured using GPS units. These data allow us to test multiple hypotheses ranging from asking if some species tend to co-occur less than expected (competition or predation), to testing for species habitat preferences, to models of hydrology, substrate variation, and fish assemblages. We collected 2,773 fishes in 40 species that will be presented with habitat data using three-dimensional graphics.

Qu, **L.**, Memorial University of Newfoundland, St.John's, Canada, liang.qu@mun.ca

Way, C. J., Memorial University of Newfoundland, St.John's, Canada, cjway@mun.ca

Tang, X. X., Ocean University of China, Qingdao, China, tangxx@ouc.edu.cn

Rivkin, R. B., Memorial University of Newfoundland, St.John's, Canada, rrivkin@mun.ca

SEASONAL CHANGES OF GROWTH AND MORTALITY FOR BACTERIAL PHYLOGENETIC GROUPS IN RESPONSE TO BACTERIVOROUS GRAZING IN A COASTAL AREA OF NORTHEAST ATLANTIC OCEAN

Processes which mediate the transfer of carbon from dissolved pools to higher trophic levels are influenced by the growth and grazing losses of heterotrophic bacteria. Although changes in bacterial community composition have been observed in laboratory and field studies, few have characterized the rates and patterns of growth and grazing loss for individual bacterial phylotypes. Using Fluorescence *In Situ* Hybridization combined with dilution assay, we examined the seasonal changes in rates of growth and grazing mortality for individual phylogenetic groups within the bacterial community in coastal Newfoundland waters. We found both distinct seasonal patterns of growth and grazing

mortality among individual phylogenetic groups and close coupling between rates of growth and mortality. Our results have implications for understanding the relationship between bacterial community structure and the cycling of biogenic carbon in the marine microbial food web.

Qu, X. D., Chinese Research Academy of Environmental Science, Beijing, China, davidqu0108@gmail.com
Zhang, Y., Chinese Research Academy of Environmental Science, Beijing, China, zhangyuan@craes.org.cn
Kong, W. J., Chinese Research Academy of Environmental Science, Beijing, China, kongwj@craes.org.cn
Meng, W., Chinese Research Academy of Environmental Science, Beijing, China, Mengwei@craes.org.cn

SPATIAL PATTERNS IN SPECIES COMPOSITION, DIVERSITY, AND SPECIES ABUNDANCE DISTRIBUTION OF STREAM MACROINVERTEBRATE COMMUNITIES: RELATIONSHIP WITH LAND USE

The benthic macroinvertebrates were collected from up-stream to down-streams of the Taizi River in the North-East of China. Overall spatial distribution patterns of macroinvertebrate communities were analyzed by using cluster analysis (CA) and nonmetric multidimensional scaling (NMS) analysis. The patterned groups accordingly revealed the impact of different land use and land cover (LULC). The species abundance distribution and diversity also accordingly reflected LULC. The indicator species analysis reflected the sensitive species mainly located at the up-stream area, while some tolerant species were selectively collected in the middle-, and down-stream areas. The further analysis showed out that LULC appeared to be the key factor influencing the spatial distribution and community parameters such as species richness and biodiversity indices in the sampled communities. The percentage of forest area, farmer land area, metropolitan areas, bottom land area, and wet land area were the five key factors influence the species composition of macroinvertebrate communities by applying the CCA analysis. The results of this study also showed that human disturbance, mainly LULC, significantly effect on degrades of the community condition, decreasing of the species diversity, and changes of species abundance distribution from lognormal and logseries distribution at the clean up-stream area to geometric distribution at the downstream area.

Raikow, **D**. **F**., USEPA, Cincinnati, USA, raikow.david@epa.gov
Walters, D. M., USGS, Fort Collins, USA, waltersd@usgs.gov
Hammerschmidt, C., Wright State University, Dayton, USA, chad.hammerschmidt@wright.edu
Mehling, M., Miami University, Oxford, USA, mehlinmg@muohio.edu
Gevertz, A., Miami University, Oxford, USA, akgevertz@gmail.com
Oris, J., Miami University, Oxford, USA, orisjt@muohio.edu

METHYLMERCURY BIOACCUMULATION ACROSS A PRODUCTIVITY GRADIENT IN STREAMS

Conceptual models have identified periphyton as a potentially important pathway for biomagnifying pollutants in streams. This hypothesis, however, has neither been tested experimentally, nor investigated for methylmercury (MeHg), a ubiquitous aquatic contaminant. We conducted a mesocosm experiment to measure MeHg uptake from water to basal resources and primary consumers across a productivity gradient established by differences in light exposure. Simple two-level food webs were introduced to mesocosms consisting of periphyton, suspended algae, a grazer (snails), leaves, a shredder (*Hyalella*), and filter feeder (*Corbicula*). Mesocosms were amended with MeHg and fertilized with N and P. Phytoplankton biomass increased with light, but periphyton did not. With greater productivity, MeHg levels increased in phytoplankton and were reduced in water, periphyton, and consumers, including snails despite no difference in periphyton density. In stream ecosystems, where MeHg availability may not limit bioaccumulation, phytoplankton growth appears to govern bioaccumulation and transfer to associated consumers.

Ramcharan, **C**. **W**., Laurentian University, Sudbury, Canada, cramcharan@laurentian.ca

LIMNOLOGY AND ECOLOGY: A RETROSPECTIVE AND A LOOK AHEAD

This symposium has many of us in a reflective mood. Sometimes it's good to pause and look at the road ahead. The past decades have brought many changes in the way we practice ecology; some of these changes are fundamental yet have arrived largely unnoticed. When I look through my own work as well as analyses of publication and funding trends, I find that ecology has become a more local science with a shift away from testing general theories. Nowadays, communities and ecosystems are more often evaluated in terms of species occurrence and composition rather than in terms of changes in trophic and ecosystem processes. As a result, I argue, our understanding of the trophic and other machinery of ecosystems is not substantially advancing. If I'm right, then this impairs our ability to compare the machinery of different types of ecosystems and to predict how these functions might be affected by stressors of different types. On the other hand, perhaps this reflection on our science will serve to verify that we really are on the right track.

Ramirez, **A**., University of Puerto Rico, San Juan, Puerto Rico, alonso.ites@gmail.com
Bernard-Flores, M. A., University of Puerto Rico, San Juan, Puerto Rico,

AQUATIC INSECT DIVERSITY ALONG A TROPICAL ISLAND STREAM CONTINUUM IN PUERTO RICO

Aquatic insect assemblages are expected to change along a stream continuum as the environment changes. We assessed patterns in aquatic insect assemblages along a steep stream continuum in Puerto Rico that ranged from 250 to 1000 m. Insects were sampled from riffles, pools and bedrock habitats using D-nets and sampling for 15 minutes. Sampling stations were located every 50 m in elevation from 250 to 1000 m along Sonadora stream. A total of 1,446 individuals were collected, of those the greatest abundance corresponded to the family Leptophlebiidae (Ephemeroptera). Family richness and abundance was significantly different among habitats, with highest numbers on bedrocks. Both, richness and abundance, were significantly related to elevation, water temperature and channel width. The strongest relationship with elevation was for bedrock habitats. Bedrocks are relatively predator free, in comparison to pools and riffles that are dominated by decapod shrimps. Our study suggest that insect assemblages changed along the stream continuum and that environmental factors (e.g., temperature, channel width) were related to those changes. Predation can also play an important role as suggested by differences among habitats.

Ramsey, **J**. **B**., The University of Alabama, Tuscaloosa, USA, jbramsey@crimson.ua.edu
Huryn, A. D., The University of Alabama, Tuscaloosa, USA, huryn@bama.ua.edu
Benstead, J. P., The University of Alabama, Tuscaloosa, USA, jbenstead@bama.ua.edu
Parker, S. M., The University of Alabama, Tuscaloosa, USA, parke003@bama.ua.edu

LIGHT-MEDIATED CONTROL OF SEASONAL NUTRIENT DYNAMICS IN AN ARCTIC SPRING-FED STREAM ECOSYSTEM

We investigated the seasonal nutrient uptake dynamics of a perennial, Arctic spring-stream. Ivishak Spring has the stable discharge (~131 L/s) and temperature (~4-8°C) typical for springs. It is unusual, however, in having an annual cycle of photosynthetically active radiation from 480 (summer daily mean) to 0.1 $\mu M \bullet m^{-2} \bullet sec^{-1}$ (winter daily mean). We conducted monthly serial NH_4, NO_3 and PO_4 (Mar 2007 to Aug 2009). NH_4-N uptake was highest in late spring and early summer (up to 290 mg $N \bullet m^{-2} \bullet d^{-1}$, V_f of 1.44 $mm \bullet s^{-1}$ in May 2009) and lowest during winter (e.g., 7.5 mg $N \bullet m^{-2} \bullet d^{-1}$, V_f of 0.12 $mm \bullet s^{-1}$ in Jan 2009). Demand for NO_3-N and phosphorus, however, was consistently too low to be measured. We attribute the strong seasonal variation in NH_4-N demand to light availability and its effect on rates of benthic metabolism. The exceptionally high, summer demand for NH_4-N coupled with the low demand for PO_4 was surprising given the widespread observation of phosphorous limitation of productivity for other freshwater ecosystems in the Arctic.

Rancatti, **R**. **L**., University of Maine, Orono, USA, regina.rancatti@umit.maine.edu
Simon, K. S., University of Maineksimon@maine.edu
Anderson, D., University of Maine
Fernandez, I. J., University of Maine
Norton, S. A., University of Maine
Valett, H. M., University of Montana
Ely, D. T., Virginia Polytechnic Institute and State University

EFFECT OF WATERSHED ACIDIFICATION ON ABIOTIC AND BIOTIC UPTAKE OF PHOSPHORUS BY STREAM SEDIMENT

Watershed acidification can influence stream phosphorus cycling by mobilizing metals, especially aluminum, from soils to streams where the metals precipitate. These metals can bind rapidly to phosphorus, creating a strong phosphorus

sink that may increase phosphorus limitation for stream biota. We examined this issue at the Bear Brook Watershed in Maine, where a forested watershed has been experimentally acidified for over 20 years. We used laboratory assays to measure biotic and abiotic phosphorus uptake capacity of sediments from streams in the experimental watershed and an adjacent reference watershed. Abiotic processes dominated phosphorus uptake capacity and there was little difference in uptake capacity between streams. Calculated equilibrium phosphorus concentrations indicated that the sediments from both streams were releasing phosphorus into the water column under ambient phosphorus concentrations. This contrasts with much higher rates of whole-stream phosphorus uptake in the experimental stream as measured using nutrient spiraling techniques. These contradictory results may arise from spatial variability in sediment chemistry and the role of uptake on organic matter in the stream channels; these issues are the subject of ongoing research.

Rantala, **H. M.**, The University of Alabama, Tuscaloosa, USA, hrantala74@gmail.com

Parker, S. M., The University of Alabama, Tuscaloosa, USA, parker.stephanie@gmail.com

Huryn, A. D., The University of Alabama, Tuscaloosa, USA, huryn@bama.ua.edu

SUCCESSION IN ARCTIC STREAMS (NORTH SLOPE, ALASKA) ALONG A GLACIAL CHRONOSEQUENCE RANGING IN AGE FROM MODERN TO CA. 2 MILLION YEARS OLD

Succession is one of the oldest concepts in ecology. Nevertheless, there have been few studies of succession in streams, particularly those that have focused on long-term successional sequences. Using space as a substitute for time, we assessed community structure and process and habitat attributes in 15 streams on glacial terrains of 5 ages, ranging from modern glacial forelands to terrains ca. 2 million years old. Streams on modern glacial terrains had significantly lower temperatures and higher substratum instability than those on older terrains ($p<0.05$). Secondary production of macroinvertebrates was lower in streams on modern glacial forelands ($p<0.05$) and the community structure was significantly different than communities in other streams (ANOSIM, $p<0.05$). Production-to-biomass ratios, once normalized for temperature, were significantly higher on modern terrains ($p<0.05$), while species richness and diversity were lower ($p<0.05$). Our results suggest that ecosystem structure and function of North Slope streams become stabilized after about 10,000 years, a pattern similar to that reported for forest ecosystems.

Rasmussen, **A. K.**, Florida A&M University, Tallahassee, USA, andrew.rasmussen@famu.edu

Pescador, M. L., Florida A&M University, Tallahassee, USA, manuel.pescador@famu.edu

Harris, S. C., Clarion University of Pennsylvania, Clarion, USA, Harris@clarion.edu

CADDISFLIES (TRICHOPTERA) OF EGLIN AIR FORCE BASE, FLORIDA: ENDEMISM OF AN INSULAR NETWORK OF SPRING-FED STREAMS ON THE SOUTHEASTERN COASTAL PLAIN

We conducted a survey from 1996 to 2008 of the caddisfly (Trichoptera) fauna of Eglin Air Force Base, which is located in the western panhandle of Florida. Approximately 95 samples of adult caddisfly specimens were collected by light-trapping at approximately 30 sampling stations during different times of year along upper and lower stream reaches. A summary of the faunal survey and a species inventory are presented. The structure of caddisfly assemblages is characterized and compared across streams and drainages, and the biogeographic patterns are discussed. The caddisfly fauna of streams on Eglin AFB shows a high degree of endemism. The role of insular, spring-fed stream habitats in the creation of biodiversity hot spots is emphasized.

Rasmussen, **T. J.**, U.S. Geological Survey, Kansas Water Science Center, Lawrence, KS, USA, rasmuss@usgs.gov

Poulton, B. C., U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO, USA, bpoulton@usgs.gov

Graham, J. L., U.S. Geological Survey, Kansas Water Science Center, Lawrence, KS, USA, jlgraham@usgs.gov

EVALUATION OF RELATIONS BETWEEN STREAM BIOLOGICAL CONDITIONS AND ENVIRONMENTAL VARIABLES IN URBANIZING WATERSHEDS OF NORTHEASTERN KANSAS

Relations between stream biological conditions and environmental variables were evaluated in urbanizing watersheds of northeastern Kansas. Macroinvertebrate and algal periphyton data were used in conjunction with water chemistry, streambed-sediment chemistry, streamflow, habitat, and land use data. Statistical analyses indicated that the primary factor explaining biological quality was the amount of urbanization upstream in the watershed. In addition, specific conductance of stream water was strongly negatively correlated with biological stream quality. Specific conductance generally depends on the amount of groundwater contributing to streamflow in these watersheds, the amount of urbanization, and discharges from wastewater and industrial sites. Concentration of polycyclic aromatic hydrocarbons (PAHs) in streambed sediment also was negatively correlated with biological stream quality. Individual habitat variables that most commonly were positively correlated with biological indicators included stream sinuosity, buffer length, and substrate cover diversity. Riffle substrate embeddedness and sediment deposition commonly were negatively correlated with favorable metric scores. This evaluation is useful for understanding factors that affect stream quality and for monitoring and managing water-quality programs.

Raub, **S. C.**, Monash University, Bandar Sunway, Malaysia, scraub@yahoo.com

Jackson, C. R., University of Mississippi, University, USA,

Kuehn, K. A., University of Southern Mississippi, Hattiesburg, USA,

Jauhiainen, J., University of Helsinki, Helsinki, Finland,

Yule, C. M., Monash University, Bandar Sunway, Malaysia,

CHANGES IN LAND-USE OF SOUTHEAST ASIAN PEAT SWAMP FORESTS INFLUENCE DETRITAL DECOMPOSITION THROUGH ALTERED MICROBIAL ENZYME ACTIVITY

Southeast Asian peat swamp forests represent unique wetland ecosystems harboring a large percent of terrestrial carbon stores. Detrital decomposition in these systems is slowed and carbon is sequestered in sinks measuring 10 meters or deeper. Draining and logging of peat swamp forests for agricultural and industrial purposes results in degraded peat and uncontrollable fires, releasing CO2 equaling > 10% of fossil fuel emissions worldwide. Land use changes alter water-table-levels in peat swamp forests, and increased aeration of peat promotes microbial activity and accelerates decomposition, converting peat into a source of green house gases rather than a carbon/nutrient sink. Peat samples from 10, 45, 85, 115 and 150cm depth and 3 land-use types (forest, cleared and agriculture) were evaluated for carbon, nitrogen and phosphorous cycling. Significant differences in microbial extracellular enzyme activities ($p< 0.001$) were observed among peat land-use types. Water-table-levels correlated to land-use, and carbon, nitrogen and phosphorous cycling ($p<0.02$). In addition, microbial community structure and biomass differed with land-use, suggesting that changes in land-use and water-table-levels alter microbial activity and community structure in tropical peat swamp forests.

Rautio, **M.**, University of Jyväskylä, Jyväskylä, Finland, milla.rautio@uqac.ca

Mariash, H., University of Jyväskylä, Jyväskylä, Finland, h88ski@gmail.com

FRESHWATER ZOOPLANKTON REPRODUCE IN ARCTIC WINTER AFTER MONTHS OF STARVATION

We addressed the question of how autotrophic and heterotrophic food sources contribute to the reproduction of several large-bodied zooplankton in oligotrophic arctic lakes. We quantified the pelagic food sources (bacteria, phytoplankton and nanoflagellates), measured bacterial and primary productivity, and sampled organic matter and zooplankton for stable isotopes and fatty acids for a full complete year in a subarctic lake in Finnish Lapland. Results show that primary productivity that is restricted to four months from July to November allows zooplankton to build a lipid storage that accounts for 40-70 % of the body mass. This energy reserve allows copepod and cladoceran reproduction under the ice in March-April, after months of starvation and no access to algal food. Concurrent laboratory experiments support the field data and show that copepods thrive months in filtered water and die if are given food in winter when their metabolism has slowed down.

Ray, **H. L.**, U.S. Fish and Wildlife Service, Klmath Falls, USA, heather_ray@fws.gov

Pearl, C. A., U.S. Geological Survey, Corvallis, USA, christopher_pearl@usgs.gov

RESPONSE OF AQUATIC ASSEMBLAGES TO HABITAT ENHANCEMENTS IN CRANE CREEK, OREGON, USA

In the 1950s and 1980s, Crane Creek, Klamath Basin, Oregon was diverted from its historic channel into irrigation canals, draining surrounding wetlands and blocking fish passage. Numerous native fish species that were historically

productive in Crane Creek have been extirpated. Crane Creek has been designated as Proposed Critical Habitat for extirpated Lost River suckers (*Deltistes luxatus*), Shortnose suckers (*Chasmistes brevirostris*), and bull trout (*Salvelinus confluentus*). Crane Creek was identified as important Oregon spotted frog (*Rana pretiosa*) habitat and continued to support a small population within remnant floodplain habitat. *R. pretiosa* is estimated lost from 70% of its historic range in the Pacific Northwest and is a candidate for Federal Listing. In 2007, a cooperative habitat restoration project began to improve instream, riparian, and floodplain habitat in Crane Creek. Monitoring efforts to quantify aquatic habitat condition, translocation success of *R. pretiosa*, and fish colonization/presence before and after restoration are ongoing. Results from restoration activities, fish surveys, *R. pretiosa* breeding and mark-recapture surveys, temperature gradients, and aquatic and terrestrial invertebrate surveys will be presented.

Reams, **E. J.**, Eastern Washington University, Cheney, USA, ejreams@eagles.ewu.edu

McNeely, C., Eastern Washington University, Cheney, USA, cmcneely@gmail.com

CARBON TURNOVER RATE OF *GAMMARUS* TISSUE.

Stable isotope ratios ($\delta^{13}C$) are widely used to trace carbon flows through food webs. One disadvantage of this otherwise powerful technique is that it is often unclear how quickly consumer body tissue turns over, and therefore over what period of time consumer tissue $\delta^{13}C$ integrates information about diet. This is especially true for freshwater macroinvertebrates. We determined $\delta^{13}C$ half-life for whole body *Gammarus*, a widespread crustacean that is often important in aquatic food webs. In three laboratory controlled water temperatures, we fed *Gammarus* (initial $\delta^{13}C$ -25.10‰) a diet of C4 plant material (*Zea mays*, $\delta^{13}C$ -12.91‰). Carbon isotope ratios of *Gammarus* parallel those of an abundant C3 plant in their habitat, *Phalaris arundinacea* ($\delta^{13}C$ -27.05‰). We sampled corn-fed *Gammarus* from each temperature after intervals ranging from 3 to 70 days, and determined their $\delta^{13}C$ to estimate the length of time when 50% of the carbon in the amphipods' bodies was replaced by carbon derived from corn. Determining the average period for new assimilation of carbon by invertebrates is critical to better understanding ecological studies using stable isotope analysis.

Reeves, **G. H.**, PNW Research Stn., Corvallis, OR, USA, greeves@fs.fed.su

Berg, M. B., Loyola Chicago University, Chicago, IL, USA,

Cummins, K. W., Humboldt State University, Arcata, CA, USA,

CLIMATE CHANGE ON THE COPPER RIVER DELTA, ALASKA: POTENTIAL CONSEQUENCES TO AQUATIC BIOTA

The Copper River Delta, Alaska (CRD) is the largest intact wetlands in western North America and supports diverse and productive populations of waterfowl, other birds, and fish. There is a array of habitats including glacial rivers, clear streams, ponds with and without glacial groundwater, and ponds bordering intertidal areas. As a result of the juxtaposition with terrestrial and marine environments, it will potentially be subjected to impacts of climate change that occur in both environments. Actual affects of climate change on the CRD will likely varying widely, however, depending on location. A potential major, but not widely recognized, impact on aquatic invertebrates and fish could be from elevated winter temperatures. This could alter the timing and duration of various life-history stages. Such changes in invertebrates could have significant impacts on the reproductive success of birds and other organisms. Timing of migration of anadrmous salmonids could also be affected with potential impacts to smolt survival. Understanding the impacts of climate change on the CRD will be valuable not just on the CRD but in helping understand responses in less intact ecosystems.

Regmi, **B. P.**, University of Bergen, Bergen, Norway, bishnu.regmi@bio.uib.no

Wivegh, J. S., , Bergen, Norway,

THE EFFECTS OF PERCH (*PERCA FLUVIATILIS*) INTRODUCTION ON THE PHANTOM MIDGE (*CHAOBORUS FLAVICANS*) IN A MESOTROPHIC LAKE IN BERGEN, NORWAY.

Lake Myravatn was originally without planktivorous fish, and its plankton community was dominated by invertebrate predation. Illegally introduced European perch (*Perca fluviatilis*) was discovered in 2008. The abundance and behaviour of *Chaoborus flavicans* were studied from 2007 to 2009 and compared with 1983 results. *Chaoborus flavicans* was sampled at various depths with Schindler-Patalas sampler (25 or 26.5 L) and the fish were sampled with multi mesh gillnets. In addition, dual beam acoustics (38/200 KHz) were used to record data on both *Chaoborus flavicans* and fish in 2004 and 2008-09. Drastic changes have been recorded. *Chaoborus flavicans* population has declined from a maximum of 1918 ind.m^{-3} in 1983 to 27 ind.m^{-3} in 2009. The reproductive period of *Chaoborus flavicans* has been delayed after the perch introduction. Instead of appearing in early June, the first instar now appears in late June to early July. In summer, *Chaoborus flavicans* was found at an average depth of about 5 m at day time in both 1983 and 2007 which shifted to an average depth of about 10 m or deeper in 2008-09.

Reichert, **P.**, Eawag, Duebendorf, Switzerland, reichert@eawag.ch

Langhans, S., Eawag, Duebendorf, Switzerland, simone.langhans@eawag.ch

Lienert, J., Eawag, Duebendorf, Switzerland, judit.lienert@eawag.ch

Schuwirth, N., Eawag, Duebendorf, Switzerland, nele.schuwirth@eawag.ch

DECISION SUPPORT FOR INTEGRATIVE RIVER MANAGEMENT – A DECISION-ANALYTIC PERSPECTIVE

River management needs a well organized and transparent decision-making procedure due to the interdisciplinarity of the underlying problem, partially conflicting objectives, a high degree of uncertainty, a complex institutional decision framework, and the need to justify decisions. Decision sciences offer useful techniques to structure such decision and stakeholder involvement processes. Based on these techniques, we suggest to base river management on a six step procedure consisting of (1) defining the decision problem and identifying stakeholders, (2) formulating objectives and quantitatively eliciting stakeholders' subjective preferences of desired states, (3) creating management alternatives, (4) predicting outcomes of alternatives, (5) analyzing results, ranking alternatives and iterating the procedure if new alternatives came up, and (6) evaluating success and establishing an adaptive management procedure. The application of these steps to river management will be briefly outlined and it will be shown that the decision support framework, constructed in this way, can be used to support integrated and sectoral river management. Additionally, the explicit representation of preferences and predictions support the construction of improved alternatives and the communication of the final decision.

Reichwaldt, **E. S.**, The University of Western Australia, Crawley, Australia, elke.reichwaldt@uwa.edu.au

Nang, S. C., The University of Western Australia, Crawley, Australia, sinang@sese.uwa.edu.au

Ghadouani, A., The University of Western Australia, Crawley, Australia, Anas.Ghadouani@uwa.edu.au

IDENTIFYING KEY DRIVERS OF CYANOBACTERIAL TOXIN VARIABILITY IN AQUATIC SYSTEMS

Toxic cyanobacterial blooms threaten the safety of many water resources around the world and their occurrence is thought to increase even further in the future as a consequence of climate change. Up to date we still have an insufficient understanding of the variability of blooms and of the environmental triggers that control this variability. It has been suggested that an increase in the variability of ecosystems precede ecological regime shifts. Thus, it is urgent to advance our understanding of the mechanisms that control bloom and toxin dynamics. The objectives of this study were to establish the spatial and temporal variability of cyanobacterial blooms and their toxins in water bodies in Western Australia and to identify key drivers of this variability. The temporal variability is analysed on a seasonal and an inter-annual level. Early data suggest that there are gradients of biomass, toxicity and variability that seem to be controlled by total phosphorous, however iron is believed to play a role as well. Our results emphasize the fact that toxin production is a complex process that might be highly site-specific.

Reid, **B. L.**, CIEP, Universidad Austral de Chile, Coyhaique, Chile, brian.reid@ciep.cl

Woelfl, S., Universidad Austral de Chile, Valdivia, Chile, swoelfl@uach.cl

Torres, R., CIEP, Universidad Austral de Chile, Coyhaique, Chile, rtorres@ciep.cl

LOADING AND DYNAMICS OF BIOAVAILABLE SILICA ALONG A LARGE GLACIAL SYSTEM IN PATAGONIA CHILE

Dissolved silica, a nutrient that affects productivity, trophic efficiency and global carbon cycling in marine systems, has not received as much attention at its origin within the freshwater landscape. We investigated the sources of biogenic (BSi), dissolved (DSi) and lithogenic silica (LSi) along a lake-river-delta sequence along the 170 kilometer Baker River (Chile, 46 - 49S). The lake is primary

regulator on DSi loading (90.6 +/- 3.2 &micromol/l; 4.8x10^{-1}7 kg/yr), and seasonal loading downstream varies with glacial meltwater contribution (70.1 +/- 13.9 &micromol/l; 6.8 x10^{-1}7 kg/yr at the delta). BSi was insignificant (<0.1% based on direct counts and opal) except at the lake outlet. LSi increased from 1.2 to 67.4 mg/l, while weathering experiments yielded 5% increases in DSi within 20 days. These patterns are strongly altered by recent natural disturbances: repeated glacial lake outburst floods (GLOFs) since 2007 result in 10-fold increases in LSi, and the eruption and mass wasting of sediment from Volcan Hudson in 1991 has potentially increased DSi loading to the lake by a factor of four, possibly affecting downstream systems on a 30-40 year delay.

Reid, **M**. **A**., University of New England, Armidale, Australia, mreid24@une.edu.au

Capon, S. J., Griffith University, Brisbane, Australia, s.capon@griffith.edu.au

WETLAND VEGETATION AND SEED BANK RESPONSES TO ENVIRONMENTAL FLOWS IN FLOODPLAIN WETLANDS OF A DRYLAND RIVER

Environmental water allocations (EWAs) are a common component of water management strategies for regulated rivers across the world. This study examined the response of wetland vegetation and the wetland seed bank to flooding resulting from an EWA to wetlands on a lowland river floodplain in Australia using a Before-After/Control-Impact design (BACI). Differences in extant vegetation after flooding were clear from the first post-flood survey (approximately 2 months after flooding) and persisted until the final survey almost 12 months after inundation. In contrast, no differences were evident between the germinating assemblages of flooded and not flooded sites. The germinating assemblages differed significantly from the extant assemblages, although this difference reduced over time. We hypothesize that the initial vegetation response to flooding was from vegetative reproduction from dormant rhizomes of Eleocharis sphacelata, the dominant taxon in flooded wetlands, which was rare in germinating assemblages; however, we argue that the contribution of the soil seed bank to the vegetation assemblages of flooded wetlands increased over time and was the principal reason for a gradual increase in plant species richness.

Reisinger, **A**. **J**., Kansas State University, Manhattan, USA, areisin1@ksu.edu

Dodds, W. K., Kansas State University, Manhattan, USA, wkdodds@ksu.edu

IMPACT OF WOODY ENCROACHMENT OF PRAIRIE ON RIPARIAN AND BENTHIC DENITRIFICATION

Woody encroachment and its effects on nitrogen cycling in terrestrial ecosystems have been well-studied relative to the impacts on riparian and aquatic ecosystems. Riparian areas of headwater prairie streams were historically dominated by grasses, but are being invaded by woody vegetation. To determine potential consequences of woody plant expansion on denitrification, three reaches (grassy, woody, and woody vegetation removed riparian zones) were sampled from each of two branches of Kings Creek, a prairie stream on Konza Prairie Biological Station. Potential and actual soil denitrification was measured seasonally along longitudinal transects perpendicular to the stream. Riparian denitrification significantly differed among treatments ($p<0.05$), with the removal reach exhibiting highest potential denitrification ($p=0.001$). Distance from the stream was not correlated with denitrification. For in-stream benthic denitrification, potential denitrification was measured seasonally. Substrata and sampling date were significant factors ($p<0.001$), with grass roots and filamentous algae exhibiting greater rates than sediment or leaf packs. Removal of woody vegetation can increase riparian denitrification and woody encroachment changes the dominant stream denitrification substrata from grass roots to mosses and leaf packs.

Reithel, **S**. **A**., Department of Biological Sciences, Auburn University, Auburn, USA, sar0008@auburn.edu

Schneid, B. P., Department of Biological Sciences, Auburn University, Auburn, USA, bps0002@auburn.edu

Feminella, J. W., Department of Biological Sciences, Auburn University, Auburn, USA, feminjw@auburn.edu

FISH ASSEMBLAGE RESPONSES TO ENVIRONMENTAL VARIATION IN COASTAL STREAMS OF ALABAMA

We explored fish assemblage relationships with hydrologic, physicochemical, and land use parameters in small streams of Wolf Bay Basin in coastal SW Alabama. Study streams drain southern pine hill and coastal lowland physiographic provinces, and were typically black or clear water with low- to moderated-gradient sandy channels containing patchy large woody debris and benthic organic matter. Initial results from spring 2009 indicated low to moderate richness (3 to 16 species) per stream, including 2 Gulf Coast brackish-water sleeper species (Dormitator maculatus and Eleotris amblyopsis) that occur rarely in Alabama. Cyprinidae (3 species) and Centrarchidae (7 species) composed 25 and 33% of total catch, respectively. Fish abundance was strongly and positively correlated with streamwater N concentration, and richness was positively related with stream wetted width and flashiness but negatively correlated with amount of benthic particulate organic matter in the channel. Preliminary analysis revealed some species with DELT (deformities, eroded fins, lesions, tumors, parasites) factors, although it is unclear if these maladies are associated with increased urbanization or fish assemblage structure in general within these coastal watersheds.

Reynoldson, **T**. **B**., Acadia University, Wolfville NS, Canada, trefor.reynoldson@gmail.com

Bailey, J. L., University Western Ontario, London, Canada, jbailey@northwestel.net

A SIMPLE APPROACH TO CREATING SIMPACTED DATA TO ESTABLISH THE POWER OF RCA ASSESSMENT METHODS.

The statistical power of bioassessment methods is rarely discussed. Typically the only statistical tests applied are those addressing the null hypothesis that a site is equivalent to reference or control and the alpha level used sets the Type 1 error level. However, Type 2 error is rarely considered as there is no a priori method for knowing if an exposed site is disturbed. We suggest that the method for resolving this issue is to create artificially disturbed sites by modifying data from reference sites. This method uses a stressor such as organic discharge and then using known tolerance values adjusts the counts at reference site(s) to create a theoretically disturbed (SIMPACT) community with a known level of disturbance. The various assessment methods can then be used to determine if the method has the power to detect the simulated impact. Two questions arise from this, first is this a reasonable method for creating simulated communities, and second what levels of simulated disturbance should we be able to detect?

Richardson, **D**. **C**., SUNY New Paltz, New Paltz, USA, richardsond@newpaltz.edu

Ewing, H. A., Bates College, Lewiston, USA, hewing@bates.edu

Weathers, K. C., Cary Institute of Ecosystem Studies, Millbrook, USA, weathersk@caryinstitute.org

Baer, N. A., Colby-Sawyer College, New London, USA, nbaer@colby-sawyer.edu

FLUXES OF DISSOLVED AND PARTICULATE PHOSPHORUS INTO A NEW ENGLAND OLIGOTROPHIC LAKE, LAKE SUNAPEE, WITH INCREASING CYANOBACTERIAL BLOOMS

Most phosphorus (P) enters lakes from streams and rivers draining terrestrial ecosystems. We sampled 13 different sized streams draining into Lake Sunapee, an oligotrophic New Hampshire, United States lake with recent blooms of a nuisance cyanobacterium. We measured the transport of sediment and P, partitioned into dissolved P and particulate P fractions, during low flow and episodic high-flow events to identify temporal patterns of P fluxes. Across all tributaries and flows, dissolved P, particulate P, and total suspended sediment averaged 10 ± 7 μg P L^{-1}, 7.4 ± 11.7 μg P L^{-1}, and 1.5 ± 2.4 mg L^{-1} (means ± s.d.), respectively. The ratio of particulate to dissolved P fluxes averaged 0.77; however during two summer storms, particulate P fluxes exceeded dissolved P fluxes by ~30%. At one site, where a beaver dam broke during 2008, dissolved and particulate P concentrations exceeded 30 μg P L^{-1}. Limnologists and managers must identify the size fraction of P fluxes and their relationship to flow regimes (e.g., during baseflow or high flow events) to best understand the ecological implications of lake P loading.

Richardson, **W**. **B**., U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, USA, wrichardson@usgs.gov

Knights, B. C., U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, USA, bknights@usgs.gov

Bartsch, L. A., U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, USA, lbartsch@usgs.gov

Bartsch, M. R., U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, USA, mbartsch@usgs.gov

Vallazza, J. X., U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, USA, jvallazza@usgs.gov

Houser, J. N., U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, USA, Upper Midwest Environmental Sciences Center

Gutreuter, S. X., U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, USA, sgutreuter@usgs.gov

Decker, J. K., Louis Calder Center – Biological Field Station, Fordham University, Armonk, USA, jismith@fordham.edu

Bartels, A., Wisconsin Department of Natural Resources, La Crosse, USA, abartels@usgs.gov

CHANNEL-BACKWATER CONNECTIVITY IN THE UPPER MISSISSIPPI RIVER: POTENTIAL CONSEQUENCES FOR NUTRIENTS, FOOD WEBS, AND FOOD QUALITY

Hydrologic connection among channels and backwaters in floodplain rivers influences the nutrient cycling, phytoplankton composition, and food web interactions. In the Upper Mississippi River, we tested the hypothesis that isolated aquatic areas will exhibit lower concentrations of nitrate, higher soluble phosphorus and elevated density of cyanobacteria compared to more connected areas; and that tissue lipid biomarkers in upper trophic levels will reflect phytoplankton composition. Six times during the summer, 2008, we sampled nutrients (soluble and total P, nitrate, ammonium and total N), phytoplankton, and fish (relative abundance) in 6 sites arrayed along a connectivity gradient in the UMR near La Crosse, WI. Decreased nitrate concentrations and increased cyanobacteria and diatom densities correlated with seasonal low flows, especially in the most isolated site. Fatty acid biomarkers for BGA were inversely correlated with NO3 and positively with cyanobacteria biovolume, suspended particles and total phytoplankton volume. Fish tissues exhibited biomarkers for cyanobacteria in the most isolated areas and highest diatom biomarkers in flowing habitats. Hydrologic influences on phytoplankton and their biomarkers appear to be conveyed through river food webs.

Richoux, **N**. **B**., Rhodes University, Grahamstown, South Africa, n.richoux@ru.ac.za

TROPHIC ECOLOGY OF ZOOPLANKTON AT A FRONTAL TRANSITION ZONE: FATTY ACID SIGNATURES AT THE SUBTROPICAL CONVERGENCE, SOUTHERN OCEAN

Regional variations in fatty acid composition were assessed in zooplankton communities situated immediately north and south of the subtropical convergence (STC), where warm (21C) nutrient-poor waters of the southwest Indian Ocean converge with cool (11C) nutrient-rich subantarctic waters of the Southern Ocean. I hypothesized that food web structures would differ from north to south based on spatial differences in primary productivity, and that zooplankton in the more productive northern region of the STC would contain higher concentrations of polyunsaturated fatty acids (PUFAs). Several taxonomic groups including euphausiids showed differences in their fatty acid signatures from north to south, indicating the existence of measurable within-species and among-species differences in trophic relationships between the two communities stemming from variations in food quality and availability. Carnivory was the dominant feeding mode in the north, whereas herbivory was more prevalent in the south. However, PUFA levels showed high variability and were not consistently greater in the north or south STC regions. The key findings in this study shed light on the regional variations in zooplankton food quality and web dynamics in a poorly understood but critically important frontal zone bordering the Southern Ocean.

Rier, **S**. **T**., Bloomsburg University of Pennsylvania, Bloomsburg , USA, srier@bloomu.edu

Nawrocki, K., Bloomsburg University of Pennsylvania, Bloomsburg, USA,

RESPONSE OF EXTRACELLULAR ENZYMES ALONG A STREAM PHOSPHORUS GRADIENT IN AN AGRICULTURAL REGION OF NORTH CENTRAL PENNSYLVANIA

We tested the hypothesis that relative patterns in the activities of carbon- and phosphorus-acquiring extracellular enzymes associated with stream microbial communities will reflect a stoichiometric response to changes in the relative availability of phosphorus along an anthropogenically-produced phosphorus gradient in an agricultural region of North Central Pennsylvania. Both water column and biofilm extracellular enzyme activities (β-glucosidase, β-xylosidase, phosphatase and leucine-aminopeptidase, phenol oxidase) were measured in 19 streams spanning a phosphorus concentration gradient from ulta-oligotrophic to eutrophic. We also measured water column total nitrogen, total phosphorus, and dissolved organic carbon along with biofilm chlorophyll a, ash free dry mass, and phosphorus concentrations. The relative activities between carbon- and phosphorus-acquiring enzyme activities were positively correlated with phosphorus concentrations indicating that there was a stoichiometric shift from phosphorus limitation to carbon limitation at higher phosphorus concentrations. These results might have implications for establishing nutrient guidelines for streams because they indicate that nutrients such as phosphorus might elicit a significant ecosystem-level response before more apparent changes in community structure or biomass are observed.

Riessen, **H**. **P**., SUNY College at Buffalo, Buffalo, USA, riessehp@buffalostate.edu

REVISITING THE COSTS OF PREDATOR-INDUCED MORPHOLOGICAL DEFENSES IN DAPHNIA

One of Stanley Dodson's great accomplishments was in helping to decipher the role of predation in the plankton communities of lakes and ponds. This included his pioneering work on the development of predator-induced defenses in zooplankton prey. While the various induced morphological defenses that are common in cladocerans and rotifers have clear benefits in reducing predation, the costs associated with their development have been difficult to discern. I revisit the question of the costs of Chaoborus-induced neck spine development in Daphnia with a modified life table experiment that examines two clones of D. pulex that differ greatly in their ability to induce these defensive structures. I compare the results of this experiment with previous studies and offer a new hypothesis that proposes more than one set of potential costs. These depend on the specific morphological and life history responses of the prey, which in turn are related to the relative sizes of predator and prey.

Riley, **A**. **J**., Kansas State University, Manhattan, USA, standorf@ksu.edu

Dodds, W. K., Kansas State University, Manhattan, USA, wkdodds@ksu.edu

MEASURING WHOLE-STREAM METABOLISM: STRATEGIES FOR MEASUREMENT AND MODELING DIURNAL TRENDS OF O_2

Stream metabolism, reflected by diurnal changes in O_2, characterizes the heterotrophic and autotrophic basis of streams. We were interested in how long a stream reach needed to be to allow significant O_2 changes to be measured, and how to best calculate metabolic rates. O_2 was measured at noon and midnight in 15 stream segments in Kings Creek, Kansas using the Winkler method. A segment of at least 20 m was required to get statistically significant metabolism measurements. Diurnal O_2 flux and aeration were measured in streams around Manhattan, Kansas to assess the accuracy of modeling aeration and test the effect of temperature on metabolic rate calculations. Measured aeration was regressed against modeled aeration values ($r^2 = 0.58$). Nineteen aeration equations from literature provided poor estimates of measured aeration. Temperature correction of metabolic rates allowed accounting for increases in O_2 that occurred over night, and more accurately fit diel O_2 trends and allowed characterization of light effects on photosynthesis. Temperature corrected metabolic rates should allow for more general cross-site comparisons.

Riley, **L**. **A**., Ohio Northern University, Ada , USA, l-riley.1@onu.edu

Dybdahl, M. F., Washington State University, Pullman, USA, dybdahl@wsu.edu

THE ROLES OF PRODUCTIVITY AND DIVERSITY IN MEDIATING DOMINANCE OF AN INVASIVE FRESHWATER SNAIL

According to long-standing theory, native diversity should limit the ability of species to invade and dominate. However, the importance of biotic resistance in repelling invasions remains controversial and it appears that high resource availability (i.e. high productivity) has the ability to neutralize competitive effects from native community members. Here, we tested whether production, diversity or both, influenced dominance of an invasive freshwater snail. The New Zealand mud snail, *Potamopyrgus antipodarum*, dominates macro-invertebrate communities in some western U.S. streams, but constitutes only a small portion of the community in other streams. Thus, we quantified relative abundance of

Potamopyrgus across eleven streams in northwestern Wyoming. In addition, we measured primary production, native macro-invertebrate diversity and other supplementary variables. We found that primary production and macro-invertebrate diversity were both highly variable across streams. In addition, the dominance of *Potamopyrgus* was also highly variable, with *Potamopyrgus* abundance (relative and absolute) highest in the most productive stream. These results suggest that primary production might be more important than native community diversity in predicting success of this invasive freshwater snail.

Rinehart, **A**. **J**., University of Alaska Fairbanks, Fairbanks, USA, ajrinehart2@alaska.edu

Jones, J. B., University of Alaska Fairbanks, Fairbanks, USA, Jay.Jones@alaska.edu

HOW ARE HYPORHEIC RESIDENCE TIME, CARBON UPTAKE, AND PRESENCE OF PERMAFROST COUPLED IN NEAR-STREAM ECOSYSTEMS?

Carbon uptake in streams is controlled by the balance between organic matter and nutrient inputs from the catchment and subsequent transformation in the hyporheic zone. Dissolved organic matter transport and concentration is further influenced by hydrologic residence time in the hyporheic zone. This study examined near-stream hyporheic exchange and carbon uptake in streams draining watersheds underlain by discontinuous permafrost. The research was conducted in two subcatchments of the Caribou-Poker Creeks Research Watershed (interior Alaska), which had underlying permafrost extents of 5% and 50%, respectively. Steady-state solute injections amended with acetate were performed in both streams throughout the summers of 2008 and 2009 to capture variation in soil thaw and stream discharge. Hyporheic residence time was described with the one-dimensional transport with inflow and storage (OTIS) model. The acetate mass transfer coefficient (mm min^{-1}) increased with thaw depth in both streams, but was significantly larger in the low permafrost stream for all injections reflecting differences in stream dissolved organic carbon concentration. With warming, permafrost thaw will alter the linkage between terrestrial and aquatic systems resulting in reduced hyporheic carbon cycling.

RIOS-TOUMA, **B**., Departament d'Ecologia - Universitat de Barcelona/ Lab. Ecología Acuática U. San Francisco de Quito, Barcelona- Spain/Quito, Ecuador, brios@ub.edu

Encalada, A. C., Laboratorio de Ecología Acuática - Unviersidad San Francisco de Quito, Quito, Ecuador, aencalada@usfq.edu.ec

Gonzalez, F., Laboratorio de Ecología Acuática - Unviersidad San Francisco de Quito, Quito, Ecuador, fernany83@hotmail.com

Prat, N., Departament d'Ecologia - Universitat de Barcelona, Barcelona, Spain, nprat@ub.edu

MACROINVERTEBRATE PHENOLOGY IN PÁRAMO STREAMS AT 0° LATITUDE

During 2009, at a monthly basis, we followed the composition and size distribution of the macroinvertebrate community of a small high-altitude tropical stream (Saltana creek) at the Ecuadorian Andes. We found that most taxa (e.g *Andesiops*,*Ochrotrichia*, Orthocladiinae) were present throughout the year and every month we found most instars. Several taxa (e.g *Varipes*, *Neoelmis*) are rare and only appear in a certain times of the year, and we were able to detect only small instars (e.g. *Varipes*). Density was related to flow, being higher at low flow months. Also size distribution of certain dominant groups changed at different flow conditions (e.g. *Andesiops* presented developed individuals only at low flow periods). At high flow conditions development and emergence were delayed for some species(e.g. *Andesiops*). Our results suggest that most species are multivoltine, except for the less abundant ones that were found in specific times of the year. In high altitude tropical streams, as temperature does not change throughout the year, hydrology might be critical parameter to understand patterns of species phenology and life-history traits of different species.

Riseng, **C**. **M**., University of Michigan, Ann Arbor, USA, criseng@umich.edu

Wiley, M. J., University of Michigan, Ann Arbor, USA, mjwiley@umich.edu

Black, R. W., U.S. Geological Survey, Tacoma, USA, rwblack@usgs.gov

Munn, M. D., U.S. Geological Survey, Tacoma, USA, mdmunn@usgs.gov

A CAUSAL ANALYSIS OF AGRICULTURAL LAND USE IMPACTS ON BIOLOGICAL INTEGRITY IN U.S. STREAMS

Agricultural land use across the U.S. has been linked to nutrient enrichment, habitat degradation, hydrologic alteration, and loss of biotic integrity in streams. We used water quality, biological, and physiographic USGS data from agriculturally dominated watersheds across the U.S. to investigate the interacting effects of agriculture and geographic variation on stream biotic integrity. We developed casual (SEM) national and regional models to examine the effects of agriculture acting through different nutrient and habitat pathways. Nationally, cropland primarily affected benthic communities by altering structural habitats and water quality related stresses. Regional models demonstrated that the landscape of context of the watershed controlled the relative influence of the various pathways by which agricultural activities potentially impact stream biotic integrity. In the western mountainous and eastern coastal plain regions basin cropland impacts were transmitted primarily through water quality contaminants and in the Midwestern model through eutrophication and presumably resulting oxygen stresses. The relative effects of riparian forested wetlands also varied regionally having positive effects on biotic integrity in the eastern coastal plain and western mountainous regions and no effect in the Midwest region.

Risgaard-Petersen, **N**., Aarhus University, Århus, Denmark, nils.risgaard-petersen@biology.au.dk

Nielsen, L. P., Aarhus University, Århus, Denmark, lars.peter.nilesen@biology.au.dk

Fossing, H., Aarhus University, Silkeborg, Denmark, hfo@dmu.dk

Christensen, P. B., Aarhus University, Silkeborg, , pbc@dmu.dk

Sayama, M., National Institute of Advanced Industrial Science and Technology, Tskkuba, Japan, m.sayama@aist.go.jp

INSTANT COUPLING OF SULPHIDE OXIDATION AND OXYGEN REDUCTION OVER CENTIMETER DISTANCE INDICATES ELECTRIC CURRENTS IN MARINE SEDIMENTS

Oxygen is consumed in marine sediments with organic matter and reduced inorganic compounds serving as electron donors. The processes are generally assumed to depend on direct contact between the reactants being mixed vertically by physical and biological mechanisms. Sediment bacteria like Geobacter sp. have been shown to generate conductive appendages allowing them to direct free electrons to insoluble acceptors outside the cell. Beyond this nanometer scale there is no firm evidence of electric currents mediating transformation of matter in nature. Here we provide evidence that electric currents running through defaunated sediment couple oxygen consumption at the sediment surface to oxidation of hydrogen sulphide and organic carbon deep within the sediment. Probably the electric current was conducted by bacterial nanowires combined with pyrite, soluble electron shuttles and outer-membrane cytochromes. Electric communication between distant chemical and biological processes in nature adds an entirely new dimension to our understanding of biogeochemistry and microbial ecology.

Riva-Murray, **K**., U.S. Geological Survey, Troy, USA, krmurray@usgs.gov

Chasar, L. C., U.S. Geological Survey, Tallahassee, USA, lchasar@usgs.gov

Bradley, P. M., U.S. Geological Survey, Columbia, USA, pbradley@usgs.gov

Burns, D. A., U.S. Geological Survey, Troy, USA, daburns@usgs.gov

SPATIALLY VARIABLE METHYLMERCURY CONCENTRATIONS IN MACROINVERTEBRATES OF STREAMS IN A HIGH ELEVATION, FORESTED WATERSHED

Aquatic organisms in high-elevation forested regions of the northeastern United States and Canada are particularly sensitive to atmospheric deposition of mercury, especially where conditions favor its conversion to methylmercury (MeHg) and its transport to the aquatic ecosystem. We studied mercury cycling and bioaccumulation at eight stream sites in the 66 km2 Fishing Brook watershed in New York's central Adirondack region. Macroinvertebrates in shredder, scraper, and predator functional feeding groups were collected seasonally during 2007-09, and were analyzed for MeHg. Mean MeHg concentration was lowest in shredders and highest in predators at all sites. Differences among stream sites in mean MeHg concentration within each feeding group were statistically significant, and the spatial pattern was similar for all groups. Macroinvertebrate MeHg concentrations were positively related to land cover and topographic metrics that represent potential catchment wetness and hydrologic connectivity and were negatively associated with the presence of open water bodies located upstream of the sampling reach. We conclude that MeHg bioaccumulation can vary widely within mercury-sensitive regions due to relatively small-scale landscape heterogeneities that influence the dynamics of MeHg production and transport.

Rivkin, **R**. **B**., Memorial University of Newfoundland, St. John's, Canada, rrivkin@mun.ca

SEASONAL AND LONG TERM PATTERNS OF MICROBIAL DYNAMICS IN COLD OCEANS

High latitude regions are especially sensitive to climate change and the assessment of the climate-ocean interactions are hampered by the very few time-series studies on marine biota in these regions. Ecosystem processes, which both control biogeochemical cycles and are influenced by climate forcings, are mediated by the activity of heterotrophic bacteria. These microbes dominate the fluxes of organic carbon in the upper ocean where they remineralize most of the primary production back to CO2. Although these small organisms and their interactions are well studied in low latitudes, there is far less known about their distributions, community structure, activity and food web interactions, and their impact on upper open biogeochemistry in high latitude and in cold oceans. Here we report on a 17-year punctuated time series study of the distribution and activity of heterotrophic bacteria, and associated hydrographic and climate variables in a sub-Arctic coastal area off the east coast Newfoundland, Eastern Canada where coordinated trend in climatic and biotic variables are observed. These results suggest a strong feedback control that operates on a sub-decadal time scale.

Roach, **K**. **A**., Texas A&M University, College Station, USA, roackat@gmail.com
Winemiller, K. O., Texas A&M Univesity, College Station, USA, k-winemiller@tamu.edu

VARIATION IN PRODUCTION SOURCES IN SIX MEANDERING FLOODPLAIN RIVERS: THE INFLUENCE OF HYDROLOGY, SUSPENDED SEDIMENT LOAD, AND NUTRIENTS

Conceptual models have traditionally attempted to predict the most important production sources to riverine ecosystems in general, rather than attempt to predict how sources shift seasonally. My research goals are to develop a predictive model of how limitation of algal production by abiotic environmental factors influences the proportion of terrestrial-based versus algal-based production sources supporting the food web in the main channel of meandering floodplain rivers. My six study rivers (Brazos, Neches, and Guadalupe in Texas, Tambopata in Peru, Pirara in Guyana, and Monkey in Belize) are very different in terms suspended sediment levels, nutrient concentrations, and primary productivity. In each river during the low- and high-water period I will: 1) Measure abiotic environmental variables including turbidity, nutrients, and discharge, 2) Determine at which point each of the study rivers switch from autotrophic to heterotrophic by estimating respiration and net primary production of the water-column and benthos using light and dark chambers to measure fluxes of dissolved oxygen, and 3) Use stable isotope analysis to estimate the relative proportion of autochthonous-based versus allochthonous-based production sources supporting consumers.

Roach, **W**. **J**., SimBiotic Software, Missoula, USA, jroach@simbio.com
Bird, S., SimBiotic Software, Missoula, USA, sbird@simbio.com
Maruca, S., SimBiotic Software, Missoula, USA, maruca@simbio.com
Meir, E., SimBiotic Software, Missoula, USA, meir@simbio.com
Steinberg, E., SimBiotic Software, Missoula, USA, eks@simbio.com
Stal, D., SimBiotic Software, Missoula, USA, stal@simbio.com
Wallner, J., SimBiotic Software, Missoula, USA, jennifer@simbio.com

BUILDING A BETTER ECOLOGY TEXTBOOK FROM THE GROUND UP: A PREVIEW OF THE

Electronic or "e-texts" are the current buzz in academic publishing, but most current e-texts are essentially scanned versions of existing texts with accompanying web pages. SimBiotic Software has taken a different tact, rethinking the textbook from the ground-up. With support from the National Science Foundation, we have been developing the SimUText© Active Learning System, a new learning environment that offers interactive chapters that are not just inquiry-based, but are inquiry-*driven*. Sections of text are integrated with simulations and animations that provide students with instant feedback on their work and offer instructors means to monitor individual student and class progress. Building on our experience creating simulated labs, our first collection of SimUText i-chapters offers a dynamic replacement for the traditional Ecology textbook. This talk presents our SimUText i-chapter on the science of climate change to demonstrate how an inquiry-driven interactive textbook can teach concepts that otherwise can be dry and/or difficult to grasp. We also present some preliminary data from assessments of students and professors who have used SimUText in classes over the past year, indicating that our approach is effective.

Roark, **J**. **N**., University of Kansas, Lawrence, USA, roark.jessica@gmail.com

RESPONSE OF BENTHIC MACROINVERTEBRATE COMMUNITIES TO INCREASES IN SEDIMENT SUPPLY FROM DAM REMOVAL

There are approximately 85,000 dams in the U.S. that have an average age of 51 years and a typical design life of 50 years. An increasingly common management strategy for these dams is to decommission them but the information on environmental impact of releasing impounded sediment on the fresh water ecosystem downstream is unknown. The objective of this study is to investigate the use of benthic macroinvertebrate community response to geomorphologic change after a dam removal as a biological indicator of ecosystem health by comparing the results of a field study on the Sandy River in Oregon to other studies on macroinvertebrate response to dam removal. Increasing knowledge on this type of ecosystem response will improve ability to effectively manage dam removal for restoration purposes as well as help us understand ecosystem processes. Mixed results of macroinvertebrate responses either through density, diversity, or dominant species, were observed in both the Sandy River field study and in the comparison of previous field studies. Since there is very little existing literature, the biogeoscience community is encouraged to continue studying benthic macroinvertebrate communities and their response to dam removal. Using a standard sampling method and implementing further research will help to clarify the definition of what typical reactions would be from these benthic species and how to apply this information toward an understanding of dam removal on ecosystem processes.

Rober, **A**. **R**., Michigan State University, East Lansing, USA, roberall@msu.edu
Wyatt, K. H., Michigan State University, East Lansing, USA, wyattkev@msu.edu
Stevenson, R. J., Michigan State University, East lansing, USA, rjstev@msu.edu

REGULATION OF ALGAL STRUCTURE AND FUNCTION BY NUTRIENTS AND GRAZING IN A BOREAL WETLAND

We investigated the independent and interactive effects of nutrient enrichment and snail grazing on benthic algal biomass and community composition in a shallow Alaskan wetland. We added nutrients to mesocosm enclosures and either removed grazers (absent), or nested both caged (excluded) and un-caged (grazed) substrates together inside enclosures with natural abundances of snails. We had control enclosures without nutrients for each grazing treatment. There was no difference in algal biomass between grazed and absent treatments in nutrient enriched enclosures, which suggests that consumer-driven nutrient recycling may have played a role in maintaining algal biomass when grazers were present. This hypothesis is supported by significantly greater algal biomass in excluded treatments where grazers were present but unable to graze, compared to absent treatments where grazers were removed. Nutrient enrichment increased the proportion of green and bluegreen algae, and grazers decreased large filamentous green algae in favor of smaller coccoid taxa. Our results suggest that nutrient-grazer interactions may be complex in boreal wetlands, and should be considered when estimating algal responses to nutrient enrichment expected with climate change in the region.

Roberts, A. D., U.S. Fish and Wildlife Service, Ecological Services, Columbia, USA, Andy_Roberts@fws.gov
Mosby, D., U.S. Fish and Wildlife Service, Ecological Services, Columbia, USA, Dave_Mosby@fws.gov
Weber, J., U.S. Fish and Wildlife Service, Ecological Services, Columbia, USA, John_Weber@fws.gov
Besser, J. M., U.S. Geological Survey, Columbia Environmental Research Center, Columbia, USA, jbesser@usgs.gov
Hundley, J., U.S. Fish and Wildlife Service, Ecological Services, Columbia, USA, Josh_Hundley@fws.gov
McMurray, **S**. **E**., Missouri Department of Conservation, Resource Science Division, Columbia, USA, Stephen.McMurray@mdc.mo.gov
Faiman, J. S., Missouri Department of Conservation, Resource Science Division, Columbia, USA, John.Faiman@mdc.mo.gov

AN ASSESSMENT OF FRESHWATER MUSSEL POPULATIONS AND HEAVY METAL SEDIMENT CONTAMINATION IN THE LEAD MINING-IMPACTED BIG RIVER, MISSOURI

An assessment of freshwater mussels and heavy sediment contamination was conducted to determine the downstream extent of heavy metal contamination of sediment; to determine distribution, diversity, and abundance of freshwater mussels; and to evaluate the relationship between heavy metal concentrations

in sediment and mussel community characteristics in the lead mining-impacted Big River, Missouri. Sediments exceeded Probable Effects Concentrations for over 180 river km downstream of mining for Pb, and for approximately 80 km downstream of mining for Zn and Cd. Mussel species richness and CPUE and mussel sediment toxicity data showed broad-based negative associations with metals in sediments. Species richness was also significantly lower at sites below mining areas compared to past data. Further, mean mussel densities at 6 sites downstream of mining areas ranged from 0 to 0.4 individuals/m^2, significantly lower ($p<0.0001$) than average densities at 2 reference sites (1.9 and 9.1 individuals/m^2). These mussel community data indicate that mussel populations in a reach extending 159 km downstream from mining inputs are impacted from heavy metal contaminated sediment in the Big River.

Roberts, **B. J.**, Louisiana Universities Marine Consortium, Chauvin, USA, broberts@lumcon.edu
Mulholland, P. J., Oak Ridge National Laboratory, Oak Ridge, USA, mulhollandpj@ornl.gov
Hill, W. R., University of Illinois, Champaign, USA, wrhill@uiuc.edu

ECOSYSTEM METABOLISM IN A FORESTED STREAM: RESULTS FROM 6 YEARS OF CONTINUOUS MONITORING OF PATTERNS AND CONTROLS IN THE WEST FORK OF WALKER BRANCH

Daily rates of gross primary production (GPP) and ecosystem respiration (R) have been measured continuously for over six years in a first order, forested stream in eastern Tennessee using an open-system single station diel O2 approach allowing for analysis of temporal variability at daily, seasonal, episodic, and inter-annual scales. GPP and R show large seasonal variations, largely controlled by phenology and productivity of riparian forest. R is greater in spring (driven by autotrophic C production) and autumn (driven by heterotrophic consumption of allochthonous C inputs) than in summer. Episodic storms depressed GPP for several days in spring, but increased GPP in autumn by removing leaves shading the streambed. Storms depressed R initially, but then stimulated R to 2-3 times pre-storm levels for several days. Annual GPP and R ranged between 226 and 535 and -1152 and -1647 g O2 / m2 / d, respectively. Light is a good predictor of GPP in Walker Branch, but the slope of the relationship varies inter-annually and correlates with the extent of macroalgal coverage in spring which, in turn, is correlated with snail density.

Robertson, **D. R.**, University of Minnesota, Saint Paul, USA, robe0494@umn.edu
Holzenthal, R. W., University of Minnesota, Saint Paul, USA, holze001@umn.edu

BIOGEOGRAPHY AND DIVERGENCE TIMES IN THE CADDISFLY SUBFAMILY PROTOPTILINAE (TRICHOPTERA: GLOSSSOMATIDAE)

The subfamily Protoptilinae has a very disjunct distribution: 1 genus is known from the Nearctic, East Palaearctic, and Oriental regions; the remaining 10 genera are restricted to the Nearctic and Neotropical regions with regional endemism occurring in the Greater Antilles, southeastern Brazil, and the southern Andes. Several alternative hypotheses regarding the historical biogeography of protoptiline caddisflies have been proposed including possible North American, Asian, or ancient Gondwanan origins for the subfamily. However, such hypotheses are only speculative since there has never been a modern phylogenetic analysis of Protoptilinae. Based on a phylogeny from both morphological and molecular data, we investigated the biogeographic history of Protoptilinae using molecular dating with multiple fossil calibrations, independent geologic evidence, and dispersal-vicariance analysis. Our findings suggest a complicated biogeographic history for the subfamily with several plausible alternative hypotheses. Minimum age estimates indicate that early diversification of Protoptilinae most likely occurred well after the break-up of Gondwanaland. Additionally, the current distribution of Protoptilinae is probably the result of a combination of both dispersal and vicariance events.

Robinson, **C. T.**, Eawag, Duebendorf, Switzerland, robinson@eawag.ch
Ortlepp, J., Hydra, Constance, Germany, jo.ortlepp@t-online.de

LONG-TERM AFFECTS OF EXPERIMENTAL FLOWS ON RIVERINE BIOTA BELOW A RESERVOIR

Large dams have altered the flow regime of most rivers on the globe with consequent effects on riverine biota. Experimental flows (multiple floods per year) have been used on the regulated Spöl River below Livigno Reservoir for over 9 years to enhance the ecological condition of the river. The flow program has improved the brown trout fishery in the river as indicated by an increased number of redds. Floods have reset periphyton assemblages from a moss-dominated streambed to one dominated by diatoms and patches of filamentous algae. Zoobenthic assemblages have shown dramatic shifts in benthic structure in line with predictions from altered state models. Ecosystem regime shifts have been characterized with increases in parameter variances followed by periods of stable states. The system appears to be entering a second zoobenthic regime shift after year 8, perhaps in response to biotic interactions due to changes in the fishery. The response patterns clearly show that a long-term perspective must be in place when assessing biotic responses to changes in physical habitat properties resulting from flow experiments.

Roehm, **C. L.**, Buffalo State SUNY, Buffalo, USA, roehmcl@buffalostate.edu

ECOSYSTEM RESPIRATION IN SWEDISH SUBARCTIC STREAMS

Sub-arctic watersheds are characterized by distinct soil, vegetation and permafrost gradients, making sources of metabolic carbon difficult to track. Herein, is a field and laboratory based study on a set of arctic streams that flow through different vegetation, soil and altitudinal gradients. The objective was to quantify ecosystem respiration and organic carbon characteristics in stream sections representing end-members, allowing for whole stream. Measurements of ecosystem respiration were made using a non-invasive oxygen fiber optic probe. To date our results have shown distinct zonations in respiration potentials from these end members. Additionally, high altitude streams that lie in zones of little to no vegetation and that are characterized by shallow soils, provide clear waters that are rich in DOC. Carbon quality was reflected in the respiration rates and were governed by soil/vegetation and permafrost gradients. The data indicate that export of DOC from high altitude streams plays a more important role in the total stream metabolic pathways than previously thought and can have potentially pronounced effects both on the energy mobilization within the landscape and on the biosphere-atmosphere carbon balance.

Roesner, **R.**, University of Hamburg, Hamburg, Germany, ralph.roesner@zmaw.de
Mueller-Navarra, D., University of Hamburg, Hamburg, Germany, doerthe.mueller-navarra@uni-hamburg.de
Zorita, E., GKSS, Geesthacht, Germany, eduardo.zorita@gkss.de

TEMPERATURE VARIABILITY OF LAKE PLUSSEE FROM 1969-2006

Temperature is one major factor affecting natural processes in diverse ecosystems and it also determines the most important seasonal events in lakes. Plussee is a well documented dimictic lake located in Northern Germany. Physical-chemical and biological data from this lake are available monthly from 1969 till 1980 and weekly measurements are available from 1981 onwards. In our studies we jointly analyze physical parameters (e.g. temperature and oxygen) of the lake from 1969 till 2006 together with external forcing data (e.g. gridded metereological data obtained from the National Center for Environmental Prediction). Our aim is to identify the influence of the external forcing on the variability and long-term trends observed in the lake. We focus initially on the onset and breakdown of stratification, the depths of the thermocline, epilimnion, metalimnion and hypolimnion, and whether there was a significant change in the heat content of these three layers.

Rogers, **D. C.**, EcoAnalysts, Inc., Davis, USA, branchiopod@gmail.com
Slusark, J., Chico Foundation, Chico, USA, jslusark@csuchico.edu
Johnson, S., Aquatic Bioassay & Consulting Laboratories, Inc., Ventura, USA, scott@aquabio.org
Kratz, K., NMFS, Lake Oswego, USA, kimkratz@comcast.net
Mazor, R., SCCWRP, Costa Mesa, USA, raphaelm@sccwrp.org

AN INTRODUCTION TO SAFIT; THE SOUTHWEST ASSOCIATION OF FRESHWATER INVERTEBRATE TAXONOMISTS

SAFIT (www.safit.org) is an independent, nonprofit organization of professional invertebrate biologists whose mission is to promote standardized freshwater invertebrate taxonomy in support of aquatic ecosystem biotic assessments in the southwestern USA. SAFIT is also charged with promoting a better understanding of macroinvertebrate taxonomy and systematics, and fostering scientific research, education, training and professional development of our membership. SAFIT is primarily a support organization for entities conducting aquatic bioassessment.

Rogowski, **D**. **L**., Texas Tech University, Lubbock, USA, david.rogowski@ttu.edu
Martinez, M. A., U.S. Fish and Wildlife Service, Phoenix, USA, mike_martinez@fws.gov

TEMPERATURE AND APPARENT HABITAT PARTITIONING BETWEEN A RARE SPRINGSNAIL (PYRGULOPSIS TRIVIALIS) AND A COMMON SNAIL (PHYSA GYRINA)

The Three Forks springsnail (Pyrgulopsis trivialis) is a listed Federal candidate species that occupies two spring systems near Alpine, Arizona. The springsnail occurs in limited areas within small spring seeps. Previous research suggested that the springsnail and a physid snail partition habitat based primarily on distance to the spring source, water depth, and temperature. Springsnail density was greater in shallower water (< 5.6 cm) nearer the spring source, while physid snails were more abundant at greater distances away from the spring source and in warmer water. Springsnails only occupied stream areas where temperature were lower (13-15° C), whereas the physid snail occupied sections that were considerably warmer (> 15.8° C). Temperature data loggers were placed at a variety of sites within the spring systems to continuously record temperature. Additionally, laboratory experiments using a temperature gradient apparatus were conducted to determine snail temperature preference. Preliminary results reveal that there is no significant difference in temperature preference between the two snail species. Both species prefer temperatures that were generally warmer (~21° C) than what was available in their native habitat.

Roiha, **T**., University of Jyväskylä, Jyväskylä, Finland, toni.roiha@jyu.fi
Laurion, I., Institut national de la recherche scientifique, Quebec, Canada, isabelle.laurion@ete.inrs.ca
Rautio, M., Université du Québec à Chicoutimi, Chicoutimi, Canada, Milla_Rautio@uqac.ca

FIRST RECORD OF BACTERIAL DYNAMICS DURING WINTER IN PERMAFROST THAW PONDS IN SUBARCTIC QUEBEC

Global warming has accelerated the formation of permafrost thaw ponds in subarctic regions. Their role in the transformation of the mobilised soil organic carbon into greenhouse gasses has been acknowledged. Microbial activity has been suggested to be mainly responsible for GHG production. However, not much is known on carbon cycling and seasonal variations in these systems. Thermokarst thaw ponds in the Canadian subarctic (Whapmagoostui-Kuujjuarapik) were sampled during late winter (April) and summer (August) 2009. Our aims were to measure seasonal variations in bacterioplankton and primary production rates, to assess the importance of bacterial production associated to particles and estimate if the ponds are using autotrophic or heterotrophic energy pathways. Results show that bacterial and primary production is active under the ice in late winter, but the ponds are approximately two orders of magnitude more productive during summer. There was also a shift from a combination of both auto- and heterotrophy prevailing in late winter to a strong dominance of heterotrophy in summer. In addition, bacterioplankton tended to be associated with smaller particles in late winter as compared to the summer.

Roley, **S**. **S**., University of Notre Dame, Notre Dame, USA, sroley@nd.edu
Tank, J. L., University of Notre Dame, Notre Dame, USA, tank.1@nd.edu

IDENTIFYING PHYSICOCHEMICAL CONSTRAINTS ON SURVIVAL OF THE ENDANGERED CLUBSHELL MUSSEL, *PLEUROBEMA CLAVA*

The endangered clubshell mussel (*Pleurobema clava*) has been eliminated from streams throughout most of its native range, but the cause of its decline is not fully understood. In river basins where clubshell formerly thrived, land use has converted to row crop agriculture and sedimentation and eutrophication may have negatively influenced clubshell survival. We are testing this hypothesis in the upper Tippecanoe River, Indiana, where clubshell still occur in patchy distributions. Along a 30 mile river reach, we established sites with viable clubshell populations and sites where they have died out. At each site, we measured interstitial sedimentation rates, porewater dissolved oxygen (DO), porewater and surface water ammonia (NH_3) concentrations, and sediment organic matter content. In summer 2009, interstitial sedimentation rates and interstitial DO were not significantly different between clubshell and non-clubshell sites (ANOVA, all $p>0.09$), but sediment organic matter content was significantly higher at non-clubshell sites (ANOVA, $p<0.02$). Preliminary results suggest that sedimentation rates did not influence mussel populations directly, but that sediment quality and subsequent decomposition of sediment organic matter may limit clubshell via production of toxic NH_3.

Rollins, **M**. **A**., Appalachian State University, Boone, USA, rollinsma@appstate.edu
Creed, R. P., Appalachian State University, Boone, USA, creedrp@appstate.edu

DETRITIVORE DIVERSITY OR DOMINANT SPECIES: WHAT DRIVES DETRITAL PROCESSING IN A HEADWATER STREAM?

Previous research suggested that a dominant species (the caddisfly Pycnopsyche gentilis) and not detritivore diversity determined leaf breakdown in a southern Appalachian stream. However, in these previous studies the effects of other large detritivores (the stonefly Tallaperla and the crane fly Tipula) could not be directly compared to Pycnopsyche. Here we report the results of a field experiment in which we created monocultures of these three species as well as 2- and 3 species combinations and examined their effect on leaf breakdown. This experimental design allowed us to determine if these other taxa facilitated the effect of Pycnopsyche, inhibited it or had no effect whatsoever. We found that treatments containing Pycnopsyche exhibited the highest levels of leaf breakdown. The effect of Tallaperla was indistinguishable from controls in which only microbial breakdown occurred. Tipula monocultures exhibited leaf breakdowns intermediate between those of Pycnopsyche and Tallaperla. Neither Tallaperla nor Tipula facilitated or inhibited Pycnopsyche. However, Tallaperla inhibited leaf breakdown by Tipula in the treatments in which both were present. Our results confirm that Pycnopsyche is the dominant detritivore in this system. They also suggest that interactions among functionally subordinate species may result in reduced ecosystem function as species richness increases.

Rolon Merette, **M**., University of Ottawa, Ottawa, Canada, mrolo078@uottawa.ca
Pick, F. R., Ottawa University, Ottawa, Canada, Frances.Pick@uottawa.ca
Xenopoulos, M. A., Trent University, Peterborough, Canada, mxenopoulos@trentu.ca
Frost, P. C., Trent University, Peterborough, Canada, paulfrost@trentu.ca

PRIMAIRY PRODUCTIVITY AND NUTRIENT DYNAMICS OF URBAN PONDS

Ponds are becoming a prominent feature of many urban areas across North America. Most urban ponds are built to retain sediments and nutrients from in-flowing stormwater. While the basic hydrology of these unique urban aquatic ecosystems has been well documented, less is known about their biogeochemical processes. This study measured rates of primary production, community respiration, and water chemistry in urban ponds. Seventeen ponds (survey ponds) were sampled twice in the summer of 2009 and two ponds (target ponds) were sampled biweekly in the City of Ottawa, Canada. Primary production and respiration experiments using light/dark bottle incubations and $\delta^{18}O\text{-}O_2$ analyses were performed on target ponds. Ponds exhibited a large range in dissolved oxygen (53% to 200%) and midmorning $\delta^{18}O\text{-}O_2$ was consistently below atmospheric equilibrium. Results indicate that high rates of primary productivity is a significant feature of urban ponds and is related to the high planktonic algal biomass likely resulting from elevated nutrient concentrations found in these systems. It remains unclear whether the elevated rates of primary production will translate into greater biological retention of N and P.

Romanuk, **T**. **N**., Dalhousie University, Halifax, Canada, tromanuk@gmail.com

ECOSYSTEM DEGRADATION AND FOOD-WEB TOPOLOGY

The potential consequences of environmental disturbances on the composition and functioning of ecological communities is a major research focus in ecology. Despite the fact that changes in composition and functioning will alter energy-flow pathways, the potential consequences of environmental change on the topological structure of food-webs are only beginning to be explored. Using a range of case studies of various environmental disturbances including fishing pressure in Mediterranean food-webs, environmental warming and species invasions in meiofaunal communities, and nutrient enrichment in seagrass food-webs I will explore how changes in the structural properties of food-webs can be used to assess levels of ecosystem degradation and the robustness of food-webs to further species loss.

Rominger, **J**. **T**., Massachusetts Institute of Technology, Cambridge, USA, jtr@mit.edu
Nepf, H. M., Massachusetts Institute of Technology, Cambridge, USA, hmnepf@mit.edu

INVESTIGATING THE PHYSICAL CONTROLS OF NUTRIENT UPTAKE IN AQUATIC VEGETATION: A NOVEL EXPERIMENTAL METHOD

Aquatic vegetation such as seagrasses and macroalgae rely on advective motions from waves, currents and random turbulent fluctuations as well as on molecular diffusion to acquire essential nutrients directly from the surrounding water. The complex interactions between flexible aquatic vegetation and these local hydrodynamics can greatly affect nutrient uptake rates. A novel method for studying the physics of nutrient uptake is presented along with initial results. Polyethylene (LDPE) strips were submerged into water and subjected to varying current speeds and waves. An organic compound present in chlorinated water was measured as it sorbed into the strips. Because of the high partitioning constant of the compound between LDPE and water, uptake into the plastic mimics nutrient uptake in mass-transfer limited conditions. The uptake rates into the LDPE were measured across the different hydrodynamic conditions. By successfully isolating the physics of nutrient uptake from the plant physiology, this set of experiments documents the efficacy of this new method for studying nutrient uptake.

Roon, **D**. **A**., University of Alaska Fairbanks, Fairbanks, USA, daroon@alaska.edu
Wipfli, M. S., University of Alaska Fairbanks, Fairbanks, USA, mwipfli@alaska.edu
Wurtz, T. L., USDA Forest Service, Fairbanks, USA, twurtz@fs.fed.us
Prakash, A., University of Alaska Fairbanks, Fairbanks, USA, prakash@gi.alaska.edu

INVASIVE EUROPEAN BIRD CHERRY AFFECTS ECOLOGICAL PROCESSES WITHIN ALASKAN STREAMS AND RIPARIAN FORESTS

Invasive species are a concern worldwide as they can displace native species and disrupt ecological processes. European bird cherry (*Prunus padus*) (EBC) is an invasive tree that is rapidly spreading and possibly displacing native riparian vegetation along streams in some urban areas of Alaska. The objectives of this study were to: (1) map the distribution of EBC along two Anchorage streams, Campbell and Chester Creeks, and (2) determine the effects of EBC on selected ecological processes linked to salmonid food webs. Data showed that EBC was widely distributed along Chester Creek, that EBC leaf litter decomposed at different rates than native species, and that EBC supported different species of terrestrial invertebrates than native plants. Stomach contents taken from juvenile Chinook and coho salmon indicated that much of the prey these fish ingested originated from riparian plants. This study provides information on how invasive plant species can affect native species and ecological processes in and along streams. These findings will ultimately help guide management of EBC by city, state and federal agencies involved in managing urban watersheds and controlling invasive species.

Rose, **K**. **C**., Department of Zoology, Miami University, Oxford, USA, rosekc@muohio.edu
Williamson, C. E., Department of Zoology, Miami University, Oxford, USA, willia85@muohio.edu
Saros, J. E., School of Biology and Ecology & Climate Change Institute University of Maine, Orono, USA, jasmine.saros@maine.edu
Kissman, C., Department of Zoology, Miami University, Oxford, USA, kissmac@muohio.edu

INDICATORS OF ALLOCHTHONY IN HIGH MOUNTAIN LAKES

Degree of allochthony is an important property of aquatic ecosystems that regulates many limnological characteristics including transparency, net ecosystem production, and energy flow through food webs. Even small changes in allochthony, concurrent with global climate change, have the potential to induce large changes in lakes. New techniques have been developed to assess degree of allochthony within aquatic ecosystems; however no work has yet to compare these indicators across lakes that vary in degree of terrestrial influence. Degree of allochthony in high mountain lakes can vary widely within small geographic distances as lakes are found above and below the tree-line. We compared a number of allochthony indicators, including spectral slope, DOC/Chl ratio, particulate organic material deuterium, fluorescence, and transparency ratios across 15 lakes in the Beartooth Mountains (MT/WY, USA) and Glacier National Park (MT, USA). We found that more allochthonous lakes had a steeper (more negative) 350-400 nm spectral slope, higher DOC/Chl ratio, less negative deuterium enrichment, lower fluorescence index ratio, and lower 320 nm UV transparency relative to 380 nm UVR and PAR (400-700 nm) compared with more autochthonous lakes.

Rosemond, **A**. **D**., University of Georgia, Athens, GA, USA, rosemond@uga.edu
Wallace, J. B., University of Georgia, Athens, GA, USA, bwallace@uga.edu
Suberkropp, K., University of Alabama, Silver City, NM, USA, ksuberkp@bama.ua.edu
Gulis, V., Coastal Carolina University, Conway, SC, USA, vgulis@coastal.edu
Eggert, S. L., USDA Forest Service, Northern Research Station, Grand Rapids, MN, USA, seggert@fs.fed.us
Benstead, J. P., University of Alabama, Tuscaloosa, USA, jbenstead@bama.ua.edu
Cross, W. F., Montana State University, Bozeman, MT, USA, wyatt.cross@montana.edu
Greenwood, J. L., University of Tennessee-Martin, Martin, TN, USA, jgreenwood@utm.edu
Davis, J. M., Idaho State University, Pocatello, ID, USA, picodes.borealis@gmail.com
Tant, C. J., University of Georgia, Athens, GA, USA, ctant@uga.edu

SYNTHESIZING RESULTS FROM A LONG-TERM NUTRIENT ADDITION TO A DETRTUS-BASED ECOSYSTEM: FOOD WEB AND CARBON FLOW CONSEQUENCES

Although most carbon flow through ecosystems occurs along detrital pathways, we know little about how chronic nutrient enrichment affects these pathways and the food webs that mediate them, from heterotrophic microbes to higher-level detritivores. We continuously enriched a headwater stream with nitrogen and phosphorus for 5 years. Relative to a reference stream, we observed increased production of leaf litter-associated fungi and bacteria and increased respiration on leaves, wood, and fine particulate organic matter (FPOM). Detrital nutrient content increased, leading to higher macroinvertebrate production. Increased microbial activity and detritus consumption rates by macroinvertebrates increased organic matter breakdown rates. Nutrient enrichment increased carbon export and evasion due to greater amounts of consumer-generated FPOM and microbial respiration. As a result, allochthonous carbon standing crops declined and were more temporally variable. Our results suggest that nutrient inputs are important in altering carbon transformations, leading to lower in situ retention in detritus-based streams. These effects likely interact with and may be exacerbated by other aspects of global change (e.g., warming, high discharge events) that similarly affect carbon transformations and retention in aquatic systems.

Rosero, **D**., Universidad San Francisco de Quito, Quito, Ecuador, daniela79rosero@yahoo.de
Encalada, A. C., IMAR-CMA, Universidade de Coimbra, Coimbra, Portugal, aencalada@usfq.edu.ec
Jowett, I. G., NIWA, National Institute of Water & Atmospheric Research, Hamilton, New Zealand, ian.jowett@ihug.co.nz

HABITAT SUITABILITY MODELS FOR AQUATIC INVERTEBRATES IN HIGHLAND TROPICAL STREAMS: AN ALTERNATIVE FOR THE ASSESSMENT OF THE IMPACTS OF WATER ABSTRACTIONS

The high-altitude grasslands of the Ecuadorian Andes provide approximately 85% of the water supply for many of the main Andean cities. This life zone, known as "páramo", has extraordinary water storage capacities, but streams after water diversions are deprived of any flow until natural recharge appears downstream. In this study, we explore the development of conventional habitat suitability models and generalized additive models for stream invertebrates as an approach to determine flow regimes that would maintain ecological conditions downstream. We sampled up-stream control reaches in four streams and developed preference curves for selected macroinvertebrate species, based on their requirements of velocity, depth, and substrate type. Preliminary results suggest that distributions of *Austrelmis sp.* and *Andesiops sp.* exhibit strong responses to changing hydraulic conditions. These models will be confirmed by more intensive data collection programs. Modeling species abundance and community composition will then allow us to predict potential impacts of water withdrawal in páramo streams, and to recommend flow regimes that could help to maintain the integrity and functionality of aquatic ecosystems intensely used for water abstraction.

Roskosch, **A**., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, roskosch@igb-berlin.de
Hupfer, M., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, ,
Nützmann, G., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlind, Germany,
Lewandowski, J., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, lewe@igb-berlin.de

BIOIRRIGATION INDUCED FLUXES IN SEDIMENTS AND THEIR EFFECTS ON NUTRIENT DISTRIBUTION

Tube-dwelling macrozoobenthos irrigates the anoxic sediment by pumping overlying water through its burrows in order to provide oxygen and food. Bioirrigation alters the redox conditions by oxygen import and simultaneously pore-water solutes are removed. Consequently, the spatial distribution of nutrients in sediments is seriously affected. The intensity of the bioirrigation induced advective fluxes is driven by water temperature and oxygen concentrations. The spatial distributions of pore-water phosphate, iron, ammonium and sulphate around bioirrigating *Chironomus plumosus* larvae were investigated with high resolution two-dimensional pore-water samplers and microphotometric methods. Furthermore, P concentrations in the oxidized burrow walls and the surrounding sediment were determined. By using measurement techniques suitable for burrow diameters = 2 mm we quantified pumping intensity and advective fluxes at different temperatures and oxygen concentrations. Our investigations show that the spatial patterns of pore-water nutrients are highly affected by bioirrigation. P-release is decreased when larvae dwell in the sediment. Increased temperature and decreased oxygen concentrations cause increased pumping intensity and advective fluxes. Thus, bioirrigation is vulnerable to environmental changes, such as global warming.

Rost, **A**. **L**., Desert Research Institute, Reno, USA, arost@dri.edu
Fritsen, C. H., Desert Research Institue, Reno, USA, Chris.Fritsen@dri.edu

DIFFERENCES IN BENTHIC COMMUNITY STRUCTURE AND FUNCTION IN THE PRESENCE OF DIDYMOSPHENIA GEMINATA, IN SIERRA NEVADA STREAMS, CA, USA

Two tributary streams (one with *Didymosphenia geminata*, LVC, and one without, SC) were studied just upstream and downstream of their confluence to determine if differences in benthic community structure and function occur in the presence of *D. geminata*. Upstream from the confluence, some similarities occurred in algal communities but different taxa dominated and biomass was an order of magnitude higher in LVC. Macroinvertebrate communities had similar taxa, but differences occurred in feeding guilds with a 52 % reduction in grazer and 75 % increase in collector-gatherer densities in LVC. Delta ^{13}C in LVC periphyton was highly enriched (–13.72 ‰) and different from all BMI feeding guilds, especially grazer delta ^{13}C (–25.79 ‰) while SC periphyton delta ^{13}C (–22.22 ‰) and grazer delta ^{13}C (–22.95 ‰) were more congruent. Immediately downstream from the confluence, community composition structure and stable isotopes were similar to LVC but shifted towards SC in a downstream gradient. Findings are consistent with the immerging model that *D. geminata* blooms substantially impact ecosystem structure and function.

Rowan, **A**. **K**., Scottish Association for Marine Science, Oban, United Kingdom, arlene.rowan@sams.ac.uk
Wilson, S. T., Center for Microbial Oceanography: Research and Education (C-MORE), Honolulu, USA,
Hart , M. C., Scottish Association for Marine Science, Oban, United Kingdom, mark.hart@sams.ac.uk
Green, D. H., Scottish Association for Marine Science, Oban, United Kingdom, david.green@sams.ac.uk
Hatton, A. D., Scottish Association for Marine Science, Oban, United Kingdom, angela.hatton@sams.ac.uk

THE ROLE OF HOTSPOT FACEAL PELLET MICRO-ENVIRONMENTS IN OCEANIC METHANE PRODUCTION

Zooplankton faceal pellets in the pelagic environment represent important hotspots for biogeochemical cycling. Despite this, the microbial communities and processes involved are not well understood. The 'oceanic methane paradox' signifies an example of this. Methane exists at super-saturated concentrations in oxygenated upper oceans and is thought to result from in situ production. This is paradoxical as methanogens, the organisms thought to be responsible, are considered to be strict anaerobes. One possible explanation is that anaerobic micro-sites may exist; such as within zooplankton faecal pellets which may support methanogenic populations. Active methanogensis has been observed in faceal pellets however there is some debate as to the existence of true anoxic zones, capable of supporting methanogens, in pelagic particulate material. We applied culture-independent approaches to determine the microbial communities present in faecal pellets from natural and cultured copepods. A highly diverse microbial consortium including methanogens, sulphate-reducers were detected. Furthermore anaerobic incubations using faceal pellets demonstrated methane production and indicated viability of the methanogenic populations. These findings have important implications for the understanding of microbial biogeochemical cycling in the pelagic environment.

Roy, **A**. **H**., Kutztown University, Kutztown, USA, roy@kutztown.edu
Lubbers, H. R., Office of Environmental Quality, Batavia, USA, hlubbers@co.clermont.oh.us
Miller, M. C., University of Cincinnati, Cincinnati, USA, millermc@email.uc.edu

DOUBLE WHAMMY: EFFECTS OF SEASONAL DRYING AND URBANIZATION ON HEADWATER MACROINVERTEBRATES

In developing watersheds, biota in headwater streams are not only impacted by anthropogenic disturbance, but also by seasonal drying. We asked whether macroinvertebrates in temporary streams are sensitive to urbanization, and, if so, whether the response is influenced by the severity of seasonal drying. We sampled macroinvertebrates in riffle habitats of 10 intermittent streams with 11.7–97.1% urban land cover. In spring 2008, following an exceptionally dry summer, macroinvertebrate density was significantly lower (1541 m^{-2}) than in spring 2007 (4589 m^{-2}; $t = 2.86$, $p<0.021$), but composition was similar among years. Few macroinvertebrate metrics were related to hydrologic permanence, suggesting that macroinvertebrates in these temporary habitats have traits enabling their persistence through dry spells, and relative permanence within intermittent habitats does not drive assemblage composition. Several macroinvertebrate metrics (total richness, EPT richness, % EPT abundance, % Isopoda abundance) were negatively related to % urban land cover, and these relationships held in both years. The strong effect of landscape development and associated stressors on macroinvertebrate assemblages in temporary habitats highlights the importance of headwater stream protection, regardless of permanence.

Royer, **T**. **V**., Indiana University, Bloomington, USA, troyer@indiana.edu
Johnson, L. T., Indiana University, Bloomington, USA, latjohn@indiana.edu
Leff, L. G., Kent State University, Kent, USA, lleff@kent.edu

EFFECT OF A LABILE DOC ADDITION ON ORGANIC CARBON CYCLING IN AN AGRICULTURAL STREAM

The biogeochemistry of organic carbon in agricultural streams is poorly resolved. We injected a mixture of acetate, formate and a conservative tracer into a stream in Indiana (USA) for 5 days to examine interactions among microbial communities and C and N cycling. Total DOC concentration at the beginning of the experimental reach was elevated nearly 2-fold above the reference reach and declined downstream. DOC spiraling metrics were calculated daily based on longitudinal declines in DOC, acetate, and formate. Background concentrations of acetate and formate were below detection, allowing us to separate cycling of ambient DOC from added DOC. Throughout the experiment, the uptake velocity of acetate exceeded that of formate by several fold. Of the added DOC, 98% was accounted for via export (69%) or uptake and respiration (29%). Community respiration increased linearly from 2.0 g C/m^2/day initially to 3.7 g C/m^2/d by the end of the injection. Acetate and formate uptake stabilized after day-3 of the injection, whereas uptake of ambient DOC appeared to increase as a result of the labile DOC addition, possibly reflecting a microbial priming effect.

Rudstam, **L**. **G**., Cornell University, Ithaca, USA, lgr1@cornell.edu

FISH POPULATION DYNAMICS IN AN ECOSYSTEM CONTEXT – ANALYSIS OF 50+ YEARS OF DATA ON WALLEYE AND YELLOW PERCH IN ONEIDA LAKE

Walleye and yellow perch form a coupled predator – prey system in Oneida Lake, New York that has been studied for over 50 years. The tight coupling between walleye and yellow perch that prevailed in before 1980 has been modified by changes in the ecosystem. I will present the temporal patterns in mortality and abundance of different age groups of both species and interpret these patterns in an ecosystem context. Changes to Oneida Lake include decreased nutrient loading, increased abundance of alternative prey fish

(shad and white perch), increased water clarity (zebra mussels), and increased piscivory from cormorants. These ecosystem changes affect life stages of the two species differently and the effects depend on the biology of each species. For example, the interplay between depensatory and compensatory mortality through the first two years of life is associated with whether growth is density dependent (yellow perch) or not (walleye). This and other examples will highlight the importance of long term data series for assessing effects of ongoing ecological change on fish population dynamics.

Rüegg, **J**., University of Notre Dame, Notre Dame, USA, jrueegg@nd.edu
Currier, C. M., University of Notre Dame, Notre Dame, USA, ccurrier@nd.edu
Tiegs, S. D., Oakland University, Rochester, USA, tiegs@oakland.edu
Chaloner, D. T., University of Notre Dame, Notre Dame, USA, dchalone@nd.edu
Lamberti, G. A., University of Notre Dame, Notre Dame, USA, glambert@nd.edu

DECOMPOSITION OF PACIFIC SALMON TISSUE (*ONCORHYNCHUS* SPP.) DIFFERS BETWEEN AQUATIC AND TERRESTRIAL HABITATS IN SOUTHEAST ALASKA

Resources delivered by Pacific salmon spawners have been shown to support terrestrial and stream food webs. We hypothesized that salmon tissue decomposition would be faster, and macroinvertebrate density greater, in terrestrial than in stream habitats. Fresh salmon tissue (mean wet mass: 81±14g) was enclosed in mesh bags and placed in four habitats (terrestrial: riparian, active channel; aquatic: stream sediment surface, hyporheic) of four different watersheds and retrieved after 12-28 days depending on the habitat. Decomposition rates were higher in terrestrial than aquatic habitats (mean: k=0.103 and 0.073, respectively) and differed among watersheds (range: k=0.073-0.113). Decomposition rates in terrestrial habitats were highly variable among watersheds and habitats (range: k=0.048-0.160) while aquatic habitats were less variable (range: k=0.051-0.100). Macroinvertebrate densities were higher in salmon tissue in riparian zones (mean: 177/g) than in other habitats (mean: 3/g). Communities were dominated by Diptera (Chironomidae) and Plecoptera (Chloroperlidae) larvae in streams and only Diptera larvae (Calliphoridae, Scathophagidae) in terrestrial habitats. Our study suggests that habitat type can influence the decomposition of salmon carcasses, and their subsequent incorporation into food webs.

Ruetz III, **C**. **R**., Grand Valley State University, Muskegon, USA, ruetzc@gvsu.edu
Breen, M. J., Utah Department of Natural Resources, Vernal, USA, mattbreen@utah.gov

INTRASPECIFIC VARIATION IN LITTER QUALITY: IMPORTANCE OF LEAF SIZE

We evaluated the effect of intraspecific variation in litter quality on shredder consumption as a mechanism for higher breakdown of leaf packs comprised of large leaves. To test the hypothesis that large leaves are preferred by shredders based on litter quality, we examined C:N ratios of autumnal-senescent *Acer rubrum* leaves from randomly selected trees. From each tree, we collected small, medium, and large leaves and incubated them in a stream. We tested whether shredder consumption (*Gammarus pseudolimnaeus* or *Pycnopsyche lepida*) differed with leaf size. C:N ratios were lower for large leaves than medium/small leaves and varied among trees. C:N ratio was negatively associated with leaf mass, suggesting litter quality increased with leaf size. However, shredder consumption was not affected by leaf size, although it differed between species. Our results did not support the hypothesis that shredder consumption is the primary mechanism for higher breakdown of packs comprised of large leaves. Nevertheless, given that leaf size was associated with litter quality, intraspecific variation in addition to interspecific variation in leaf litter quality may be an important factor affecting detritus processing.

Rugenski, **A**. **T**., Southern Illinois University, Carbondale, IL, USA, rugenski@siu.edu
Whiles, M. R., Southern Illinois University, Carbondale, IL, USA, mwhiles@mail.science.siu.edu
Vanni, M. J., Miami University, oxford, OH, USA,
Lips, K. R., University of Maryland, College Park, MD, USA, klips@umd.edu
Pringle, C. M., Institute of Ecology, University of Georgia, Athens, GA, USA, cpringle@uga.edu
Kilham, S. S., Drexel University, Philadelphia, PA, USA, kilhams@drexel.edu

QUANTIFYING THE ROLES OF LARVAL AMPHIBIANS IN TROPICAL STREAM NUTRIENT CYCLING: ARE AMPHIBIAN DECLINES ALTERING ECOSYSTEM PROCESSES?

Tadpoles can be diverse and abundant in tropical streams, where they may regulate flows and ratios of nitrogen, phosphorus, and carbon, influencing ecosystem processes by altering supplies of nutrients to other organisms. Understanding the ecological roles of amphibians is becoming increasingly important as populations decline around the world. We used ecological stoichiometry as a framework for assessing nutrient cycling and consumer-resource interactions in pre- and post-amphibian decline headwater streams in Panama. We measured N and P excretion and C:N:P ratios of tadpoles, macroinvertebrates, and resources. Excretion rates varied among tadpole functional feeding groups (FFG) and supplied between 83-134 µg/m2/hr NH4-N and 40-62 µg/m2/hr PO4-P. Excretion rates of macroinvertebrate shredders differed between pre- (0.824 µgN/mg/hr) and post-decline (0.071 µgN/mg/hr) sites. We found no difference in tissue C:N among sites for all FFG (3.1-3.6 among tadpoles; 4.5-9.2 among macroinvertebrates), but C:P and N:P varied among FFGs. C:N and C:P ratios of tadpoles and macroinvertebrates were lower than food sources at all sites. Results indicate that amphibian declines are altering ecosystem processes by changing taxon-specific patterns of nutrient cycling within stream food webs.

Rusak, **J**. **A**., OMOE - Dorset Environmental Science Centre, Dorset, Canada, jim.rusak@ontario.ca
Kasian, S. E., Freshwater Institute, Winnipeg, Canada,
Kratz, T. K., University of Wisconsin - Madison, Boulder Junction, USA,
Leavitt, P. R., University of Regina, Regina, Canada, jim.rusak@ontario.ca
Somers, K., OMOE - Dorset Environmental Science Centre, Dorset, Canada,
Yan, N. D., York University, Toronto, Canada,

LIMNOLOGY ACROSS LANDSCAPES: REGIONAL DIFFERENCES IN THE SPATIAL SYNCHRONY OF LAKE PHYSICS, CHEMISTRY, AND BIOLOGY

The spatial synchrony (or temporal coherence) of lake variables has now been documented for a number of different regions. Although there is some agreement that synchrony decreases as we move along the gradient from physical, through chemical and into biological variables; little is known about how synchrony scales among regions and whether increased or decreased synchrony has climatic or limnological correlates. Using data from lakes in the northern Great Plains, northern Ontario, northern Wisconsin and south central Ontario, we quantified the magnitude of spatial synchrony as well as the patterns observed across regions. Synchrony in lake physical and chemical variables was high and fairly well-constrained, but biological variables exhibited greater variability and large differences among regions. Further, spatial proximity was not a good predictor of the prevalence of synchrony. These results suggest that, although climate plays a large role in generating synchronous behaviour among lakes, its effects are not necessarily generalizable and management strategies applied at regional scales may have a much better chance of succeeding in one area than another.

Ryan, **J**. **A**., Western Michigan University, Kalamazoo, USA, julie.ryan@wmich.edu
Kohler, S. L., Western Michigan University, Kalamazoo, USA, julie.ryan@wmich.edu

EVALUATING THE CONTEXT-DEPENDENCE OF MICROSPORIDIAN INFECTION ON MOTTLED SCULPIN FITNESS

Mottled sculpins are important predators in trout streams and can have strong effects on invertebrate community structure. Microsporidians are fungal parasites that infect a broad range of animal phyla in aquatic systems. Mottled sculpins (*Cottus bairdii*) are host to *Glugea* sp., a microsporidian parasite that produces xenomas (parasite filled cysts) in the body cavity of infected fish. Prevalence often exceeds 80% in infected sculpin populations in Southwest Michigan. We evaluated the effect of *Glugea* infection on sculpin growth under conditions of low and high food availability. Fish collected from an uninfected stream were exposed to infection or an equivalent sham treatment and randomly assigned to *ad libitum* or maintenance food levels. Fish were fed *Gammarus* daily and growth and survival were recorded for 13 weeks. *Glugea* reduced growth rates when parasite mass was subtracted from host mass for both food levels. However, mortality associated with the parasite was higher for fish fed *ad libitum* than the maintenance ration. These data suggest *Glugea* may affect population and community-level interactions in sculpin dominated systems.

Rychtecka, **M.**, The City College Of New York, New York, USA, rivermag@gmail.com
Fekete , B. M., The City College of New York , New York , USA, bfekete@ccny.cuny.edu
Vörösmarty, C. J., The City College of New York, New York, USA, cvorosmarty@ccny.cuny.edu

SPATIO-TEMPORAL IMPACT OF WASTEWATER POINT SOURCES ON NITROGEN POLLUTION IN U.S. RIVER SYSTEMS

Water treatment plants play critical role in protecting the health of river systems. In return healthy rivers provide invaluable ecosystem services. We investigate the delicate balance between operating expensive wastewater treatment facilities and the consequences of a relaxed wastewater management in terms of degraded ecosystem services. We address these questions by assembling a spatially distributed wastewater treatment data set for three time shots (1984, 1996, 2004) and testing the impact of point source pollutions in high resolution gridded river flow simulations. The water treatment data set is accompanied with a series of attributes about the water treatment facilities such as flows, influent and effluent concentrations of biochemical parameters, treatment levels, and population served by treatment facilities. We carry out flow and constituent simulations in a 6' simulated topological network. We assess the fate of total nitrogen in the aquatic system using a coupled river flow and aquatic nutrient flux model. We will test various scenarios (i.e. nitrogen loading with/without biological activity, facilities releasing wastewater at different treatment levels) to explore river system responses to different levels of nitrogen loadings.

Sada, **D.**, Desert Research Institute, Reno, USA, don .sada@dri.edu
Herbst, D., University of California, Santa Barbara, Santa Barbara, USA, dherbst@lifesci.ucsb.edu

CASCADING INFLUENCES OF WATER CHEMISTRY ON HABITAT AND THE BENTHIC COMMUNITY OCCUPYING A DEATH VALLEY NATIONAL PARK THERMAL SPRING

Springs are biodiversity hotspots in desert environments, and they provide the only surface water for humans and wildlife over vast regions. Characteristics of benthic communities and their relationships with these wide spread and numerous habitats are poorly studied. BMIs and the aquatic environment were sampled to examine variability along a gradient from spring source to its terminus. The spring flowed approximately 650 m before percolating into a wash, and its discharge and temperature at the source were constant (200 l/min and 33oC, respectively). The community included 49 taxa, including five endemic species, which were the sole members of the community from the source to approximately 60 m downstream. Other widespread taxa usually dominated the community below this point. Change in the community and substrate at 60 m from the source can be attributed to channel armoring caused by CO2 degassing, increasing pH, and changing temperature facilitating travertine deposition. Relationships between benthic communities, water chemistry, and benthic environments in Travertine Springs suggests that assessing biological effects of habitat degradation in arid land springs may require integrating a diversity of physico-chemical and biological disciplines.

Sadro, **S.**, University of California: Department of Ecology, Evolution, and Marine Biology, Santa Barbara, USA, sadro@lifesci.ucsb.edu
Melack, J. M., University of California: Bren School of Environmental Science and Management, Santa Barbara, USA,
MacIntyre, S., University of California: Institute for Computational Earth System Science, Santa Barbara, USA,

PATTERNS IN ECOSYSTEM METABOLISM FROM A HIGH-ELEVATION LAKE (SIERRA-NEVADA, CALIFORNIA, USA)

It remains unclear if autotrophic or heterotrophic processes dominate the metabolism of alpine lakes, where nutrient and dissolved organic matter concentrations are simultaneously low. Because conditions are limiting to both phytoplankton and heterotrophic microbial production, these lakes are ideal environments to explore patterns in metabolic rates from diel to seasonal time scales. We used a combination of *in situ* chamber incubations, discrete vertical profiles, and continuous free-water measurements of dissolved oxygen to characterize spatial and temporal variability in net ecosystem production (NEP), community respiration (CR), and gross primary production (GPP) in a high-elevation lake. While the system was slightly autotrophic during the growing season (NEP ~ 100 $\mu M/d^{-1}$), under-ice measurements of CR suggest net heterotrophy on an annual basis. Heterotrophic microbes accounted for 74 % of CR during the growing season and were important in structuring variability in night-time rates, which we found to be highest just after dusk and lowest just before dawn. Ignoring diel variability in CR (an 8 to 12 fold difference in night-time rates) resulted in significant underestimation of both CR and GPP.

Saeck, **E. A.**, Griffith University, Brisbane, Australia, e.saeck@griffith.edu.au
Burford, M. A., Griffith University, Brisbane, Australia, m.burford@griffith.edu.au
O'Brien, K., University of Queensland, Brisbane, Australia, k.obrien@uq.edu.au

USING FLUORESCENCE TO QUANTIFY NUTRIENT STATUS OF NATURAL PHYTOPLANKTON COMMUNITIES (MORETON BAY, AUSTRALIA)

This study aims to develop a quick and robust method to quantify the nutrient status of natural phytoplankton communities. The PhytoPAM (pulse amplitude modulation) has been used to identify changes in photosynthetic efficiency and infer nutrient limitation by measuring the ratio of variable to maximum fluorescence (Fv/Fm). However so far this method has been limited to qualitative assessment of nutrient status because the relationship between Fv/Fm and nutrient status is ambiguous and can vary depending on nutrient history, the nutrient that is limiting, the phytoplankton species present and diurnal variation. Bioassays of nitrogen limited water from Moreton Bay were enriched with increasing concentrations of nitrogen (ammonia) to enable quantification of the saturating nitrogen concentration. Photosynthetic yield (Fv/Fm) and stable isotope (13C-bicarbonate, 15N-ammonium) uptake rates within the bioassay bottles were measured at 24 h. To validate the method the nitrogen concentration at which the maximum Fv/Fm was reached was compared with the nitrogen concentration corresponding to maximum nutrient uptake. Results to date indicate that Fv/Fm is a useful tool for identifying concentration thresholds for maximum productivity and nutrient uptake rates.

Sakai, M., Kyoto University, Kyoto, Japan, m.sakai@fw3.ecs.kyoto-u.ac.jp
Natuhara, Y., Kyoto University, Kyoto, Japan,
Imanishi, A. , Kyoto University, Kyoto, Japan,

IMPACTS OF DEER OVERBROWSING ON BENTHIC ARTHROPOD ASSEMBLAGES IN HEADWATER (FIRST-ORDER) STREAMS

Increase of Sika deer effects not only understory but phytophagous insect, anthophilous insect and others directly or indirectly throughout Japan. Declination of understory also brings on soil erosion via reducing soil infiltration capacity. This hydrological alteration might provide fine sediment into streams and change their substrates. However, it isn't obvious whether these problems change structure of benthic arthropod assemblage. To reveal the impacts of deer overbrowsing on benthic arthropod assemblages in headwater (first-order) streams, 1:Coverage of understory, 2:Stream substrates, 3:Benthic arthropod assemblages were surveyed in 8 small catchments (4:excluded site from deer, 4:control site) in Kyoto, Japan where deer population density becomes high for the last decade. The coverage of understory was much higher in the excluded site than in the control site. A total of 118 arthropod taxa were observed. Simpson index were higher in the excluded site than in the control site. In the control site, stream substrates were highly dominated by fine sediment compared with those in the excluded site. Our results suggest poor understory by overbrowsing unifies stream microhabitats and deprives diversity of aquatic arthropods.

Sakamaki, **T.**, University of Ryukyu, Okinawa, Japan, sakamaki@lab.u-ryukyu.ac.jp
Richardson, J. S., University of British Columbia, Vancouver, Canada,

RELATIONSHIPS BETWEEN STREAM CHANNEL SIZE, CHEMICAL PROPERTIES OF FINE PARTICULATE ORGANIC MATTER, AND FOOD SOURCE FOR BENTHIC INVERTEBRATES

We examined whether channel size can explain in-stream biogeochemical condition and its linkage with local environment. Stream sediment and suspended fine particulate organic matter (FPOM), biofilm (considered as OM produced in-stream), bed CPOM, benthic invertebrates, and irradiance were sampled at 49 stations of 14 streams in south-western British Columbia, Canada. Sites ranged from 2 m to 39 m bankfull width, and were sampled under summer, low-flow conditions in 2008. C:N ratio of sediment FPOM ranged from 10 to 24 and decreased with bankfull width. Particularly in the range of 4-10 m bankfull width, C:N ratio of sediment FPOM was positively related to the bed CPOM standing crop and negatively to irradiance. Relations with canopy closure and bed CPOM were likely responsible for the distinct changes of FPOM chemical

properties relative to channel size. Meanwhile, carbon stable isotopes for benthic invertebrate species (i.e. Chloroperlidae, Heptageniidae, *Despaxia* sp., *Lepidostoma roafi*) showed no relation to channel size. Diets of the particular species likely had strong consistency (i.e. terrestrial OM or in-stream produced OM) throughout the range of channel width which we examined.

Sandin, **L**., Swedish University of Agricultural Sciences, Uppsala, Sweden, leonard.sandin@vatten.slu.se
Bergfur, J., Linköping University, Linköping, Sweden, jenny.bergfur@liu.se

MULTIPLE STRESSOR EFFECTS (EUTROPHICATION AND HYDROMORPHOLOGY) ON ECOSYSTEM STRUCTURE AND FUNCTION IN SOME SWEDISH STREAMS

Different types of human induced pressures on stream and river ecosystems affect primarily the community composition, ecosystem functioning (processes) or both. Whether or not structural or functional parameters are more sensitive to environmental change depends on if i) species are primarily redundant, ii) species have a unique contribution to functioning, or iii) species impacts are context-dependent and unpredictable (Naeem et al 2002). Here we tested the relationship between ecosystem structure and functioning in relation to two types of human induced pressure (eutrophication and hydromorphological change) in some Swedish streams. Nine medium sized, well buffered streams along a pre-defined nutrient and hydromorphology gradient was sampled for in-stream biota (diatoms, macroinvertebrates, macrophytes, and fish) as well as leaf-litter breakdown (as a measure of organic matter processing). At the same time standard water chemistry samples were taken and the sites were assessed using the River Habitat Survey Hydromorphological assessment. We assessed the response of the biota and the ecosystem process to the environmental change gradients as well as between biota and the functional measurement. Using this approach we could evaluate possible ecosystem responses to multiple human induced environmental change effects on organisms and functioning in running waters.

Sanpera-Calbet, **I**., University of Barcelona, Barcelona, Spain, isanpera@ub.edu
Ylla, I., University of Girona, Girona, Spain, irene.ylla@udg.edu
Romaní, A. M., Universitat de Girona, Girona, Spain, anna.romani@udg.edu
Sabater, S., University of Girona, Griona, Spain, sergi.sabater@udg.edu
Muñoz, I., University of Barcelona, Barcelona, Spain, imunoz@ub.edu

DROUGHT EFFECTS ON RESOURCE QUALITY IN A MEDITERRANEAN STREAM

Seasonal drought in Mediterranean streams shapes their physical, chemical and biological characteristics. Effects of drought on stream ecosystems have been relatively well studied, but little is known about their effects on basal resources. In summer 2006, drought caused a complete loss of surface water and hydrological connectivity in the studied stream. One of the indirect effects of drought is the alteration of food resources. We studied the changes in quality and quantity of the organic matter in the benthic substrates and water. Lipid content of resources was analyzed because they are the most efficient energy-storing compound for most freshwater benthic organisms. Fatty acids and sterols were used as biomarkers for organic matter sources. Total lipid content was higher in the particulate fraction of water before the drought period. Lipid content in leaves was higher before the drought period and it was the richest substrate in lipids, mainly due to the algae content in the associated biofilm. In all substrates, fatty acid from algal origin decreased after the drought period. From these results, we suggest that drought causes a decrease in the lipid content and therefore, in the quality of available resources.

Sansom, **B**. **J**., Washington & Jefferson College, Washington, USA, SANSOMBJ@washjeff.edu
March, J. G., Washington & Jefferson College, Washington, USA, jmarch@washjeff.edu

QUANTIFYING COMMUNITY STRUCTURE AND ECOSYSTEM FUNCTION IN STREAMS PRIOR TO DRILLING FOR MARCELLUS SHALE NATURAL GAS

Drilling for natural gas in the Marcellus Shale geological formation is occurring at unprecedented rates across the Mid=Atlantic Region of the United States. Establishing baseline data prior to drilling is essential in order to quantify impacts. Studying leaf decomposition offers a holistic approach because nutrient leaching, microbial colonization, and macroinvertebrate shredders all play key roles. In this study, we measured leaf decomposition rates, community structure, and water chemistry in two perennial streams in Southwestern PA. The two streams differed in k-values, water temperature, and shredder biomass, while no differences occurred in total macroinvertebrate biomass, abundance, or taxa richness. Mean Total Dissolved Solids (mg/l) ranged from 224-325 and Conductivity (uS/cm) ranged from 385 to 608. Drilling under these streams is scheduled to occur in early 2010.

Saros, **J**. **E**., University of Maine, Orono, USA, jasmine.saros@maine.edu
Wolfe, A. P., University of Alberta, Edmonton, Canada, awolfe@ualberta.ca
Clow, D. W., US Geological Survey, Lakewood, USA, dwclow@usgs.gov
Rose, K. C., Miami University of Ohio, Oxford, USA, rosekc@muohio.edu
Williamson, C. E., Miami University of Ohio, Oxford, USA, willia85@muohio.edu

MELTING ALPINE GLACIERS ENRICH LAKE ECOSYSTEMS WITH REACTIVE NITROGEN AND REDUCE BIODIVERSITY

Over the last century, alpine glaciers have receded rapidly in many regions of the world, and increasing glacial runoff has altered physical and biogeochemical aspects of downstream aquatic ecosystems. We compared nutrient concentrations, transparency gradients, algal biomass, and fossil diatom species diversity in two sets of high-elevation lakes: those fed by snowpack melt alone (SF lakes) and those fed by both glacial and snowpack meltwaters (GSF lakes). We found that nitrate concentrations in the GSF lakes were one to two orders of magnitude higher than in SF lakes. Although nitrogen (N) limitation is common in alpine lakes, algal biomass was consistently lower in highly N-enriched GSF lakes than in the N-poor SF lakes. Contrary to expectations, GSF lakes were more transparent than SF lakes to UV and PAR. Sediment diatom assemblages had lower taxonomic richness in the GSF lakes, a feature that has persisted over the last century. High influxes of reactive N from glacial meltwater have changed the stoichiometric balance of critical limiting nutrients in these lakes, altering both the structure and function of these fragile ecosystems.

Sass, **G**. **Z**., University of Alberta, Edmonton, Canada, gabor.sass@uwo.ca
Creed, I. F., The University of Western Ontario, London, Canada, icreed@uwo.ca
Bayley, S. E., University of Alberta, Edmonton, Canada, sbayley@ualberta.ca

WETLAND LOSSES IN THE BOREAL TRANSITION ZONE OF ALBERTA: THE BEGINNING OF THE END FOR SURFACE WATER?

As with many wetlands globally, Beaverhill Lake, a RAMSAR wetland of international significance, which is located in Alberta, Canada, dried up in 2008. We propose adoption of a hydrologic systems approach to wetland management that considers the timing, magnitude and organization of hydrologic linkages between contributing source areas of water and the wetlands. We hypothesize that wetlands with a high degree of hydrologic linkages are more resilient to environmental change. We test this hypothesis using the combinatory power of LIDAR, optical and radar remote sensing data on the Beaverhill watershed. We observe that since the early 1970s, significant wetland loss (>70%) occurred within the watershed, but that the rate of loss was not uniform, as wetlands with a relatively high number of surface water and/or groundwater connections were more resilient and experienced less wetland loss. We conclude that not all wetlands are the same, and that wetlands with a higher degree of hydrologic linkages to its source areas of water should receive priority protection if we are to protect the ecological services afforded by these important ecosystems.

Saunders, **P**. **A**., Ashland University, Ashland, USA, psaunder@ashland.edu
Day, R. E., Ashland University, Ashland, USA, rday@ashland.edu

A SEASONAL DIFFERENCE IN LITTORAL–PELAGIC TRAFFIC: EVIDENCE FOR DIEL HORIZONTAL MIGRATION OF *DAPHNIA DENTIFERA* IN A KETTLE LAKE

Sites Lake, OH (40°N, 82°W) is a small, deep, eutrophic kettle lake (2.6 ha, Z_{max} = 12.8 m) with ≈20–30% littoral area. Previous studies in Sites Lake have found evidence for diel horizontal migration (DHM) of *Daphnia dentifera* in fall (Sep–Nov), with larger individuals (>0.5 mm) nearly doubling in abundance at night around the near–central pelagic station. However, more recent research has not found evidence of this predator–avoidance behavior during the spring abundance maximum (May–Jun). Diel abundance and size–frequency data were from whole–water column net tows and 30–L Schindler–Patalas trap profiles. The hypolimnion grows more and more anoxic in spring. This ecosystem characteristic may help to explain fall DHM by *Daphnia*. We do not know where these animals are going during the day. Dominant littoral macrophytes include emergent *Nuphar* and submergent *Ceratophyllum*. New lake morphometric data

allow us to estimate the areal coverage of each dominant plant and will help with future studies of littoral-pelagic interaction in Sites Lake.

Saunders, **W. C.**, Dept. Fish, Wildlife, & Conservation Biology, Colorado State University, Fort Collins, USA, csaunder@warnercnr.colostate.edu
Fausch, K. D., Dept. Fish, Wildlife, & Conservation Biology, Colorado State University, Fort Collins, USA, kurtf@warnercnr.colostate.edu

EFFECTS OF RIPARIAN GRAZING MANAGEMENT FOR CATTLE ON TERRESTRIAL INVERTEBRATE SUBSIDIES THAT SUPPORT TROUT IN CENTRAL ROCKY MOUNTAIN STREAMS

Research worldwide indicates that terrestrial invertebrate prey provide about 50% of the annual energy for stream fish, yet the importance of this subsidy in agricultural landscapes has not been evaluated. We integrated comparative studies with a large-scale field experiment to evaluate the importance of falling invertebrate input to trout in streams with riparian zones under season-long, rotational, or wildlife-only grazing regimes. Input of terrestrial invertebrates to streams and their biomass in trout diets were significantly greater in streams under rotational versus season-long grazing. In turn, trout biomass also was greater in these streams. In the field experiment, we used four treatments to evaluate mechanisms driving the response of stream-riparian food webs to riparian grazing: control, moderate, and intensive grazing, and intensive grazing with woody vegetation removal. Results demonstrated that terrestrial invertebrates provide important resources that sustain trout in western U.S. rangeland streams, prescribed grazing management can increase trout biomass by supporting these food web subsidies, and that grazing intensity influences the magnitude of the effects cattle have on stream food webs independent of changes to the physical structure of streams.

Sawyer, **A. H.**, University of Texas-Austin, Austin, USA, asawyer@mail.utexas.edu
Cardenas, M. B., University of Texas-Austin, Austin, USA, cardenas@mail.utexas.edu
Buttles, J., University of Texas-Austin, Austin, USA, buttles@mail.utexas.edu

QUANTIFYING HYDROLOGIC AND THERMAL PROCESSES WITHIN HYPORHEIC ZONES FORMED BY LARGE WOODY DEBRIS: NUMERICAL AND LABORATORY FLUME EXPERIMENTS

The flow of river water around wood debris creates pressure gradients along the bed that drive a large zone of river-groundwater mixing, or hyporheic exchange. Hyporheic zones associated with wood debris exhibit strong thermal heterogeneity that can impact hyporheic community patterns. We quantify hyporheic exchange and heat transport induced by channel-spanning logs using two approaches: laboratory flume experiments and numerical experiments that link turbulent open-channel and groundwater flow. In flume experiments, dye streaks in the sediment delineate a deep zone of hyporheic exchange beneath channel-spanning logs. River water downwells into the bed upstream of the log and upwells downstream. These flow paths are consistent with streamlines from numerical simulations. Exchange increases with log blockage ratio (log diameter : channel flow depth), sediment permeability, and river velocity. Channel-spanning logs produce a characteristic temperature pattern within sediment. Upstream from a log, downwelling water causes daily temperature ranges to approach those in the river. Downstream, upwelling water forms a wedge of buffered (low-amplitude) temperatures. These temperature patterns shift in response to log blockage ratio, sediment permeability, and river velocity.

Schade, **J. D.**, St. Olaf College, Northfield, MN, USA, schade@stolaf.edu
Seybold, E. C., St. Olaf College, Northfield, MN, USA, seybold@stolaf.edu
Drake, T., Carleton College, Northfield, MN, USA, draket@carleton.edu
Bulygina, E., Woods Hole Research Center, Falmouth, MN, USA,
Bunn, A., Western Washington University, Bellingham, USA,
Chandra, S., University of Nevada-Reno, Reno, NV, USA,
Davydov, S., Northeast Science Station, Cherskiy, Russian Federation,
Frey, K., Clark University, Worcester, MA, USA,
Holmes, R. M., Woods Hole Research Center, Falmouth, MA, USA,
Sobczak, W., College of the Holy Cross, Worcester, MA, USA,

ASSESSING BIOGEOCHEMICAL CYCLING AND TRANSIENT STORAGE OF SURFACE WATER IN EASTERN SIBERIAN STREAMS USING SHORT-TERM SOLUTE ADDITIONS

Streams actively regulate fluxes of carbon, nitrogen, and phosphorus from upland terrestrial ecosystems to downstream aquatic environments. This is of particular interest in Arctic streams because of the potential impact of permafrost thaw on inputs of nutrients and organic matter. We quantified nutrient spiraling metrics in 5 streams in the Kolyma River watershed in eastern Siberia, including 3 streams draining Pleistocene soils (yedoma) and 2 floodplain streams. Yedoma streams showed higher uptake of N than P, suggesting N limitation of biological processes, while floodplain streams showed substantially higher P uptake than N uptake, indicating strong P limitation. Given these results, it is probable that these two types of streams will respond quite differently to changes in nutrient and organic matter inputs as permafrost thaws. Furthermore, uptake was strongly linked to discharge and transient storage of surface water with lower nutrient uptake in low discharge, high transient storage streams. Given the possibility that both discharge and nutrient inputs will increase as permafrost thaws, longer-term nutrient enrichment experiments are needed to develop predictions of change in these ecosystems with changes in climate.

Schapira, **M.**, Southern Ocean Group, Department of Zoology & Entomology, Rhodes University, Grahamstown, South Africa, M.Schapira@ru.ac.za
McQuaid, C. D., Southern Ocean Group, Department of Zoology & Entomology, Rhodes University, Grahamstown, South Africa, C.McQuaid@ru.ac.za
Froneman, P. W., Southern Ocean Group, Department of Zoology & Entomology, Rhodes University, Grahamstown, South Africa, W.Froneman@ru.ac.za

PROKARYOTIC METABOLISM IN THE VICINITY OF SUB-ANTARCTIC ISLANDS: EVIDENCE OF AN ISLAND MASS-EFFECT AND IMPLICATIONS FOR BENTHO-PELAGIC COUPLING

The sub-Antarctic Prince Edward Archipelago lies in the path of the Antarctic Circumpolar Current, giving the islands a distinct upstream/downstream axis. The distributions of total and particle-attached prokaryote abundance (PA), heterotrophic production (PHP), suspended particulate (POM) and dissolved organic matter (DOM) were investigated in the upstream, inter-island and downstream regions during autumn (April-May) 2009. Particulate organic nitrogen (PON) was significantly higher in the inter-island and downstream regions, with no trend in DOM distribution. PA ranged from 3.3 - 5.5 $\times 10^5$ ml^{-1} with no regional pattern. The attached fraction formed 62% - 85% of total PHP. While total microbial specific activity (i.e. SA=PHP/PA) showed no trend, SA of the particle-attached fraction was significantly higher in the inter-island and downstream regions. Local primary production is primarily controlled by large-scale oceanographic effects and during the cruise low chlorophyll levels indicated through-flow conditions around the islands with little water retention in their vicinity. Regional gradients in particle-attached SA indicate that, even under these circumstances, an island-mass effect is discernible in microbial communities, with implications for bentho-pelagic coupling in the vicinity of the islands.

Scharold, **J.**, US EPA Mid-Continent Ecology Division, Duluth, USA, scharold.jill@epa.gov
Kelly, J. R., US EPA Mid-Continent Ecology Division, Duluth, USA, kelly.johnr@epa.gov
Corry, T. D., US EPA Mid-Continent Ecology Division, Duluth, USA, corry.timothy@epa.gov

STATUS OF THE AMPHIPOD *DIPOREIA* SPP. IN LAKE SUPERIOR

The amphipod *Diporeia* spp. has historically been the dominant benthic macroinvertebrate in deeper waters of the Laurentian Great Lakes. Although *Diporeia* populations in the lower Great Lakes have experienced severe declines in recent years, densities have remained relatively stable in Lake Superior. In 2006 we used a probability based sampling design to assess population density of *Diporeia* in Lake Superior. *Diporeia* were sampled at 52 sites using a Ponar grab. Thirty-four sites were in the nearshore (0-150 m depth) stratum and 18 in the offshore (>150 m) stratum. The lake-wide mean density of *Diporeia* was 435 ± 63(SE) m^{-2}. In nearshore and offshore regions, mean densities were 895 ± 114 m^{-2} and 157 ± 28 m^{-2}, respectively. These values are above the minimum objectives set by the Great Lakes Water Quality Agreement. The observed densities are also higher than those reported from the only previous comprehensive lake-wide survey of *Diporeia* populations, conducted in 1972. These results suggest that the conditions causing the observed reductions in *Diporeia* populations of the lower Great Lakes are not present in Lake Superior.

Scherwass, **A**., University of Cologne, Center for Biological Sciences, Cologne, Germany, anja.scherwass@uni-koeln.de

Erken, T., University of Cologne, Center for Biological Sciences, Cologne, Germany, anja.scherwass@uni-koeln.de

Haagensen, J. A., Stanford University, Bio-X Program,, Cologne, Germany,

Molin, S., BioSys-DTU, Infection Microbiology Group, Lyngby, Denmark,

Arndt, H., University of Cologne, Center for Biological Sciences

GRAZING OF A BROWSING CILIATE (TETRAHYMENA PYRIFORMIS) ON A MICROCOLONY FORMING BIOFILM BUILDING BACTERIUM (ACINETOBACTER SPEC.)

It is known from pelagic environments in aquatic systems that formation of bacterial clusters such as filaments, microcolonies etc. act as a protection against protozoan grazing. We hypothesized that formation of microcolonies shields against protozoan grazing in biofilms. The influence of the browsing ciliate Tetrahymena pyriformis on a mono-species Acinetobacter sp. strain C6 variant biofilm was investigated using a continuous flow channel system. The response of the biofilm under grazing pressure was investigated under the influence of two different substrate supply rates and two different carbon sources (sodium benzoate and citrate). The presence of the grazer led to an increase of the size of microcolonies at high substrate supply (sodium benzoate), whereas biofilms grown under 'low flow' conditions showed a clear reduction in biomass as well as a change of microcolony shape under grazing influence. Biofilms supplied with citrate (a less optimal carbon source for Acinetobacter) were also affected by protozoan grazing resulting in almost elimination of the formed microcolonies already after 4 days of growth. These results indicate that microcolony formation of Acinetobacter sp. strain C6 variant did not generally protect bacteria from protozoan grazing. Substrate quality and quantity seem to modulate the interaction between grazers and biofilm bacteria.

Scheuerell, **M**. **D**., NOAA Fisheries Service, Seattle, WA, USA, mark.scheuerell@noaa.gov

Buhle, E. R., NOAA Fisheries Service, Seattle, WA, USA, eric.buhle@noaa.gov

Semmens, B. X., NOAA Fisheries Service, Seattle, WA, USA, brice.semmens@noaa.gov

Ford, M., NOAA Fisheries Service, Seattle, WA, USA, mike.ford@noaa.gov

Cooney, T., NOAA Fisheries Service, Portland, OR, USA, tom.cooney@noaa.gov

Carmichael, R., Eastern Oregon University, La Grande, OR, USA, rcarmich@eou.edu

ANALYZING LARGE-SCALE ECOSYSTEM EXPERIMENTS WITH BAYESIAN STATE-SPACE MODELS: A CASE STUDY OF HATCHERIES AND THREATENED PACIFIC SALMON

Large-scale experiments, such as those conducted by J.F. Kitchell and colleagues, have played an important role in furthering our understanding of how fish influence aquatic ecosystems. Analyzing the results of such studies can prove problematic, however, due to various statistical assumptions and philosophical differences. We demonstrate how Bayesian state-space models can overcome these potential shortcomings by considering an economically and ecologically important fish: Pacific salmon. Many populations across their range are currently listed under the Endangered Species Act. Consequently, various programs have been initiated to supplement at-risk populations with hatchery-reared fish. Despite this widespread practice, there has been no large-scale effort to evaluate the efficacy of hatchery programs in rebuilding depleted populations. Thus, we analyzed 40 years of data on Chinook salmon from the Columbia River basin to compare the response of 10 supplemented populations relative to 11 reference populations that had never received any hatchery fish. We found supplementation had no effect on the density of natural-origin adults, and a *negative* effect on population productivity measured as spawner per spawner, suggesting supplementation may have not met its intended goal.

Schiel, **D**. **R**., University of Canterbury, Christchurch, New Zealand, david.schiel@canterbury.ac.nz

MULTIPLE STRESSORS ON ROCKY SHORES: ASYMMETRICAL BIOTIC RESPONSES, FEEDBACKS AND THE LOSS OF RESILIENCE ALONG GRADIENTS

Understanding and managing the effects of stressors over localised and coast-wide gradients presents one of the greatest challenges in coastal reef ecosystems. The reduction or loss of key species can lead to cascading effects on communities, which vary across gradients, and exposes different susceptibilities of species, varying resilience of populations, and often fine-scale feedbacks between biota and stressors. The layered canopy structure is a critical feature of algal-dominated communities, and stressors affecting canopy species and the three-dimensional structure produce the greatest community impacts. Demonstrating the feedbacks between stressors, community composition and change critically underpins our scientific advice to managers of the coastal zone.

Schindler, **D**. **E**., University of Washington, Seattle, USA, deschind@uw.edu

Scheuerell, M. D., NOAA, Seattle, USA, mark.scheuerell@noaa.gov

HETEROGENEITY AND MANAGING RISK TO FISH STOCKS FROM CLIMATE CHANGE

Although enormous effort has been dedicated to studying recruitment variability in fish stocks, our understanding of the ecological processes causing variability, and our ability to forecast recruitment strength, remain weak. Recruitment variability is generated by spatial and temporal matching/mismatching at many spatial and temporal scales. The inherent complexity of ecological processes producing these match/mismatches may make them immeasurable, and we suggest that developing a mechanistic understanding of these processes is not a practical goal. Even at regional and sub-regional spatial scales, populations show limited coherence in their dynamics despite general expectations that populations should be regionally synchronous. Such asynchrony could motivate increasingly intensive research to understand local scale dynamics. Alternatively, regional heterogeneity could be viewed as important for buffering variability at the broad scales over which fisheries integrate, and efforts should be focused on maintaining population- and habitat diversity across these landscapes. This latter approach may be a particularly effective way to manage risk to fisheries from ongoing climate change.

Schindler, **E**. **U**., British Columbia Ministry of Environment, Nelson, Canada, Eva.Schindler@gov.bc.ca

Sebastian, D., Province of British Columbia, Ministry of Environment, Victoria, B.C., Canada, Dale.Sebastian@gov.bc.ca

Vidmanic, L., Limno-Lab Ltd., Vancouver, B.C., Canada, lvidmanic@telus.net

Pick, F. P., University of Ottawa, Ottawa, ON, Canada, Frances.Pick@uottawa.ca

Harris, S., Province of British Columbia, Ministry of Environment, Vancouver, BC, Canada, Shannon.Harris@gov.bc.ca

Ashley, K. I., University of British Columbia, Vancouver, BC, Canada, Ken.Ashley@shaw.ca

Andrusak, H., Redfish Consulting Ltd., Nelson, BC, Canada, handrusak@shaw.ca

RESTORATION OF KOKANEE SALMON IN KOOTENAY LAKE, BRITISH COLUMBIA: RESULTS OF A WHOLE LAKE NUTRIENT ADDITION PROGRAM

Kootenay Lake has been influenced by several anthropogenic stressors during the past 60 years. These include the introduction of Mysid shrimp (Mysis relicta), cultural eutrophication and the construction of upstream hydroelectric impoundments. These impoundments caused nutrient retention leading to oligotrophication of Kootenay Lake and declines in kokanee salmon (Oncorhynchus nerka). To address this, nitrogen and phosphorus have been added seasonally to Kootenay Lake since 1992 as part of a large scale adaptive management experiment to restore pelagic productivity and rebuild kokanee salmon. Kokanee are the primary food source for piscivorous rainbow trout (Oncorhynchus mykiss) and bull trout (Salvelinus confluentus) and are considered keystone species of this ecosystem. A suite of physical, chemical and biological parameters were monitored to study the ecosystem response. The bottom up approach to restoring kokanee has resulted in increased primary production rates, shifts in phytoplankton species and increased Daphnia biomass. Kokanee biomass has responded with a three-fold increase, suggesting that the restoration strategy is successful.

Schladow, **S. G.**, UC Davis Tahoe Environmental Research Center, Davis, USA, gschladow@ucdavis.edu
Reuter, J. E., UC Davis Tahoe Environmental Research Center, Davis, USA, jereuter@ucdavis.edu
Malyj, G. J., UC Davis Tahoe Environmental Research Center, Davis, USA, gjmalyj@ucdavis.edu
McGrew (dec.), D., UC Davis Tahoe Environmental Research Center, Davis, USA, dmcgrew@malamutesaloon.org

UNDERWATER, NOBODY CAN HEAR YOU SCREAM – THE LEGACY OF 52 YEARS OF GRADUATE STUDENT EDUCATION AND COLLABORATIVE RESEARCH WITH CHARLES GOLDMAN

In 52 years at UC Davis, Charles Goldman has created an academic institution that has guided the research and education of well over 100 graduate students, countless undergraduates and dozens of postdocs. The research conducted by the graduate students has advanced the field of limnology, and since graduating many of them have gone on to be leaders in the field and have produced a new generation of limnologists. The long term monitoring programs he initiated at Lake Tahoe and Castle Lake almost half a century ago continue to this day, and provide valuable resource for present and future scholars. Finally he played the lead role in the creation of a new research and education center at Lake Tahoe, the Tahoe Center for Environmental Sciences. In this presentation we review and reflect upon the many facets of Charles Goldman's career, and present a unique view of his impact on the field of limnology.

Schlais, M., Bowling Green State University, Bowling Green, USA, mschlai@bgsu.edu
Mukherjee, M., Bowling Green State University, Bowling Green, USA, maitrem@bgsu.edu
McKay, R. M., Bowling Green State University, Bowling Green, USA, rmmckay@bgsu.edu
Bullerjahn, **G. S.**, Bowling Green State University, Bowling Green, USA, bullerj@bgsu.edu

DETECTION AND DIVERSITY OF BACTERIAL AND ARCHAEAL AMMONIA OXIDATION GENES (*AMOA*) IN LAKE SUPERIOR.

Nitrate concentrations in Lake Superior have increased 5-6 fold over the past century, and recent work has indicated that such increases have arisen due to biological in-lake processes, rather than anthropogenic runoff or atmospheric deposition. We have used PCR to detect the presence of nitrifying microbes responsible for ammonia oxidation, using PCR primers to amplify the *amoA* gene, encoding a subunit of the ammonia monooxygenase gene. To date, bacterial and archaeal *amoA* sequences have been obtained from pelagic stations, reflecting the presence of ammonia-oxidizing *Betaproteobacteria* and Group I Crenarcheota. Phylogenetic analysis suggests that the endemic ammonia oxidizers are of low diversity and may represent novel groups of microbes endemic to Lake Superior. Analysis of *amoA* and 16S gene sequences from enrichment cultures reveal archaeal nitrifyers in mixed culture with bacteria. The archaea detected reflect the natural diversity detected in our environmental DNA samples.

Schlickeisen, **E.**, Mississippi State University, Mississippi State, USA, ericaschlick@hotmail.com
Tietjen, T. E., Southern Nevada Water Authority, Las Vegas, USA, todd.tietjen@snwa.com
Dibble, E. D., Mississippi State University, Mississippi State, USA, edibble@cfr.msstate.edu

EVALUATION OF THE ENVIRONMENT'S ROLE IN DETERMINING AQUATIC COMMUNITY COMPOSITION: A STUDENT EXERCISE UTILIZING MICROBIAL FUNCTIONAL DIVERSITY

Undergraduate laboratory experiments that demonstrate the concepts of community dynamics and biodiversity can be challenging to implement, as measurement of species composition shifts in many aquatic communities can be limited by time and/or taxonomic constraints. Naturally occurring aquatic bacterial communities are easy to manipulate over a short time period, and can be used to explore changes in community composition without the need for complex enrichment media or molecular techniques. Bioassays have been used to demonstrate nutrient limitation and toxicological responses in aquatic communities. We have extended this approach to bacterial communities and demonstrate how environmental changes generate shifts in bacterial community composition by using commercially available Biolog EcoPlates. By evaluating the combinations of carbon sources utilized via colorimetric changes, non-taxonomic descriptions of the community can be generated. Qualitative (visual) or quantitative (spectrophotometric) data can be used to examine community changes depending on instructor resources and access to instrumentation. This approach can be adapted to undergraduate laboratory courses (e.g. Ecology, Microbial Ecology, General Biology), and encourages active and open-ended learning, as students can generate and test hypotheses of interest.

Schmidt, **S. J.**, University of Kansas, Lawrence, USA, schmidts@ku.edu
Thorp, J. H., University of Kansas, Lawrence, USA, thorp@ku.edu

INFLUENCE OF FLOW REFUGES ON ALGAL COMMUNITIES IN A DYNAMIC PRAIRIE RIVER

Discharge flashiness, shallow depths, and ephemeral sandbars characterize Great Plains rivers. Unstable substrates and discharge flashiness constantly alter hydrogeomorphic complexity. During high discharge periods in these rivers, only a single channel may be visible. However, during periods of moderate to low flow, braided and point bar areas occur (longitudinal habitats). These braided habitats have multiple lateral habitats, including the main channel, side channels, and backwaters. Changes in hydrogeomorphic complexity can impact several aspects of ecosystem function, including primary producer abundance. Algal samples were collected at seven sites in a 20 km stretch of the Kansas River from June through September. Physical parameters (temperature, pH, conductivity, turbidity, depth, flow, dissolved oxygen) were recorded. Algal diversity, abundance, and biomass were determined for each site and sample date. Algal community and abiotic data were analyzed using nonparametric multivariate statistics to test effects of hydrogeomorphic complexity on algal abundance and species richness. Our data support the hypothesis that side channels, which provide flow refuges while still receiving a constant supply of nutrients, should have the greatest algal abundance and species richness.

Schneid, **B. P.**, Auburn University, Auburn, USA, bps0002@auburn.edu
Feminella, J. W., Auburn University, Auburn, USA, feminjw@auburn.edu

VARIATION IN STREAM MACROINVERTEBRATE ASSEMBLAGES AND ENVIRONMENTAL PARAMETERS WITHIN SMALL COASTAL WATERSHEDS OF THE WOLF BAY BASIN, SW ALABAMA

We studied relationships between benthic macroinvertebrate assemblages and physicochemical and hydrologic parameters in eleven 1st- to 3rd-order coastal streams within the Wolf Bay Basin, a small sea-locked watershed in SW Alabama. Study streams drained subwatersheds varying in land use/cover from predominately forested to a high proportion of medium-intensity urban land. Study streams varied greatly in several physicochemical parameters (pH, conductivity, DOC, TSS, TIN, TP) and instream habitat (benthic particulate organic matter, amount of large woody debris, bankful depth) and likely are disturbed from historical agriculture and silviculture. Macroinvertebrate assemblage structure during summer baseflow revealed high among-stream variation in richness and density (15-35 taxa per stream, 318-2750 ind/m^2, respectively), relative proportions of two aquatic insect families, Chironomidae (12-91%) and Elmidae (3-60%), and several functional feeding groups, collector-filterers (0-31%), collector-gatherer (9-70%), scrapers (2-38%) and shredders (6-63%). Preliminary analysis of faunal dissimilarities (as Bray-Curtis distance) using NMDS suggested that differences among streams in benthic particulate organic matter, amount of large woody debris, streamwater dissolved oxygen, DOC, pH and TIN, and stream flashiness explain some of the observed variation.

Scholle, **S. D.**, University of New Mexico, Albuquerque, USA, sscholle@unm.edu
Turner, T. F., University of New Mexico, Albuquerque, USA, turnert@unm.edu
Bixby, R. J., University of New Mexico, Albuquerque, USA, bbixby@unm.edu

THE EFFECTS OF EDGES ON ALGAL BIOMASS IN THE MIDDLE RIO GRANDE

In river systems, there are many factors that impede or facilitate algal standing stock and therefore impact primary production in these environments. We are interested in the influence of edges, including bars and islands, in riverine systems and how these geomorphic features affect the available surface area for algal production. The middle Rio Grande is a turbid ecosystem and we hypothesize that edges become important zones of production, due in part to decreased depth, providing increased light availability. Further, edges provide regions of reduced flow velocity resulting in reduced substrate turnover and

increased nutrient retention facilitating algal attachment and growth. This study aims to elucidate the relationships among substrate type (i.e. sand, mud, cobble), water chemistry (particularly turbidity), depth, flow velocity and algal biomass. Algal biomass was determined by spectrophotometric analysis of chlorophyll *a* concentrations in benthic cores and rock scrubs taken from the middle Rio Grande near Albuquerque, New Mexico. This work will develop our understanding of key contributing abiotic factors that influence primary production in the middle Rio Grande and similar aridland ecosystems.

Schoo, **K**. **L**., Alfred-Wegener-Institute for Polar and Marine Research, Helgoland, Germany, Katherina.Schoo@awi.de

Aberle, N., Alfred-Wegener-Institute for Polar and Marine Research, Helgoland, Germany, Nicole.Aberle-Malzahn@awi.de

Malzahn, A. M., Alfred-Wegener-Institute for Polar and Marine Research, Helgoland, Germany, Arne.Malzahn@awi.de

Boersma, M., Alfred-Wegener-Institute for Polar and Marine Research, Helgoland, Germany, Maarten.Boersma@awi.de

TROPHIC INTERACTIONS IN THE MARINE FOOD WEB: THE MISSING NUTRIENT LINK

Trophic interactions are governed by the predator-prey relationships in the food web, linking primary producers at the base of the food web to consumers in higher trophic levels. In terms of nutrients, the requirements of predators and the supply by prey rarely match. Traditionally it was assumed that herbivorous consumers buffer the nutrient imbalances provided by their food, thereby providing constant quality to higher consumers. However, recent studies have shown that the homeostasis in consumers is less than perfect and quality effects can be traced through the food web. Hence, higher order consumers are not completely disconnected from the base of the food web, but are directly affected by both quality and quantity of the lowest trophic level. Laboratory-based nutrient-limitation experiments were conducted with three-trophic food chains using a variety of top-predators as model organisms: different species of fish larvae, jellyfish, ctenophores, copepods and lobster larvae. We compare the repercussions of varying food qualities at the base of the food web to the different 'top' predators in relation to the predators' requirements, stoichiometric mismatch and growth strategies.

Schultz , **S**., WasserCluster - Biological Station Lunz, Lunz am See, Austria, Sebastian.Schultz@wkl.ac.at

Koderbauer, B., WasserCluster - Biological Station Lunz, Lunz am See, Austria, a0301459@unet.univie.ac.at

Vallant, B., Umweltbundesamt, Vienna, Austria, birgit.vallant@umweltbundesamt.at

Kainz, M. J., WasserCluster - Biological Station Lunz, Lunz am See, Austria, martin.kainz@donau-uni.ac.at

DECREASING METHYL MERCURY BIOACCUMULATION IN COMMON CARP (*CYPRINUS CARPIO*) WITH INCREASING TROPHIC POSITION

There is a large number of evidence that methyl mercury (MeHg) bioaccumulates in organisms along the aquatic food chain. We conducted field experiments to test how MeHg bioaccumulation in common carp (*Cyprinus carpio*) of artificial systems (aquaculture ponds) changes with different food assemblages: pond zooplankton, crop-based feeds, and marine-based feeds. It was hypothesized that carp feeding on zooplankton bioaccumulate less MeHg than carp supplied with additional crop- and marine-based feeds that represent an artificial elongation of the food chain. Results showed that MeHg concentrations were higher in carp feeding mostly on zooplankton than in carp obtaining defined amounts of marine-based pellets. Adding an additional trophic level as diet supply for *C. carpio* resulted in decreasing MeHg concentrations, yet increasing concentrations of essential omega-3 polyunsaturated fatty acids, which are crucial for human nutrition. Our results indicate that carp selectively feed on diets that are vital for their physiological requirements and demonstrate how additional food sources can decrease MeHg concentrations of aquaculture fish.

Schulz, **K**. **L**., SUNY ESF, Syracuse, USA, kschulz@syr.edu

Gillette, J. P., SUNY ESF, Syracuse, USA, jpgillet@syr.edu

Teece, M. A., SUNY ESF, Syracuse, USA, mteece@esf.edu

EFFECTS OF PUFAS ON LIFE HISTORY TRAITS, GROWTH EFFICIENCY AND FATTY ACID COMPOSITION OF REPRESENTATIVE CLADOCERAN, COPEOPOD AND FISH CONSUMERS

Essential polyunsaturated fatty acids (PUFAs) are synthesized by primary producers; zooplankton and fish must obtain these biochemicals from their diet. Several PUFAs (e.g., EPA, DHA, and ARA) serve vital physiological roles, may regulate consumer growth, and are used to trace diet composition. Here we report results of two experiments; in a life-table experiment we fed *Daphnia pulicaria* diet sources varying only in EPA, and measured effects on life history parameters and growth efficiency. Under carefully controlled carbon content of the food sources, we found few effects of EPA on *D. pulicaria* growth, but strong effects on reproductive allocation patterns, suggesting an additional mechanism for observed population effects of PUFA in the field. In the second experiment, we fed two zooplankton species (*D. pulicaria, Diaptomus* sp.) and a fish (*Pimephales promelas*) diets that differed in PUFA (ARA, EPA, DHA) composition and examined effects on fatty acid composition of these consumers. Quantifying fatty acid turnover times, growth efficiency, and life history parameters under diets differing in PUFA helps inform consumer diet analysis and models of food quality effects on consumer population dynamics.

Schwalb, **A**. **N**., University of Waterloo, Waterloo, Canada, aschwalb@uwaterloo.ca

Ackerman, J. D., University of Guelph, Guelph, Canada, ackerman@uoguelph.ca

EARLY LIFE HISTORY TRAITS IN LAMPSILINI-MUSSELS IN RELATION TO THEIR HOST INFECTION STRATEGY

Lampsilini mussels (Bivalvia: Unionidae) have evolved a fascinating variety of strategies to attract and infest host fish with their glochidia (larvae). We compared early life history traits among four host infection strategies: (1) a generalist strategy of broadcasting glochidia; two intermediate strategies of luring hosts with (2) mimetic packages of glochidia (conglutinates), and (3) a mimetic mantle flap; (4) a specialized strategy of capturing a host. Fecundity tended to decrease with increased specialization in infection strategies and presumably higher infestation efficiency, and most of the variation could be explained by maternal body size. Survival periods reflected the time glochidia may take to encounter a host fish. The conglutinate species had the longest survival period, whereas host capture species had the shortest. Variation in settling velocity of glochidia and juveniles did not appear to be strongly related to host infection strategies. Overall, differences were most pronounced between the most specialized (host capture) species, and the generalist (broadcasting) species. Our results are consistent with the suggestion that the evolution within Lampsilini species proceeded to increasingly elaborate and specialized infection strategies.

Schwarting, **L**. **L**., University of Vermont, Burlington, USA, llschwar@uvm.edu

Levine, S. N., University of Vermont, Burlington, USA, slevine@uvm.edu

Lini, A., University of Vermont, Burlington, USA, alini@uvm.edu

Marsden, J. E., University of Vermont, Burlington, USA, ellen.marsden@uvm.edu

Manca, M., CNR Instituto per lo Studio degli Ecosistemi, Verbania Pallanza, Italy, m.manca@ise.cnr.it

Guilizzoni, P., CNR Instituto per lo Studio degli Ecosistemi, Verbania Pallanza, Italy, p.guilizzoni@ise.cnr.it

Lami, A., CNR Instituto per lo Studio degli Ecosistemi, Verbania Pallanza, Italy, a.lami@ise.cnr.it

USING PALEOLIMNOLOGICAL TECHNIQUES TO ASSESS HISTORIC FOOD WEB CHANGES IN LAKE CHAMPLAIN

Since the 1609 arrival of Europeans, Lake Champlain has been subjected to top-down food web disturbances associated with commercial fishing and the introduction of nonnative fish species. This explorative paleolimnological study uses zooplankton microfossils and algal paleopigments preserved in sediment to assess changes in the Lake Champlain's pelagic food web over the past four centuries, and relate them to commercial fishing records. Sediment cores collected from Missisquoi Bay and near Elm Point in the southern main lake have been dated and analyzed for algal pigments and geochemical indicators of lake trophic condition. The cores are currently being assessed for cladoceran community structure, including density, speciation and size distribution of morphological features, all of which are influenced by planktivorous predation pressure. Preliminary results from Missisquoi Bay show a major increase in overall cladoceran abundance over time. Recent sediment layers are dominated by small bosminid and chydorid species, while larger *Daphnia* remains, including ephippia (resting eggs) are relatively rare. These data are indicative of increasing planktivorous fish populations and thus, greater size-selective predation pressure on plankton.

Scott, **J**. **T**., University of Arkansas, Fayetteville, USA, jts004@uark.edu

THE IMPORTANCE OF CONSIDERING GASEOUS SOURCES OF NITROGEN IN WATERSHED MANAGEMENT DECISIONS

Anthropogenic nutrient enrichment often results in a decrease in the availability of N relative to P because human and animal wastes have a low N:P. However, some potential sources of anthropogenic nutrients, such as row crop agriculture, have very high N:P. This pattern has raised important questions about the need to manage P alone, or both N and P to decelerate eutrophication. Nitrogen fixation seldom occurs over extended periods in the presence of inorganic N, and it remains unclear if N fixation can consistently offset N deficiency when inorganic N is low. Furthermore, few studies have simultaneously explored ecosystem-scale nutrient inputs and outputs inclusive of gaseous nitrogen forms. Here I explore short-term and long-term nutrient concentrations and flux rates from several lakes to identify the relative importance of nitrogen fixation (source) and denitrification (sink) in contributing to ecosystem N availability. Preliminary results show that fixed nitrogen inputs from benthic and planktonic habitats can contribute substantial amounts of N to ecosystems, but removal by denitrification can counteract these inputs and maintain long-term N deficiency when external N:P is very low.

Scott, **R**. **W**., University of Waterloo, Waterloo, Canada, rwscott@scimail.uwaterloo.ca

Barton, D. R., University of Waterloo, Waterloo, Canada, drbarton@sciborg.uwaterloo.ca

Evans, M. S., National Water Research Institute, Saskatoon, Canada, Marlene.Evans@EC.GC.CA

BENTHIC INVERTEBRATE ASSEMBLAGES IN ARCTIC AND SUBARCTIC STREAMS: A BASELINE SURVEY OF MACKENZIE RIVER TRIBUTARIES ACROSS THE NORTHWEST TERRITORIES, CANADA

Benthic macroinvertebrate assemblages and environmental variables were sampled in 50 low to mid-order tributary streams spanning the latitudinal range of the Mackenzie River system, Northwest Territories, Canada, to establish baseline reference conditions for a potential biological monitoring program. Variation in community composition had a strong latitudinal component, and MDS analysis suggested a division of sites into three regions arranged from south to north. The more diverse benthic fauna in southern streams mainly varied with nutrient concentrations, which may be related to summer permafrost conditions. In northern areas with continuous permafrost, perennial streams harboured assemblages that were distinct from lake outlets and streams that freeze to the substrate during the winter. Streams in the far north drain relatively flat terrain containing thousands of thermokarst lakes, shallow active soil layers and limited terrestrial vegetation, and the fauna of these mostly soft-bottomed streams was dominated by sessile invertebrates and Chironominae; greater diversity was present in streams with coarser substrates. We conclude that reference conditions should be established on a regional basis and for stream types based on substrate, winter conditions and permafrost.

Scott, **S**. **E**., Miami University, Oxford, USA, scottse3@muohio.edu

Mercado, G., Fayettville State University, Fayetteville, USA, gmercado@unc.fsu.edu

Zhang, J., Miami University, Oxford, USA, Zhangj8@muohio.edu

Vanni, M. J., Miami University, Oxford, USA, vannimj@muohio.edu

ECOSYSTEM METABOLISM: RESPONSE TO STORM EVENTS

We used in situ high-frequency data to characterize the metabolic response of Acton Lake, a hypereutrophic reservoir in southwestern Ohio, to a summer storm event that flushed more than 50% of the lake's volume over a 3-day period. Metabolic parameters were highly variable for the entire season. Seasonal means of ecosystem respiration (R), gross primary production (GPP) and net ecosystem production (NEP) were 121.3 mmol O2 m-2 day-1, 416.0 mmol O2 m-2 day-1 and 40.21 mmol O2 m-2 day-1 respectively. Surface waters were always supersaturated with dissolved oxygen (DO) prior to the storm (minimum DO=132%). Following the storm, DO decreased to 76%, the lowest values recorded all season, and the daily amplitude of DO increased greatly. Two days after the storm, both GPP and R increased markedly (67 and 82% higher than pre-storm, respectively); thus, NEP decreased by only 25%. However, within 4 days after this, metabolic parameters returned to pre-storm values. Thus, lake metabolism was relatively resilient. Our analyses also suggest that dynamic linear models using high-frequency DO data may be a useful tool in characterizing the rapid response of lake metabolism to storm events.

Scrimgeour, **G**. **J**., Parks Canada, Calgary, Canada, garry.scrimgeour@pc.gc.ca

Thomas, K. E., University of Waterloo, Waterloo, Canada,

Hall, R. I., University of Waterloo, Waterloo, Canada,

Dube, M. G., Saskatchewan Research Council & University of Saskatchewan, Saskatoon, Canada,

Haggarty, G., University of British Columbia, Vancouver, Canada,

Tate, D. P., Nahanni National Park Reserve, Parks Canada, Fort Simpson, Canada,

EVALUATING THE IMPACTS OF MINING ON THE ECOLOGICAL INTEGRITY OF STREAMS IN THE SOUTH NAHANNI WATERSHED: A REFERENCE CONDITION APPROACH

Maintaining healthy ecosystems amidst increasing levels of industrial development is a central challenge to the management of Canada's north. Expansion of mining activities in northern latitudes has raised concerns about the cumulative environmental effects of increased loadings of pollutants, including metals and nutrients, to receiving waters and their subsequent effects on biological communities. The South Nahanni Watershed, located in the Northwest Territories of Canada, includes an operational tungsten mine, and an advanced lead-zinc exploration mine that may become operational in the future. Both operations discharge to tributaries of the South Nahanni River that eventually flow through Nahanni National Park Reserve. We collected water, benthic macroinvertebrates and select habitat variables from 118 sites throughout the South Nahanni Watershed in 2008 and 2009. Using a Reference Condition Approach, we present a preliminary environmental assessment of the effects of each mining operation on stream integrity and link possible impacts to concentrations of select contaminants within the stream food-web.

Seidel, R. A., Miami University, Oxford, USA, bergdj@muohio.edu

Lang, B. K., New Mexico Department of Game & Fish, Santa Fe, USA, brian.lang@state.nm.us

Berg, **D**. **J**., Miami University, Hamilton, USA, bergdj@muohio.edu

DETECTING CONSERVATION UNITS USING MORPHOLOGICAL VERSUS MOLECULAR CRITERIA: EVALUATING THE *GAMMARUS PECOS* SPECIES COMPLEX AS A TEST CASE

Recent studies have revealed the high frequency of morphologically cryptic aquatic invertebrates. The sharp global decline in freshwater ecosystems suggests that rapid biodiversity screening methods are urgently needed. Amphipods in the *Gammarus pecos* species complex of the northern Chihuahuan Desert represent an ideal system for comparing the detected number of discrete ecological entities according to morphological and molecular methodologies. We compared results from a morphology-based assessment to our results from screening 166 COI gene sequences according to Moritz' Evolutionarily Significant Unit (ESU) concept and a DNA barcode-based Species Screening Threshold (SST) concept. Our results showed strong concordance between the two molecular screening methods, with the main difference being the phylogenetic placement of one amphipod population. The molecular methods showed that two other populations are distinct from one another, whereas the morphological method alone failed to separate them. Our results underscore the need to look beyond morphology in screening for conservation units among aquatic invertebrates in desert ecosystems and elsewhere. Morphological and molecular techniques together can be powerful tools for addressing conservation issues dependent on the accuracy of biodiversity assessment.

Seitzinger, **S**. **P**., IGBP, Stockholm, Sweden, sybil.seitzinger@igbp.kva.se

Mayorga, E., Univ Washington, Seattle, USA,

Bouwman, A. F., Netherlands Environmental Assessment Agency, Bilthoven, Netherlands,

Kroeze, C., Wageningen University, Wageningen, Netherlands,

Beusen, A. H., Netherlands Environmental Assessment Agency, Bilthoven, Netherlands,

Billen, G., CNRS/Univ Pierre et Marie Curie, Paris, France,

VanDrecht, G., Netherlands Environmental Assessment Agency, Bilthoven, Netherlands,

Dumont, E., Center for Ecology and Hydrology, Oxfordshire, United Kingdom,

Fekete, B., CUNY, New York, USA,

Garnier, J., CNRS/Univ Pierre et Marie Curie, Paris, France,

Harrison, J. A., Washington State University, Vancouver, USA, john_harrison@wsu.edu

GLOBAL RIVER NUTRIENT EXPORT: A SCENARIO ANALYSIS OF PAST AND FUTURE TRENDS

Past trends (1970-2000) and four future scenarios of N, P, C and Si sources and controlling factors in watersheds globally were analyzed using the NEWS model. Nutrient management in agriculture was a key factor effecting the magnitude and direction of change of future DIN river export. In contrast connectivity and level of sewage treatment and P detergent use were more important for differences in DIP river export. Global particulate nutrient export was calculated to decrease for all scenarios, in part due to increases in dams for hydropower. Small changes in dissolved silica and dissolved organics were calculated for all scenarios at the global scale. From a regional perspective, South Asia accounted for over half of the global increase in DIN and DIP river export between 1970-2000 and in the subsequent 30 years under the Global Orchestration scenario; DIN river export decreased in the Adapting Mosaic scenario by 2030, although DIP continued to increase. River nutrient ratios (N:P:Si) varied regionally as a function of anthropogenic forcings with potential consequences for receiving estuaries.

Selman, **C**., Missouri S&T, Rolla, USA, csn56@mst.edu
Niyogi, D. K., Missouri S&T, Rolla, USA, niyogid@mst.edu
Fitch, M. W., Missouri S&T, Rolla, USA, mfitch@mst.edu

DOMINANT PROCESSES THAT AFFECT THE NUTRIENT RETENTION IN SMALL MISSOURI-OZARKS STREAMS

Nutrients, mostly produced from human activities, are carried through streams to open-water systems that are sensitive to nutrient pollution. As nutrients are transported in streams, they may be taken up by stream microorganisms, adsorbed, or transformed into other compounds. The object of this research is to quantify the major mechanisms that affect nutrient retention and uptake in several small streams in the Missouri Ozarks. Experimental systems were used to measure the effects of single parameters, such as discharge, nutrient concentration, light intensity, and type of algae, on uptake rates of phosphorus. Water velocity did not have a significant effect on P retention up within the range of 0.001-0.15 m/s. Uptake rates under varying phosphorus concentrations followed Michaelis-Menten kinetics, but with a very high half-saturation concentration (> 0.5 mg/L). Surprisingly, light did not have a significant effect on uptake rates during short-term incubations. Field studies (whole-stream and mesocosm experiments) for other parameters were also conducted. After determination of dominant processes, an engineering solution that will enhance nutrient removal in lotic systems will be developed.

Sepulveda, **A**. **J**., University of Montana, Misosula, USA, adam.sepulveda@mso.umt.edu
Lowe, W. H., University of Montana, Missoula, USA, winsor.lowe@umontana.ed

COEXISTENCE IN STREAMS: DO SOURCE-SINK DYNAMICS ALLOW SALAMANDERS TO PERSIST WITH FISH PREDATORS?

Theory suggests that source-sink dynamics can allow coexistence of intraguild predators and prey, but empirical evidence for this coexistence mechanism is limited. We used capture-mark-recapture and genetic methods to test whether source-sink dynamics promote coexistence between stream fishes, the intraguild predator, and stream salamanders (Dicamptodon aterrimus), the intraguild prey. Salamander populations from upstream reaches without fish were predicted to maintain or supplement sink populations in downstream reaches with fish. We found instead that downstream reaches with fish were not sinks – apparent survival, recruitment, and population growth rate did not differ between upstream and downstream reaches. There was also no difference in net emigration between upstream and downstream reaches. We did find that D. aterrimus move frequently along streams, but believe that this is a response to habitat changes rather than intraguild predation. Our study provides strong, empirical evidence that local-scale mechanisms are more important than dispersal dynamics to coexistence of streams salamanders and fish.

Sereda, **J**. **M**., University of Saskatchewan, Saskatoon, Canada, jeff.sereda@usask.ca
Vandergucht, D. M., University of Saskatchewan, Saskatoon, Canada, david.vandergucht@usask.ca
Hudson, J. J., University of Saskatchewan, Saskatoon, Canada, jeff.hudson@usask.ca

ULTRAVIOLET RADIATION MODULATES PHOSPHATE PARTITIONING BETWEEN PLANKTON SIZE FRACTIONS

Bacteria are in direct competition with phytoplankton for limiting nutrients (i.e., phosphate). Because bacteria are superior competitors for phosphate, the paradox arises of how these two groups of planktonic organisms coexist on a single limiting nutrient. An unexplored hypothesis is that ambient ultraviolet radiation (UVR) may suppress the uptake of phosphate by bacteria offering algae a competitive advantage. Therefore, we examined the effect of UVR on the partitioning of phosphate between plankton <2.0 and >2.0µm under ambient UVR. We sampled 14 freshwater lakes located in Saskatchewan, Canada. We measured the attenuation of UVB, UVA and mixing depth of each lake to determine ambient UVR environment in each system. Radiophosphate uptake assays were conducted to determine the partitioning of phosphate between plankton size fractions. Our results demonstrate that ambient UVR suppresses the uptake of phosphate by plankton <2.0µm allowing plankton >2.0µm to acquire proportionally more phosphate. Exposure of plankton assemblages to artificial UVR for 4h suppressed the uptake of phosphate by plankton <2.0µm from lakes with low UVR penetration. Plankton assemblages from lakes with high UVR penetration did not respond to further UVR exposure. This lack of response suggests that water column bacteria may have acclimated to UVR at the physiological or community level.

Seuront, **L**., Flinders University, Adelaide, Australia, laurent.seuront@flinders.edu.au

BIOLOGICALLY-INCREASED SEAWATER VISCOSITY: A MICRO-SCALE PROPERTY WITH BROADER SCALE IMPLICATIONS

Seawater viscosity is typically considered as a function of temperature and salinity. However, there are a dozen of papers demonstrating that a range of phytoplankton species can significantly alter seawater viscosity through the release of extracellular polymers, which consequently change the bulk-phase seawater rheological properties. The link identified between seawater viscosity and phytoplankton composition and standing stock have recently been extended to heterotrophic bacteria. This microbially-increased viscosity might quantitatively be at least as important as the one related to phytoplankton secretion. In this context, the objectives of this presentation are (i) to illustrate the extent of biologically-increased seawater viscosity in environments ranging from the North Sea to the Southern Ocean when compared to the physically-controlled component of seawater viscosity, and (ii) to discuss both experimentally and theoretically the impact of the observed increases on biologically and ecologically relevant patterns and processes such as turbulence and turbulence intermittency, sound propagation, nutrient uptake, viral infection, predator-prey and male-female encounter rates, zooplankton feeding and swimming behaviours and zooplankton sensorial abilities.

Seybold, **E**. **C**., St. Olaf College, Northfield, USA, seybold@stolaf.edu
Drake, T., Carleton College, Northfield, USA, draket@carleton.edu
Schade, J. D., St. Olaf College, Northfield, USA, schade@stolaf.edu
Schmidt, S., St. Olaf College, Northfield, USA, schmidts@stolaf.edu
Kantor, B. J., St. Olaf College, Northfield, USA, kantorb@stolaf.edu
Bulygina, K., Woods Hole Research Center, Falmouth, USA, kbulygina@nova.whrc.org
Davydov, S., Northeast Science Station, Cherskiy, Russian Federation, davydoffs@mail.ru
Frey, K., Clark University, Worcester, USA, kfrey@clarku.edu
Holmes, R. M., Woods Hole Research Center, Falmouth, USA, rmholmes@whrc.org
Sobczak, W., College of the Holy Cross, Worcester, USA, wsobczak@holycross.edu

GEOGRAPHIC VARIATION OF NUTRIENT SPIRALING IN STREAMS IN MINNESOTA, NORTHERN CALIFORNIA, AND EASTERN SIBERIA

Clear evidence exists that streams actively regulate fluxes of carbon, nitrogen, and phosphorus from upland terrestrial ecosystems to downstream aquatic environments. Knowledge of functional characteristics of streams across a range of environments is paramount to our ability to predict changes in these ecosystems as climate changes. We used nutrient spiraling metrics to infer nutrient limitation in small streams in Minnesota, California, and the Siberian Arctic. We quantified these metrics using solute addition experiments in which nitrogen and phosphorus were added simultaneously with chloride as a conservative tracer. We found significant geographical variation in nutrient uptake by streams, suggesting variation in nutrient limitation. Siberian streams exhibited high spatial variation in uptake with some streams exhibiting N limitation and others P limitation depending on their landscape position. California streams varied in degree of autotrophy and had low background

nutrient concentrations, but were strongly nitrogen limited. Minnesota streams had high background nitrate concentrations from agricultural runoff, but high rates of ammonium uptake indicating nitrogen limitation. These results suggest that streams in different landscapes will respond differently to changes in nutrient and organic matter inputs.

Shaftel, **R**., Baylor University, Waco, USA, rebecca_shaftel@baylor.edu
King, R., Baylor University, Waco, USA, ryan_s_king@baylor.edu
Back, J., Baylor University, Waco, USA, jeff_back@baylor.edu

LINKAGES BETWEEN ALDER ABUNDANCE AND NITROGEN DYNAMICS IN HEADWATER STREAMS OF THE KENAI PENINSULA, ALASKA

Nitrogen (N) is a common limiting nutrient in streams, although it can be mitigated by inputs from spawning salmon. Watershed N, particularly from N-fixing alder, may be important for production in headwater streams, which typically lack N inputs from adult salmon. To examine the relationship between alder and stream N, 25 headwater streams were sampled for nutrients in summer 2009. Alder cover was mapped in GIS using color satellite imagery. In addition, a two-month leaf decomposition experiment was conducted using control and N-enriched leafpacks in three high gradient and three low gradient streams. Mass loss; carbon, nitrogen, and phosphorus concentrations; and macroinvertebrate composition were measured on all leaf packs. Alder cover was highly correlated to stream N (R^2=0.97). Leaf decay progressed faster and leafpack carbon-to-nitrogen was lower in the high gradient streams, but both processes were only weakly influenced by leafpack N enrichment. Macroinvertebrate composition was more strongly driven by individual streams than leaf decay or quality. Alder is an important landscape predictor of stream nitrogen and high gradient headwater streams supported more rapid leaf decomposition than low gradient streams.

Sharma, **S**., University of Wisconsin-Madison, Madison, USA, sapna.sharma23@gmail.com
Vander Zanden, M. J., University of Wisconsin-Madison, Madison, USA, mjvanderzand@wisc.edu
Magnuson, J. J., University of Wisconsin-Madison, Madison, USA, jjmagnus@wisc.edu
Lyons, J., Wisconsin Department of Natural Resources, Madison, USA, john.lyons@wisconsin.gov

PREDICTING EFFECTS OF CLIMATE CHANGE AND INVASION OF RAINBOW SMELT ON CISCO EXTINCTIONS

Multiple anthropogenic stressors are acting simultaneously on aquatic ecosystems. Cisco, Corgeonus artedi, and other coldwater fishes are potential sentinels of multiple stressors, including climate change, eutrophication, and invasion of exotic species. Our objective was to predict effects of multiple stressors on cisco extinctions at the southern edge of its range. To this end, we assembled a database of over 13,000 lakes in Wisconsin, USA summarising fish occurrence, lake morphology, water chemistry, and climate. In addition, we obtained future predictions of climatic conditions for 15 climate change models and their corresponding scenarios. Logistic regression analyses indicated that cisco tended to be found in cooler, larger, and deeper lakes. Depending upon the degree of climate warming, 25 – 70% of cisco populations could be extinct by 2100. Currently 24 lakes in Wisconsin with invasive rainbow smelt, and their distribution is predicted to increase 20-fold by 2250. As such, extinction of cisco populations will be further exacerbated by the invasion of rainbow smelt, which prey on young cisco. Our results indicate that cisco extinctions from climate change far exceed extinctions driven by biotic invasions.

Sharp, **A**. **R**., University of New Mexico, Albuquerque, USA, asharp@unm.edu
Osborne, M. J., University of New Mexico, Albuquerque, USA, mosborne@unm.edu
Turner, T. F., University of New Mexico, Albuquerque, USA, turnert@unm.edu

CONSERVATION GENETICS OF REMNANT POPULATIONS OF THE CHIHUAHUA CHUB GILA NIGRESCENS (TELEOSTEI: CYPRINIDAE) IN NEW MEXICO

The Chihuahua chub is historically restricted to the Mimbres River in southwestern New Mexico and the Laguna Bustillos and Guzmán basins in Chihuahua, Mexico. The species is listed as threatened in the US under the Endangered Species Act and has suffered from habitat degradation, predation by non-native fishes, and presumed loss of genetic diversity due to demographic bottlenecks. Recently, a new population was discovered in the Mimbres River, New Mexico. We compared genetic variability of this population to more established populations in the Mimbres River drainage Rio Guzmán in Mexico, and conservation broodstock at Dexter National Fish Hatchery using 10 microsatellites and 2 mtDNA loci. All New Mexico specimens were monomorphic at both mtDNA loci and exhibited limited allelic variation at all microsatellite loci compared to other cyprinid fishes of the southwestern US, including other chub species. Low genetic diversity of broodstock at Dexter reflects limited diversity in the wild populations. It is likely that genetic diversity will continue to erode in New Mexico populations due to small local population sizes and persistent threats to demographic stability.

Shelley, **B**. **C**., Saint Joseph's College of Maine, Standish, USA, bshelley@sjcme.edu

INFLUENCE OF KNICKPOINTS ON LONGITUDINAL DISTRIBUTION OF BRYOPHYTES AND MACROINVERTEBRATES IN HIGH-GRADIENT STREAMS IN THE WHITE MOUNTAINS, U.S.A.

Low-order streams, especially those draining mountainous landscapes, may be important areas for biodiversity, and can experience significant changes in hydraulic conditions over short distances, often the result of knickpoints. Such changes may alter community structure and diversity. The objective of this study was to evaluate longitudinal changes of bryophytes and macroinvertebrates in high-gradient streams punctuated by knickpoints. Sites in four streams were sampled in July/August, 2009. In two streams, 3 sites were sampled along the longitudinal profile; sites were separated by at least 2 waterfalls greater than 2.5 m in height. Various watershed-level and reach-level parameters were determined. Percent cover and standing crop of bryophytes and epilithon were measured, and macroinvertebrates were sampled. Some parameters varied in a predictable fashion moving downstream, while others did not. Richness and density of macroinvertebrates varied among sites, and there were significant differences when community structure was compared between sites (Gower's coefficient of similarity), regardless of sites compared. Knickpoints in high-gradient streams may alter dispersal patterns, and thus community assembly, along the longitudinal profile. This may have implications when considering patterns of diversity in mountain streams.

Sherk, **T**. **E**., University of Washington, Branford, USA, tsherk@gmail.com

EMERGENCE OF TRICHOPTERA FROM THE EDGE TO THE CENTER OF SUBALPINE FINDLEY LAKE AFTER EARLY THAWS, BUT ONLY FROM THE EDGE AFTER A LATE JULY THAW

Trichoptera were collected in floating emergence traps on oligotrophic Findley Lake in the coniferous forest of the Cascade Mountains. They had their maximum emergence from the sites that thawed before the rest of the lake, the sites that had the most organic detritus from the forest and the solid bottom. The peak biomass emerged from deeper water after an early thaw when there was more sedimentation of food in the deep part of the lake. In 1973 after an early thaw on June 7, *Halesochila taylori* had its maximum emergence from the 1.8 to 11.7 m deep sites, but in 1974 after a late thaw on July 31, it had its maximum emergence only from 0.5 to 4.5 m. The biomass of *H. taylori* that emerged in 1973 was 7.2 times as much as during 1974. Most *Clistoronia magnifica* emerged from 0.5 to 11.7 m in 1973, but only from 0 to 1.8 m in 1974. *Hesperophylax designatus* emerged from the sandy shore each year and from the 11.7 m deep sand of the mid-lake ridge in warm years.

Sherman, **B**. **S**., CSIRO Land and Water, Canberra, Australia, brad.sherman@csiro.au
Ford, P., CSIRO Land and Water, Canberra, Australia, Phillip.Ford@csiro.au

METHANE AND CARBON DIOXIDE GAS EMISSIONS FROM A SMALL RESERVOIR IN A STEEP, SUB-TROPICAL RAINFOREST CATCHMENT

Floating chamber measurements of the seasonal, spatial and diurnal variability of methane (CH4) and carbon dioxide (CO2) emissions from Little Nerang Dam (volume = 9280 ML, area 49 ha, catchment area 35 km2) were made using a Picarro 1301 gas analyser. Depth profiles of pCO2 and pCH4 were made using a Liquicel membrane contactor connected to the Picarro 1301. Average methane emissions from a range of sites across the storage varied from 10 to 1800 mg CH4 m-2 d-1. During daylight, the upstream shallow reaches of the storage were net heterotrophic and emitted CO2 to the atmosphere at all times whereas pelagic sampling sites were autotrophic and exhibited CO2 drawdown during daylight hours. Periodic ebullition of CH4 was observed at a medium depth site located in 14 m of water whereas the shallow upstream reaches presented a near-continuous stream of bubbles erupting from the surface. Bubble composition

ranged from 65-95% CH4. These results raise interesting questions regarding the duration and frequency of sampling required to capture an accurate picture of emissions from a given site.

Sherson, **L. S.**, University of New Mexico, Albuquerque, USA, lsherson@unm.edu
Crossey, L. J., University of New Mexico, Albuquerque, USA, lcrossey@unm.edu
Dahm, C. N., University of New Mexico, Albuquerque, USA, Cliff.Dahm@Calwater.ca.gov
Van Horn, D. J., University of New Mexico, Albuquerque, USA, vanhorn@unm.edu
Parmenter, R. R., Valles Caldera National Preserve, Jemez Springs, USA, bparmenter@vallescaldera.gov

USE OF CONTINUOUS REAL-TIME WATER QUALITY SENSORS TO EXAMINE HYPORHEIC SOLUTE FLUXES BETWEEN GROUNDWATER AND AN ALPINE STREAM: EAST FORK JEMEZ RIVER, NM.

The hyporheic zone is a place of rapid water and solute exchange in which critical biogeochemical processes involving both groundwater and surface water take place. Water quality and solute fluxes are dynamic across a variety of time scales and respond to changes in temperature and precipitation. Our objective is to utilize continuous water quality sensors to investigate how nutrient cycling, retention, and transport vary across the annual hydrograph in the East Fork Jemez River, a fourth order stream in northern New Mexico. We hypothesize that tracer tests and the use of autonomous sensors will show nutrient retention to be higher during periods of low flow. Preliminary results exhibit substantial spatial and temporal variability in surface water dissolved oxygen concentrations between seasons, with typical daily values ranging from 4-12 mg/L during spring snowmelt into summer and 10-12 mg/L during late fall baseflow conditions. This dataset will be enhanced by comparing biogeochemical data from well transects positioned in gaining reaches to those in losing reaches during key periods throughout the annual hydrograph.

Shih, J. S., Resources for the Future, Washington, DC, USA, shih@rff.org
Alexander, R. B., US Geological Survey, Reston, VA, USA, ralex@usgs.gov
Smith, **R. A.**, US Geological Survey, Reston, VA, USA, rsmith1@usgs.gov
Boyer, E. W., Pennsylvania State University, State College, PA, USA, ewb100@psu.edu
Schwarz, G. E., US Geological Survey, Reston, VA, USA, gschwarz@usgs.gov
Chung, S., Resources for the Future, Washington, DC, USA, chung@rff.org

MODELING LAND USE AND IN-STREAM CONTROLS ON TOTAL ORGANIC CARBON IN STREAMS OF THE CONTERMINOUS UNITED STATES

Using long-term stream monitoring data and the USGS SPARROW model, we estimated rates of source-specific supply, transport, and coastal delivery of mean annual total organic carbon (TOC) in the watersheds of the conterminous United States. The model empirically quantified stream TOC associated with six terrestrial sources (see below) as well as in-stream photosynthetic production of organic carbon. In-stream photosynthesis was the largest source on average, contributing slightly more than 50 percent of stream flux. Average percent contributions from terrestrial sources were: wetlands (16%); agricultural land (12%); evergreen forest (8%); deciduous forest (5%); mixed forest (5%); and urban land (3%). A large, but variable, fraction of stream TOC was lost from the water column before reaching the coastal margin, however, and the relative importance of sources in the transport of TOC to estuaries varied accordingly. In-stream photosynthesis was the largest source of TOC flux (>60%) in the coastal waters of two regions (the Pacific Northwest and California), whereas terrestrial sources were dominant (>55%) in all other regions (North Atlantic, South Atlantic-Gulf, Mississippi-Atchafalaya-Red Valley, Texas-Gulf, and Great Lakes).

Shirley, **S. M.**, Oregon State University, Corvallis, USA, susan.shirley@oregonstate.edu
Dunham, J., USGS FRESC Corvallis Research Group, Corvallis, USA, jdunham@usgs.gov
Hibbs, D. E., Oregon State University, Corvallis, USA, david.hibbs@oregonstate.edu
Hockman-Wert, D., USGS FRESC Corvallis Research Group, Corvallis, USA, dhockman-wert@usgs.gov
Luh, H., Oregon STate University, Corvallis, USA, hans.luh@oregonstate.edu

LINKING THE EFFECTS OF RIPARIAN FOREST SPECIES AND HYDROLOGY ON STREAM INVERTEBRATES OVER SEASONAL AND SUCCESSIONAL TIMESCALES

Primary productivity influences abundances of aquatic macroinvertebrates that in turn provide prey for aquatic and terrestrial vertebrate predators. Identifying the relationships between riparian canopy cover and hydrology on stream invertebrate availability represents a significant challenge and highlights a fundamental gap in our understanding of how shifts in tree species affect invertebrate standing stocks and export. Our overall goal is to make inferences about the role of foundation species such as Douglas-fir and red alder in influencing stream invertebrate availability in landscapes undergoing succession in the western Oregon Coast Range. We used a Bayesian Belief Network (BBN) model to examine the effects and interactions of several factors that influence the biomass and export of macroinvertebrates: canopy type, canopy age, season, and discharge. Alterations due to shifts in tree species in ecosystem functions such as litter inputs, autochthonous production and streamflow were significant; however, successional effects were much larger in magnitude and varied considerably among seasons. Our results reveal intriguing relationships among drivers of changes in stream invertebrates that will improve our understanding of foodweb processes at local and watershed scales.

Shivers, **S. D.**, Joseph W. Jones Ecological Research Center, Newton, USA, sshivers@jonesctr.org
Opsahl, S. P., Joseph W. Jones Ecological Research Center, Newton, USA, sopsahl@jonesctr.org
Covich, A. P., University of Georgia, Athens, USA, alanc@uga.edu

THE IMPACT OF SUBMERGED AQUATIC VEGETATION ON DISSOLVED ORGANIC CARBON PRODUCTION AND BACTERIAL METABOLISM

Submerged aquatic vegetation (SAV) influences biogeochemical cycles in freshwater aquatic systems by fundamentally changing the surrounding physical and chemical environment. We performed diurnal studies within dense beds of Hydrilla verticillata in order to characterize temporal changes in water chemistry. These studies focused on the production of dissolved organic carbon (DOC) and its subsequent utilization by natural microbial communities. Preliminary analysis shows large fluxes of DOC with the greatest differences occurring at the surface and near the sediment during periods of high primary productivity. Oxygen consumption by bacterial communities was measured using BOD bottles to compare rates of DOC metabolism and also to assess nutrient limitation (NH4+, PO4-, NO3-, and organic carbon). Preliminary results indicate organic carbon limitation at all depths and PO4- co-limitation at lower depths. Additionally, leachate was collected from a variety of plant types within Lake Seminole to compare DOC bioavailability among the different local sources and to relate differences in bioavailability to biochemical composition. SAV fundamentally altered biogeochemical processing within the reservoir and may have downstream impacts for the Apalachicola River or the Gulf of Mexico.

Shoda, **M. E.**, University of Dayton, Dayton, USA, megan.shoda@gmail.com
Benbow, M. E., University of Dayton, Dayton, USA, benbowme@notes.udayton.edu
Hudson, J. P., , Juneau, USA, jhudson@gci.net
Campbell, E. Y., Michigan State University, East Lansing, USA, campb613@msu.edu
Tiegs, S. D., University of Notre Dame, Notre Dame, USA, tiegs@oakland.edu
Lamberti, G. A., University of Notre Dame, Notre Dame, USA, glambert@nd.edu
Merritt, R. W., Michigan State University, East Lansing, USA, merrittr@msu.edu

DOES AQUATIC INSECT PHENOLOGY EXPLAIN BENTHIC COMMUNITY RESPONSE TO SALMON SPAWNING DISTURBANCE?

This study evaluated the effects of salmon disturbance on benthic macroinvertebrate communities in Southeast Alaska. Previous studies report negative effects of salmon on macroinvertebrates, often based on density changes associated with spawning activities. However, an alternative hypothesis is that phenological emergence explains some macroinvertebrate response to this disturbance. Using monthly benthic collections, salmon exclosures and a reach with salmon carcass retention structures, we tested this hypothesis by evaluating dominant insect taxa phenology over six dates before, during and after a salmon run. Non-Metric Multidimensional Scaling, Mulit-Response Permutation Procedures and Indicator Species Analysis revealed significant differences in macroinvertebrate community structure and identified specific taxa associated with benthic community response to the salmon run: *Baetis*, Chironomidae and Turbellaria (Planariidae) before the run, *Cinygmula* during, and Oligochaete and *Sweltsa* after salmon arrival. It was clear that salmon had a significant effect on community structure, but size frequency data revealed that the loss of certain taxa may not only be due to physical salmon disturbance, but from emergence of some insect taxa immediately prior to or during the initial days of a salmon run.

Short, **T**. **M**., U.S. Geological Survey, Menlo Park, CA, USA, tmshort@usgs.gov

FUNCTIONAL BIODIVERSITY OF MACROINVERTEBRATE ASSEMBLAGES IN AGRICULTURAL STREAMS - RESPONSE TO NUTRIENT ENRICHMENT

Quantifying effects of nutrient enrichment on benthic fauna can be problematic because of complex interrelations among nutrient concentrations, primary production, and consumer-level responses. Compositional characteristics of invertebrate assemblages may be less responsive than functional characteristics to the more process-based effects of nutrient enrichment. To examine these relationships, functional properties of macroinvertebrate assemblages were examined in 115 nutrient enriched streams distributed among 4 geographically segregated drainage basins in agricultural regions of the U.S. Macroinvertebrate functional response was characterized as change in functional biodiversity (determined as trophic group dissimilarity) along gradients of benthic algal biomass (as chlorophyll a). Despite differences in algal biomass among drainage basin streams, maximum change in functional diversity occurred at similar concentration ranges of benthic chlorophyll. Contributions of individual feeding groups to turnover of functional assemblages varied among drainage basin streams, and were moderated by determinants of chlorophyll production, including incident light, flow, habitat, and stream temperature. Results suggest that more trait-based measures of macroinvertebrate assemblages, such as functional biodiversity, are less limited by biogeographic constraints and more directly respond to process-based effects of nutrient enrichment.

Sierszen, **M**. **E**., U.S. EPA Mid-Continent Ecology Division, Duluth, MN, USA, sierszen.michael@epa.gov
Stockwell, J. D., Gulf of Maine Research Institute, Portland, ME, USA, jstockwell@gmri.org
Hrabik, T. R., University of Minnesota-Duluth, Duluth, MN, USA, thrabik@d.umn.edu
Gamble, A. E., University of Minnesota-Duluth, Duluth, MN, USA, gamb031@umn.edu
Yule, D. L., USGS Lake Superior Biological Station, Ashland, WI, USA, dyule@usgs.gov
Kelly, J. R., U.S. EPA Mid-Continent Ecology Division, Duluth, MN, USA, kelly.johnr@epa.gov

DEPTH-SPECIFIC ANALYSES OF THE LAKE SUPERIOR FOOD WEB

Characteristics of large, deep aquatic systems include depth gradients in community composition, the quality and distribution of food resources, and the strategies that organisms use to obtain their nutrition. We sampled food web components throughout Lake Superior and used a combination of stable isotope and diet analyses to reveal nutritional pathways among benthic and planktonic invertebrates and nearshore and deepwater fishes. Isotope analyses discriminated benthic and pelagic energy sources, and diet analyses helped to discern feeding niches of isotopically similar fishes. We identify differences among habitats in the food web relationships between benthic and pelagic communities, and we examine the role of vertical migration as a strategy for deepwater consumers to access pelagic resources from resource-poor profundal zones.

Simmons, **T**., Central Alaska Network, National Park Service, Fairbanks, Alaska, USA, trey_simmons@nps.gov
Burkart, G., Arctic Network, National Park Service, Fairbanks, Alaska, USA, greta.burkart@gmail.com
Schmidt, J., Central Alaska Network, National Park Service, Fairbanks, Alaska, USA, joshua_schmidt@nps.gov

THE CENTRAL ALASKA NETWORK STREAM MONITORING PROGRAM: INTEGRATING TARGETED AND PROBABILISTIC SURVEY DESIGNS IN A REMOTE LANDSCAPE

The Central Alaska Network (CAKN), part of the National Park Service Inventory and Monitoring Program, covers 34,000 square miles of mostly roadless, pristine parklands in Alaska. The Network has identified stream ecosystems as a critical component of park resources and has initiated a comprehensive monitoring program to detect changes in key indicators of stream ecosystem condition in response to the effects of climate change and other anthropogenic stressors. The remote nature of these parks, in combination with limited resources, presents difficult logistical challenges, and has necessitated a survey design that integrates short-rotation sampling at targeted sentinel sites with long-rotation sampling at a larger set of probabilistic synoptic sites selected using the GRTS design. We will discuss the development of the CAKN stream monitoring program, with an emphasis on the use of this integrated survey design to maximize our ability to detect ecological change while maintaining inference to unsampled sites. We will also present preliminary results from the first 3 years of the program, and outline the development of biological water quality assessment tools for park managers.

Simon, **K**. **S**., University of Maine, Orono, USA, ksimon@maine.edu
Anderson, D. S., University of Maine, Orono, USA, dennis.anderson@umit.maine.edu
Fernandez, I. J., University of Maine, Orono, USA, ivanjf@maine.edu
Norton, S. A., University of Maine, Orono, USA, norton@maine.edu
Valett, H. M., University of Montana, Polson, USA, maury.valett@flbs.umt.edu
Ely, D. T., Virginia Techelyda1@vt.edu

CHRONIC WATERSHED NITROGEN ENRICHMENT ENHANCES PHOSPHORUS LIMITATION OF STREAM MICROBES AND CHANGES THE STOICHIOMETRY OF MICROBIAL ECOENZYMES

Chronic nitrogen enrichment likely enhances phosphorus limitation in streams, with consequences for microbial role in stream function. We examined how long-term watershed nitrogen enrichment has altered the strength of phosphorus limitation of microbes on leaves in streams. Streams draining both a reference watershed and an adjacent experimental watershed subjected to 20+ years of elevated nitrogen deposition were enriched with phosphate for 70 days and monitored for microbial ecoenzyme activity, microbial respiration, and leaf decomposition. Phosphatase activity was 3X higher in the nitrogen enriched stream, and addition of phosphate reduced phosphatase activity while simultaneously increasing the activity of carbon and nitrogen acquiring enzymes. In contrast, phosphate addition to the low nitrogen, reference stream had little effect on the magnitude and stoichiometry of enzyme activity. The patterns in enzyme activity were mirrored by rates of microbial respiration and leaf breakdown, which were both strongly enhanced by phosphorus addition, but only in the nitrogen enriched stream. These results indicate that chronic nitrogen enrichment at the watershed scale can shift the stoichiomtery of microbial nutrient limitation in streams with cascading effects on decomposition.

Simonis, **J**. **L**., Cornell University, Ithaca, USA, jls468@cornell.edu

ONTOGENETIC SHIFT IN PREDATION BY *TRICHOCORIXA VERTICALIS* DICTATES TROPHIC CASCADE IN FRESHWATER ROCK POOLS

Many predators change feeding habits or behaviors over their lifetime. Some predators shift diets entirely between life stages, others merely change consumption rates as they age. Any change in feeding by a predator can have significant consequences for trophic interactions and food-web dynamics. Freshwater rock pools on Appledore Island, ME contain a relatively simple food web: few phytoplankton species (primarily green algae), two zooplankters (*Daphnia pulex*, *Moina macrocopa*), and the water boatman *Trichocorixa verticalis* (Corixidae). *Trichocorixa* has six instars and adults are approximately 50 times larger than first-instar juveniles. Laboratory experiments show that *Trichocorixa* is a voracious predator of both *Daphnia* and *Moina*. Fitted functional responses indicate that, for both prey species, predator attack rates increase and handling times decrease with predator instar. The significance of these results was determined in a mesocosm experiment. After 14 days, mesocosms with *Trichocorixa* present had lower zooplankton densities and higher algal biomass and the effect size increased with predator instar. Results indicate that the dynamics of the rock-pool food web are strongly controlled by the ontogeny of the top predator.

Sims, **S**. **A**., The University of Alabama, Tuscaloosa, USA, sasims2@crimson.ua.edu
Ward, A. K., The University of Alabama, Tuscaloosa, USA, award@as.ua.edu
Ward, G. M., The University of Alabama, Tuscaloosa, USA,

INTERACTIONS OF WATER CHEMISTRY AND HYDROLOGY IN TWO COASTAL PLAIN STREAMS OF DIFFERENT ORDER IN A FORESTED WATERSHED

Changes in streamwater chemistry can be strongly driven by seasonal precipitation patterns that define stream hydrology. This is especially important in low-order, headwater streams that rely on inputs from terrestrial ecosystems. The goal of this study was to compare and contrast annual seasonal changes in hydrology and water chemistry of two low-order streams within the same forested watershed. Mayfield Creek (third-order) and Talladega Branch (first-order) are Coastal Plain

streams located in west Alabama. Weekly sampling over an annual period revealed consistently higher ammonium than nitrate concentrations in both streams with highest values in spring and summer for ammonium and in late spring and summer for nitrate during seasonal low flow periods. Values for both were higher in the larger Mayfield Creek than Talladega Branch (mean NH4-N: 43 µgN/L and 36 µgN/L, respectively; mean NO3-N: 15 µgN/L and 5 µgN/L). Average DOC concentrations were higher in the smaller stream (3.4 vs 2.7 mgC/L). Key water chemistry differences in the streams suggest some intriguing differences in roles of small streams of different order within the Coastal Plain landscape.

Singer, **E**. **E**., Appalachian State University, Boone, NC, USA, ErinESinger@gmail.com

Gangloff, M. M., Appalachian State University, Boone, NC, USA, gangloffmm@appstate.edu

MILL DAM ENHANCEMENT OF FRESHWATER MUSSEL GROWTH RATES IN AN ALABAMA STREAM

Small dams are common in the southeastern US, yet few studies have quantified their effects on the region's imperiled aquatic biota. We investigated why freshwater mussels are more abundant and larger immediately downstream from a small dam (mill reach) than conspecifics in up- or downstream reaches. We attempted to answer 2 questions. First, is larger size attributable to faster growth or greater age? Second, do sites up-and downstream from dams differ in mussel food quantity or quality? We thin-sectioned shells to age mussels and compare growth rates between populations and we seasonally measured seston from filtered water samples. Growth curves indicate that mill reach mussels grew faster than up- and downstream populations. Seston quantity varied seasonally but was generally highest in the impoundment and mill reach from spring-fall. Seston organic:inorganic ratios were highest upstream from the impoundment from spring-fall but highest in the impoundment and mill reach during winter. Our data suggest that some small impoundments benefit downstream mussel populations by enhancing food resources. These heretofore un-documented effects should be considered when prioritizing dam removal/stream restoration projects.

Singer, **G**. **A**., University of Vienna / Department of Limnology, Vienna, Austria, gabriel.singer@univie.ac.at

Besemer, K., University of Vienna / Department of Limnology, Vienna, Austria, katharina.besemer@univie.ac.at

Hoedl, I. A., University of Vienna / Department of Limnology, Vienna, Austria, iris.hoedl@univie.ac.at

Battin, T. J., University of Vienna / Department of Limnology, Vienna, Austria, tom.battin@univie.ac.at

CARBOHYDRATE MONOMER UPTAKE AT BIOFILM AND STREAM ECOSYSTEM SCALE

In the DOC pool of streams carbohydrate monomers have low concentration, but represent reactive carbon moieties theoretically capable of supporting 100% of a stream´s heterotrophic carbon demand. In streams, differences in biological reactivity mean differing spiralling lengths and thus a shift of metabolic relevance from local to larger spatial scales. Here we explore the uptake of glucose (GLC) and arabinose (ARA), two model carbohydrates differing in reactivity, at the scale of laboratory-cultivated biofilms and of engineered ecosystems. At the biofilm-scale differences in reactivity translate into spatially separated uptake of GLC and ARA, resulting in metabolically stratified biofilms. These can be mathematically modelled using reaction-diffusion equilibria that account for a flow-mediated diffusional boundary layer as well as for biofilm properties. To allow upscaling of the mechanisms acting at the biofilm-scale to ecosystem-scale uptake dynamics, we extend the model to a heterogeneous biofilm landscape in spatially variable flow. We then validate the model with data collected in streamside flumes hosting heterogeneous flow landscapes. Empirical results suggest overwhelming influence of hydrodynamics rather than biofilm heterogeneity on the uptake dynamics of GLC and ARA.

Sinsabaugh, **R**. **L**., University of New Mexico, Albuquerque, USA, rlsinsab@unm.edu

Follstad Shah, J. J., Duke University, Durham, USA, follstad@gmail.com

MICROBIAL ECOENZYMATIC ACTIVITY IN RELATION TO STOICHIOMETRIC AND METABOLIC THEORY

The transformation and mineralization of organic matter by heterotrophic microbial communities is mediated by enzymes released into the environment (ecoenzymes). The activities of these enzymes are commonly related to measures of microbial metabolism and environmental resource availability through a variety of statistical, conceptual and simulation models. Large synoptic data sets that include measurements of potential activity for multiple enzymes across many ecosystems, often combined with measures of environmental nutrient concentrations or microbial metabolism, have recently become available. Analysis of these data sets show patterns that reflect fundamental constraints on the functional organization of heterotrophic microbial communities. Specifically, ratios of commonly measured enzymes, β-glucosidase, acid (alkaline) phosphatase, leucine aminopeptidase and β-N-acetylglucosaminidase, are narrowly distributed relative to the variation in their component activities. Drawing from stoichiometric and metabolic theories, we propose that ratios of ecoenzymatic C, N and P acquisition activity reflect constraints imposed by the elemental C:N:P composition of biomass in relation to environmental resource availability and microbial growth efficiency in relation to nutrient assimilation.

Sipler, **R**. **E**., Virginia Institute of Marine Science, Gloucester Point, USA, sipler@vims.edu

Bronk, D. A., Virginia Institute of Marine Sciences, Gloucester Point, USA, bronk@vims.edu

CHEMICAL CHARACTERIZATION OF DISSOLVED ORGANIC AND INORGANIC NITROGEN PRESENT AT DIFFERENT STAGES THROUGHOUT THE WASTEWATER TREATMENT PROCESS

Wastewater treatment plants (WWTPs) are point source contributors of nitrogen (N) to aquatic systems. New regulations in the Chesapeake Bay region are reducing the amount of allowable N discharged from WWTPs to 3-8mg N/L by 2011, depending on location within the watershed. This study compares the nutrient removal and solids handling processes from two Virginia WWTPs, to determine which organic compounds, including those containing N, are degraded or produced and which compounds pass through unchanged. Composite samples were collected from the raw sewage, before and after the BNR process, and after chlorine disinfection process from each WWTP. Samples were analyzed for bulk nutrient concentrations including dissolved organic carbon, total dissolved N, nitrate + nitrite and ammonium and were chemically characterized using electrospray ionization mass spectrometry (ESI-MS) and Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS). More than 90% of the ammonium was removed by the BNR process in each plant and half of the masses (compounds) detected significantly decreased in abundance between the time it entered the plant as raw sewage and exited the plant as final effluent.

Skelton, **J**., Northern Michigan University, Marquette, MI, USA, jaskelto@nmu.edu

Strand, M., Northern Michigan University, Marquette,MI, USA, rostrand@nmu.edu

TROPHIC ECOLOGY OF FRESHWATER SPONGES AND THEIR SPECIALIST PREDATORS REVEALED WITH STABLE ISOTOPE ANALYSES

Carbon and nitrogen stable isotope analyses were used to infer the primary energy sources and relative trophic positions of white and green forms of the cosmopolitan freshwater sponge *Spongilla lacustris* and their specialist predators *Ceraclea resurgens* (Trichoptera: Leptoceridae) and *Climacia* sp. (Neuroptera: Sisyridae). Energy sources and trophic positions of sponges and spongivores were established through comparisons with isotope data from mollusk, crustacean, and insect species with known trophic roles in these communities. Isotopic signatures of both carbon and nitrogen were significantly different between sponges with zoochlorellae and those without, clearly demonstrating the role of symbionts in the bioenergetics and trophic status of freshwater sponges. These data also indicate that the relationship between *S. lacustris* and their zoochlorellae involve reciprocal transfers of nutrients. Carbon and nitrogen data from *Climacia* sp. indicate that zoochlorellae are their primary energy source and thus that spongillaflies function as highly specialized, infaunal algavores rather than sponge predators. Data from *Ceraclea resurgens* support observations that sponge-eating caddisflies derive energy from a combination of sponge and algal cells and thus are more accurately described as sponge predators.

Skinner, **D**. **S**., University of Adelaide, Adelaide, Australia, dominic.skinner@adelaide.edu.au
Aldridge, K. T., University of Adelaide, Adelaide, Australia, kane.aldridge@adelaide.edu.au
Brookes, J. D., University of Adelaide, Adelaide, Australia, justin.brookes@adelaide.edu.au
Oliver, R. L., Commonwealth Scientific and Industrial Research Organization, Adelaide, Australia, Rod.Oliver@csiro.au

INVESTIGATING THE EFFECTS OF WATER LEVEL DECLINES ON THE FORM AND DISTRIBUTION OF CARBON IN SEDIMENTS IN A LARGE, SHALLOW LAKE

Climate change is forecast to exacerbate water scarcity in many catchments, increasing the frequency and magnitude of water level fluctuations in lake basins. The resultant disturbance to sediment distribution can provide clues about the broader affects of water level declines on lake ecosystems. The spatial distribution of sediment characteristics in the large shallow Lake Alexandrina, South Australia, was measured in 2007 (z_m = 2.2 m) and 2009 (z_m = 1.2 m) as lake volumes decreased by almost 70%. Sediments (n = 22) were analyzed for total nutrients, organic content and particle size in both years and water quality was monitored at 8 sites monthly over the period of water level decline. Results suggest an accumulation of fine sediments and a substantial decrease in benthic inorganic carbon compared with sediments under higher water level. Possible drivers of this loss of inorganic carbon are discussed.

Slemmons, **K**. **E**., University of Maine, School of Biology and Ecology, Climate Change Institute, Orono, USA, Krista_Slemmons@umit.maine.edu
Saros, J. E., University of Maine, School of Biology and Ecology, Climate Change Institute, Orono, USA, Jasmine_Saros@umit.maine.edu

RELEASE OF REACTIVE NITROGEN BY MELTING ALPINE GLACIERS: EFFECTS ON DIATOM DIVERSITY IN LAKE ECOSYSTEMS OVER THE LAST CENTURY

Mountain glaciers have receded substantially on a global scale over the last century. Consequently, increases in the volume of glacial runoff have been observed. Changes in glacial meltwater have important implications for nutrient fluctuations into stream and lake ecosystems. Less is known, however, about how this high influx of glacial meltwater, rich in reactive nitrogen (Nr), affects the chemistry and biota of lakes. We investigated the species richness of sedimentary diatom assemblages in a suite of lakes in the central Rocky Mountains of North America, a region with relatively low Nr deposition (< 3 kg N ha-1 yr-1) and rapidly disappearing alpine glaciers. Sediment cores were extracted from glacially-fed (GF) and snow-fed (SF) lakes and examined for differences in fossil diatom taxa. Taxonomic richness of diatom communities was determined using rarefaction analysis. Preliminary results indicate that GF lakes have lower diatom diversity compared with SF lakes, and that this difference has persisted over the last century. The future trajectory for diatom communities as glaciers completely disappear from this region will be discussed.

Sluss, **T**. **D**., Kentucky State University, Frankfort, USA, tamara.sluss@kysu.edu
White, D., Murray State University, Murray, USA, david.white@murraystate.edu
Levine, T., Murray State University, Murray , USA, tlevine@murraystate.edu

TEMPORAL AND SPATIAL TRENDS OF ZOOPLANKTON COMMUNITY STRUCTURE IN A MAINSTEM RESERVOIR, KENTUCKY LAKE, OVER A TWENTY YEAR PERIOD

Zooplankton occupy a pivotal trophic level in freshwater systems by transferring energy from lower to higher trophic levels however, zooplankton densities and community assemblages can vary considerably and ecological investigations are typically limited to a few years. The objective of this study was to investigate spatial and temporal patterns in zooplankton community structure and densities in a mainstem reservoir, Kentucky Lake utilizing a twenty year water quality monitoring data set (1988-2008) including 3 channel and 7 embayment sites. Zooplankton densities were expected to be highest in the embayments compared with channel sites and that channel communities would be dominated by smaller-bodied zooplankton. This prediction held true with Bosmina longirostris which have their highest monthly mean densities (averaged over the entire sampling period) in April with higher densities in the channel. However, Daphnid species and D. lumholtzi exhibited greater densities in the main channel with their peak monthly densities occurring in May and June respectively. No differences in densities between the channel and embayments for Cyclopoida that peaked in May, nor for Diaphanasoma and Calanoida peaking in June.

Small, **G**. **E**., University of Minnesota, St. Paul, USA, chipsma@gmail.com
Ardon, M., Duke University, Durham, USA, mla5@duke.edu
Ramirez, A., University of Puerto Rico, San Juan, Puerto Rico, aramirez@ites.upr.edu
Duff, J. H., U.S. Geological Survey, Menlo Park, USA, jhduff@usgs.gov
Jackman, A. P., University of California-Davis, Davis, USA, apjackman@gmail.com
Bixby, R. J., University of New Mexico, Albuquerque, USA, bbixby@unm.edu
Triska, F. J., U.S. Geological Survey, Menlo Park, USA, fewtriska@sbcglobal.net
Pringle, C. M., University of Georgia, Athens, USA, cpringle@uga.edu

STORAGE, RETENTION AND TRANSFORMATIONS OF PHOSPHORUS IN A LOWLAND NEOTROPICAL STREAM DURING AN 8-YEAR PHOSPHORUS ENRICHMENT EXPERIMENT

Human alteration of the global phosphorus (P) cycle has led to widespread P-loading in freshwater ecosystems. The potential for downstream eutrophication depends on how effectively P is removed and retained in headwater streams. We analyze the results of an eight-year experimental P-addition to a detritus-based Neotropical headwater stream and the recovery of this ecosystem to pre-enrichment conditions. Microbial respiration increased 3-fold over background levels during P-enrichment and was accompanied by a 25–50% increase in litter breakdown rates. No changes in algal or invertebrate biomass or composition were detected as a result of P-enrichment. Transient storage of P, and P loosely bound to sediments each accounted for ~150 mg P m^{-2}, which was retained for less than one day following the end of the P-addition. Longer-term P storage occurred in detritus and epilithon, which together contributed ~ 35 mg P m^{-2} to P-storage. Our results illustrate that (1) the intact biotic community in this stream is highly resilient to high P-loading, and (2) the large capacity for P-storage in this headwater stream can potentially buffer the downstream effects of P-loading.

Smith, **A**. **S**., University of Louisville, Louisville, USA, allisunsmith@gmail.com
Carreiro, M. M., University of Louisville, Louisville, USA, margaret.carreiro@louisville.edu

THEY GROW UP SO FAST: TEMPERATURE EFFECTS ON ZOOPLANKTON GROWTH RATE AND COMPETITION

As temperatures increase in freshwater systems, the likelihood that warm-water species will spread into temperate areas increases. Understanding how these tropical species will affect community-level interactions will become important as invasions become more likely as global temperatures rise. Much research has been devoted to understanding the outcome of food competition between species, demonstrating the reliability of specific individual growth rate as a predictor of competition outcomes. In this study, individual growth rates were determined for three zooplankton species, two native to the Ohio Valley region (Daphnia pulex and Bosmina longirostris) and one tropical exotic species (Daphnia lumholtzi) at different temperatures: 23o, 25o, 28o, and 31o C. These growth rates were then used to predict the outcome of competition experiments performed at the same temperatures between D. lumholtzi and each of the native species. Preliminary results indicate that the native species are capable of reproducing at higher temperatures, but may show a reduced reproductive output compared to the tropical D. lumholtzi. Understanding how zooplankton communities respond to invasive species and changing temperature regime will help inform management of aquatic ecosystems.

Smith, **C**. **G**., United States Geological Survey, St. Petersburg, USA, cgsmith@usgs.gov
Swarzenski, P. W., United States Geological Survey, Santa Cruz, USA, pswarzen@usgs.gov
Reich, C., United States Geological Survey, St. Petersburg, USA, creich@usgs.gov

EXAMINING THE SOURCE AND MAGNITUDE OF SUBMARINE GROUNDWATER DISCHARGE ALONG THE WEST FLORIDA SHELF, USA.

Surface-water ^{222}Rn activity was measured during two cruises in 2009 to examine potential areas where groundwater discharges to the west Florida shelf. Surface-water ^{222}Rn was high during both cruises off Indian Rocks Beach (IRB), Florida, USA. To examine the extent that submarine groundwater discharge (SGD) contributed to the high ^{222}Rn activity, a geochemical and geophysical investigation of the IRB area was conducted in June/July and November 2009. Surface and groundwaters were collected along a cross-shore transect and analyzed for ^{222}Rn and ^{223,224,226}Ra activities, inorganic nutrients, major cations and anions, and dissolved metal concentrations. Cross-shore gradients of ^{222}Rn and ^{223,224,226}Ra

activities qualitatively indicate a nearshore source for these isotopes, which mix with water characterized by low activity offshore. The nearest inlet is 10 km away from the transect indicating estuarine fluxes are not the source of these radioisotopes. Groundwaters collected offshore are enriched in radon and radium isotopes and are fresher than surface water. Constructing mass balances of these radioisotopes, nutrients, and metals will help understand how the source and magnitude of SGD affect coastal material budgets in this area.

Smith, **N. D.**, Joseph W. Jones Ecological Research Center, Newton, USA, nsmith@jonesctr.org
Golladay, S. W., Joseph W. Jones Ecological Research Center, Newton, USA, sgolladay@jonesctr.org

COLEOPTERA INDICATOR SPECIES IN DROUGHT VS. FLOOD REGIMES IN THREE SOUTHWEST GEORGIA WETLAND TYPES

Yearly variation in water levels has a profound effect on the presence and response of aquatic Coleoptera. Thirty-four depressional wetlands, previously characterized as marshes, savannas or forested swamps, were sampled during flood and drought years (1997-1998 and 2006-2007 respectively) . Using Indicator Species Analysis we were able to associate coleoptera species with wetland type and hydrologic condition. Relying on species indicator values ($p<0.05$) we found that marshes contained significantly higher numbers of indicator species compared to other wetlands during both periods. Indicator species taxa were similar between wetland types within the same hydrologic period but these similarities were not consistent when compared against the alternate hydrologic regime. Species richness and diversity was higher during years with extended flooding. These findings indicate that marshes provide more suitable habitat and possess characteristics that allow for survival and recovery during overly dry and wet periods. It also suggests that certain taxonomic groups of Coleoptera are better able to survive and utilize habitat niches based on wetland type and hydrologic levels.

Smith, **R. L.**, US Geological Survey, Boulder, CO, USA, rlsmith@usgs.gov
Repert, D. A., US Geological Survey, Boulder, CO, USA, darepert@usgs.gov
Hart, C. P., US Geological Survey, Boulder, CO, USA, cphart@usgs.gov

THE RELATION BETWEEN NITROGEN BIOGEOCHEMISTRY AND CARBON IN STREAMS OF THE YUKON RIVER BASIN

High latitude, boreal watersheds are characterized as nitrogen-limited ecosystems that export large amounts of organic carbon. Key controls on carbon cycling are likely biogeochemical processes affecting the linked, but limiting, nutrient cycles, particularly the nitrogen cycle. Much remains to be learned about carbon-nitrogen linkages within boreal ecosystems and the response of these linkages to expected climate change elements. A study was conducted in streams of the Yukon River Basin to examine the relation between carbon and nitrogen pools and biogeochemical processes across varying hydrologic and C/N gradients. Results indicate that dissolved organic nitrogen (DON) is the predominant N species in the Yukon Basin; DON exceeded dissolved inorganic nitrogen (DIN) in 80% of the water samples, with little variation in organic C/N ratios. Rates of nitrogen mineralization and denitrification in laboratory incubations were related to sediment organic carbon content, while nitrification rates were variable. Synoptic sampling in one headwater stream identified increasing DOC and DON with downstream transport and increased oxygen respiration and carbon dioxide production. Additional studies investigated the effects of increased inputs of DON and DIN to this environment.

Smith, **V. H.**, University of Kansas, Lawrence, USA, vsmith@ku.edu

EUTROPHICATION AND HUMAN DISEASE RISK

The enrichment of aquatic ecosystems with nitrogen and phosphorus can cause a diverse series of undesirable symptoms of cultural eutrophication. Included among these symptoms is the excessive growth of phytoplankton algae, leading to nuisance Harmful Algal Blooms that often may toxic. Less often considered is the possibility that eutrophication may also be associated with undesirable levels of human pathogens, whether viral, bacterial, or protozoan. Data will be presented suggesting that the biomass of putative human pathogens does indeed covary strongly with the trophic state of aquatic ecosystems, as measured by measured concentrations of total phosphorus.

Snitgen, **J. L.**, Oneida Tribe of Indians of Wisconsin, Oneida, USA, jsnitgen@oneidanation.org
Gilmore, S. A., Oneida Tribe of Indians of Wisconsin, Oneida, USA, sgilmore@oneidanation.org
Melchior, M. J., Interfluve, Inc., Madison, USA, mmelchior@interfluve.com

FROM HEADWATERS TO MOUTH: A TOP-DOWN MODEL FOR SUCCESSFUL WATERSHED RESTORATION

In order to effectively restore a former trout stream in northeastern Wisconsin with a history of agricultural impacts and a surrounding apathetic community, a strategy of "headwaters down" restoration was implemented. We began by first addressing and eliminating the largest water quality stressor in the headwaters area, and then continued downstream with headwater channel restoration, as well as wetland and instream habitat enhancement projects. Biological, chemical, and physical metrics were monitored to document project successes. The visibility and positive impacts to water quality and the biological community further reinforced public support for further restoration projects. After decades of absence, brook trout have been reintroduced and a management plan implemented. Initiating watershed restoration in headwater wetlands and streams makes ecological sense, builds momentum and gains community constituency as you move downstream. Larger, main channel projects are thus easier to "sell" as a result.

Snyder, **C. D.**, U.S. Geological Survey, Kearneysville, USA, csnyder@usgs.gov
Hitt, N. P., U.S. Geological Survey, Kearneysville, USA, nhitt@usgs.gov
Smith, D. R., U.S. Geological Survey, Kearneysville, USA, drsmith@usgs.gov
Daily, J. P., U.S. Geological Survey, Kearneysville, USA, jdaily@usgs.gov

USING SIMULATIONS TO EVALUATE THE EFFECT OF TAXONOMIC RESOLUTION ON THE SENSITIVITY OF MACROINVERTEBRATE BASED STREAM CONDITION MEASURES

Benthic macroinvertebrates are widely used to assess stream condition but the appropriate taxonomic resolution for analysis remains controversial. On one hand, analysis of genera and species (i.e., lowest practical resolution) would be expected to quantify highly-tolerant and highly-intolerant taxa thereby increasing sensitivity to stressors. On the other hand, analysis of family-level data may reduce the variability of reference communities thereby increasing the probability of detecting non-reference conditions. In this study, we simulated degradation of macroinvertebrate reference communities in the Shenandoah National Park and evaluated the sensitivity of two bioassessment indices (Macroinvertebrate Biological Integrity Index and Bray-Curtis Similarity Index) calculated at the family level and lowest practical level. We based the simulations on data from two sites that naturally varied in terms of taxon diversity. Simulation results indicated little or no gain in sensitivity by identifying specimens to the lowest practical taxonomic level. Results were robust to the effects of taxon richness suggesting their general applicability. Based on these findings, we recommend identifying specimens to the family level and using the cost savings to increase sampling effort.

Snyder, **E. B.**, Grand Valley State University, Allendale, USA, snydeeri@gvsu.edu
Caldwell, C. B., Grand Valley State University, Allendale, USA, caldwech@student.gvsu.edu

FUNCTIONAL & STRUCTURAL RESPONSES TO RESERVOIR DRAW-DOWN & DAM REMOVAL, THORNAPPLE RIVER, MI

The removal of aging dams is becoming a common phenomenon, as communities rationalize the tradeoffs between rebuilding vs. removal. There is growing recognition that free-flowing rivers compensate for economic losses incurred by removal via a naturalized flow regime that better support native species of ecological and/or recreational importance, better water quality, better resistance and resilience to exotic species invasions, and additional recreational benefits. We monitored ecological responses to the removal of a low-head dam on the Thornapple River (5th order), Barry County, MI. Single-station open system metabolism measurements indicated that reaches above the dam were heterotrophic vs. downstream, likely corresponding to changes in the physical habitat template unrelated to the reservoir. Similarly, a suite of macroinvertebrate metrics including diversity and FBI values indicated impaired community assemblage structure directly below the dam. During drawdown, sedimentation reduced benthic habitat complexity ($p<0.05$) and autotrophic production. The reservoir also functioned as a sink for NO3-N and NH3-N. In summary, combining structural and functional measures of lotic ecosystem health provided a robust assessment and ongoing monitoring continues to document recovery trajectories.

Snyder, **J**. **M**., University of California DELTA Group, Davis, USA, jmssnyder@ucdavis.edu
Cahill, T. A., University of California DELTA Group, Davis, USA, tacahill@ucdavis.edu

THE IMPACT OF ASIAN DUST AEROSOLS ON LAKE TAHOE WATER QUALITY

Recent modeling of water clarity at Lake Tahoe has highlighted the importance of atmospheric deposition of insoluble fine particles. While there are many sources of such particles including construction and winter road salting, etc., numerous studies have shown that Asian dust has also impacted air quality in Western North America. Based on rotating DRUM sample records, at the Tahoe Fish Hatchery (Courtesy of the UC Davis DELTA Group), there was increased soil aerosol deposition during the period from April 27 to June 2 2006 primarily with particles ranging from 0.75 µm to 2.5 µm in diameter, which is too fine to be local soil. Low iron to calcium ratios and HYSPLIT aerosol model trajectories identified this soil as being Asian in origin. Furthermore, variations in Asian dust deposition in California are impacted by climatic variations in the Pacific Ocean including the Madden Julian Oscillation and El Nino, both of which impact mid latitude westerly winds. This study will determine how Asian aerosols impact the Tahoe Basin and how such impacts are influenced with variations in meteorology and climate.

Snyder, **M**. **N**., University of Georgia, Athens, USA, msnyder@uga.edu
Pringle, C. M., University of Georgia, Athens, USA, cpringle@uga.edu
Freeman, M. C., University of Georgia, United States Geological Survey, Athens, USA, mary@ttrout.ecology.uga.edu

PREDICTING SHRIMP DENSITIES ACROSS A SOLUTE RICHNESS GRADIENT WITH OCCUPANCY MODELING IN LOWLAND CARIBBEAN STREAMS, COSTA RICA

Geothermally-modified springs, which feed into rivers draining the lowland foothills along the volcanic spine of Costa Rica, have created high spatial heterogeneity of stream solute levels (e.g. P, Cl, Na, Ca, and Mg). High-solute reaches of streams could serve as refugia for freshwater shrimps because they are buffered from pH drops and have higher quality food resources. Using modified minnow traps we estimated shrimp occupancy at sites longitudinally within three streams with well-mapped solute gradients at La Selva Biological Station. We developed models to predict shrimp occupancy for three species (*Macrobrachium olfersi, M. heterochirus,* and *M. carcinus*) using conductivity, substrate, distance to the main stem river, and stream discharge as site-level covariates and turbidity as a sample-level covariate. Shrimp site occupancy varied from 0-80% present. Substrate, discharge and conductivity were the most important predictors of shrimp occupancy and these factors varied by species. Conductivity was an important factor in predicting shrimp occupancy for *M. carcinus* and *M. olfersi* indicating that solute levels were important in determining the distribution of these two taxa.

Sobczak, **W**. **V**., Holy Cross College, Worcester, MA, USA, wsobczak@holycross.edu
Schade, J. D., St. Olaf College, Northfield, MN, USA,
Bulygina, E. B., Woods Hole Research Center, Falmouth, MA, USA,
Bunn, A. G., Western Washington University, Bellingham, WA, USA,
Chandra, S., University of Nevada, Reno, NV, USA,
Frey, K. E., Clark University, Worcester, MA, ,
Holmes, R. M., Woods Hole Research Center, Falmouth, MA, USA,
Spektor, V. V., Yakut State University, Yakutsk, Russian Federation,
Walter Anthony, K. M., University of Alaska, Fairbanks, AK, USA,
Zimov, S. A., Northeast Science Station, Cherskiy, Russian Federation,

ORGANIC MATTER BIOAVAILABILITY AMONG AQUATIC HABITATS IN SIBERIA'S KOLYMA RIVER WATERSHED DURING SUMMER BASEFLOW

Recent research suggests that Arctic watersheds may increasingly augment the global role of freshwater ecosystems in the flux of terrestrial carbon to the atmosphere and ocean as a result of global warming. Here we document the bioavailability of dissolved and suspended organic matter in a wide variety of freshwater environments (including shallow wetlands, stratified lakes, small streams, major tributaries, and main-channel locations) throughout Siberia's Kolyma River watershed at baseflow during July 2009. The Kolyma River watershed is one of the Arctic Ocean's largest and is dominated by continuous permafrost that is underlain with rich, unglaciated organic soils that are susceptible to increased fluvial transport. Overall, the Kolyma River's fluvial network had appreciable, yet highly variable amounts of bioavailable organic carbon (mean = 0.59 mg/L, SD = 0.82 mg/L, n = 40 locations). Headwater locations generally had the highest concentrations of total dissolved and bioavailable organic carbon relative to mainstem locations, but the fraction of bioavailable organic carbon (~6%) was similar among habitats. These results suggest that the Kolyma River's fluvial network is efficiently processing terrestrial-derived organic matter during summer baseflow.

Sobota, **D**. **J**., National Research Council, in residence at the Western Ecology Division, EPA, Corvallis, USA, Sobota.Dan@epamail.epa.gov

EVALUATING THE INFLUENCE OF UNCERTAINTY IN CATCHMENT-SCALE N INPUT ON MODELING RIVER N EXPORT

Careful evaluation of how uncertainty in spatial data influences predictions of nutrient export is needed for biogeochemical modeling in river networks. In this poster I explore how uncertainty in estimates of catchment-scale nitrogen (N) input influences modeling of N export in streams and rivers. I assume a power law relationship between fraction of annual catchment-scale N input transferred to rivers and runoff (0.05 to 0.8 m/yr) and vary estimates of catchment N input taken from the Eastern United States and central California (581 to 11,234 kg N/km^2/yr) by 5, 20, and 50%. Results demonstrate that uncertainty in catchment N input influences estimates of N transfer to rivers more strongly in wet regions (runoff > 0.3 m/yr) than in dry ones. They also suggest that in-stream N removal greatly diminishes the influence of N input uncertainty in modeling river N export. Significance of results in relation to future scenarios of anthropogenic N loading and climate change will be discussed.

Sokol, **E**. **R**., Florida International University, Miami, USA, sokole@gmail.com
Benfield, E. F., Virginia Tech, Blacksburg, USA, benfield@vt.edu

THE INTERACTION BETWEEN COMMUNITY ASSEMBLY AND DISTURBANCE: HOW LOGGING AFFECTS BENTHIC MACROINVERTEBRATE COMMUNITIES IN HEADWATER STREAMS

Among-site variation in the composition of assemblages of organisms is often an emergent property resulting from the interaction between niche-based (deterministic) and dispersal-based (stochastic) community assembly processes. The current paradigm in disturbance ecology is that perturbation causes a shift away from the influence of environmental filters and toward a greater influence by stochastic processes. Here we show disturbance (logging) bolstered the relationship between environmental variation and the functional composition of benthic macroinvertebrate communities in headwater watersheds in the Nantahala National Forest. Model comparisons with AIC_C scores show stronger relationships between local habitat characteristics and functional trait composition following logging. Path analysis showed consumer composition responded to a change in resource availability concurrent with a shift in community functional characteristics related to dispersal and colonization. The community level response in this system illustrates how disturbance can simultaneously shift and strengthen the influences of local environmental constraints. Additionally, logged sites selected for organisms with specific dispersal and colonization attributes that are better suited for a stochastic landscape, blurring the differences between the two classes of community assembly hypotheses in the niche/dispersal dichotomy.

Solomon, **C**. **T**., McGill University, Ste. Anne de Bellevue, Canada, ctsolomon@wisc.edu
Bruesewitz, D. B., University of Waikato, Hamilton, New Zealand, dbruesew@waikato.ac.nz
Richardson, D. C., SUNY-New Paltz, New Paltz, USA, richardsond@newpaltz.edu
Rose, K. C., Miami University, Miami, USA, rosekc@muohio.edu
Van de Bogert, M. C., University of Wisconsin, Madison, USA, mcvandeb@wisc.edu

DRIVERS OF PELAGIC COMMUNITY RESPIRATION: EVIDENCE FROM HIGH-FREQUENCY FREE-WATER MEASUREMENTS IN LAKES AROUND THE GLOBE

We investigated the drivers of pelagic community respiration using continuous high-frequency free-water measurements of dissolved oxygen from 25 lakes around the world. These lakes ranged widely in trophic status, area, and latitude. We fit a metabolism model by maximum likelihood to estimate daily rates of respiration (R) and gross primary production (GPP) for up to 365 days in each lake, and estimated uncertainties about daily R and GPP by bootstrapping.

R varied considerably at both daily and seasonal time scales, and between 37 and 94% of the daily variation for a given lake could be explained by water temperature and GPP. Peak rates of R in the 25 lakes ranged widely, from 20 to 470 mmol O2 m-3 d-1, but baseline R (respiration not tied to autochthonous primary production) was remarkably similar among lakes. Furthermore, the change in R with GPP differed considerably among lakes, with lower slopes in eutrophic than oligotrophic systems. Our results indicate substantial day-to-day variability in pelagic community respiration, and suggest some but not all of the processes that drive such variation.

Somers, **K**. **A**., Duke University, Durham, USA, kayleigh.somers@gmail.com
Bernhardt, E. S., Duke University, Durham, USA, emily.bernhardt@gmail.com
Hassett, B. A., Duke University, Durham, USA, brookehassett@gmail.com
Sudduth, E. B., Duke University, Durham, USA, elizabeth.sudduth@gmail.com
Wang, S., Duke University, Durham, USA, siyi.wang@duke.edu
Urban, D. L., Duke University, Durham, USA, deanu@duke.edu

STREAMS IN THE URBAN HEAT ISLAND: LANDSCAPE AND LOCAL CONTROLS ON THERMAL POLLUTION IN URBAN WATERSHEDS

Urban areas create "heat islands" with temperatures higher than the surrounding landscape. The streams that drain urban areas also tend to be hotter as a result of hydrologic connections to impervious surfaces as well as decreased riparian canopy cover. Effective impervious area and effective forested area have proven more effective indicators of thermal pollution than simple estimates of impervious cover because they consider the spatial distribution of impervious surfaces relative to stream. These indicators also incorporate fine-scale patterns within cities, progressing beyond a binary perspective of urban or not. To further explore the connections between watershed development and thermal pollution, we collected high-resolution summer stream temperature data together with reach and watershed scale land cover characterization for 47 streams spanning a land use gradient across the Piedmont of North Carolina. Analyses show statistically significant relationships between total degree-days and the explanatory variables above. In this talk, we will examine the extent to which incorporating more detailed characterization of developed landscapes and their hydrologic connectivity landcover metrics improves our ability to predict thermal pollution in urban streams.

Sommer, **T**. **R**., California Dept. of Water Resources, West Sacramento, USA, tsommer@water.ca.gov
Reece, C. R., California Dept. of Water Resources, West Sacramento, USA, creece@water.ca.gov

SEASONAL HABITAT AS AN ENGINEER OF AQUATIC BIODIVERSITY: EVIDENCE FROM CALIFORNIA'S YOLO BYPASS

Quantification of the effects of seasonally inundated habitat is typically difficult, especially in large scale systems. The major river system in California is the Sacramento River, where native biodiversity has been severely affected by invasive species. The largest contiguous area of seasonal aquatic habitat in the Sacramento River is the Yolo Bypass, a 24,000 ha partially leveed floodplain. The unique structure of this system has allowed us to quantify differences between the seasonal Yolo Bypass habitat and the mainstem river channel over the past decade. Our field studies demonstrate that the Yolo Bypass seasonally supports at least 46 fish species. Based on field results, evidence suggests that temporary habitat offers selective advantages to the native fish community as compared to perennial waterways. Examples include native salmonids and cyprinids, which use the Yolo Bypass as a nursery area. Food web production is greatly enhanced on the intermittent floodplain habitat, particularly for drift invertebrates, a primary food source for the native fish community. The seasonal floodplain also appears to be a net exporter of phytoplankton and organic carbon to the heavily altered downstream food web of the San Francisco estuary.

Soranno, **P**. **A**., Michigan State University, East Lansing, USA, soranno@msu.edu
Cheruvelil, K. S., Michigan State University, East Lansing, USA, ksc@msu.edu
Bremigan, M. T., Michigan State University, East Lansing, USA, bremigan@msu.edu
Webster, K. E., Michigan State University, East Lansing, USA, webst152@msu.edu
Fergus, C. E., Michigan State University, East Lansing, USA, fergusca@msu.edu

LANDSCAPE LIMNOLOGY: DEFINING THE FRESHWATER LANDSCAPE

Cross-system linkages have been increasingly cited as important pathways for a wide variety of ecological processes. For example, nutrient transfer not only occurs in the downstream direction from terrestrial to freshwater systems, but also in the upstream direction from marine sources to freshwater systems, demonstrating the potential bi-directionality of such linkages. Interestingly, a smaller number of studies have explicitly considered cross-system linkages among elements of the freshwater landscape (lakes, streams, wetlands, and groundwater), than among freshwater elements and the terrestrial landscape. Here we synthesize research on the four ways that cross-system linkages among freshwater elements have been studied: (1) comparisons of a single process across multiple freshwater ecosystem elements; (2) unidirectional studies that examine the effect of one freshwater element on a different element; (3) bidirectional studies that examine reciprocal interactions among two or more freshwater elements; and (4) fully integrated studies that examine the freshwater landscape as an interconnected unit. Our intent is to synthesize the literature to identify when and where it is most important to consider such freshwater cross-system linkages and to identify gaps for future research.

Sorichetti, **R**. **J**., University of Western Ontario, London, Canada, rsorich@uwo.ca
Creed, I. F., University of Western Ontario, London, Canada, icreed@uwo.ca
Bayley, S. E., University of Alberta, Edmonton, Canada, sbayley@ualberta.ca
Trick, C. G., University of Western Ontario, London, Canada, trick@uwo.ca

HYDRO-BIOGEOCHEMICAL LINKAGES AND THEIR INFLUENCE ON THE TIMING AND MAGNITUDE OF HARMFUL CYANOBACTERIAL BLOOMS: A TALE OF TWO LANDSCAPES

We investigated hydro-biogeochemical linkages to lakes and how this relates to formation of cyanobacterial blooms within lakes in different hydrologic regions of Canada. We hypothesized that availability of N, P and Fe from the watershed specifically influences growth rates of cyanobacterial species. We sampled 250 lakes during peak biomass from semi-arid eutrophic lakes to sub-humid oligotrophic lakes for 18O, SUVA, fluorescence index (proxies for hydrological connectedness of a lake to its surrounding landscape), N, P and Fe concentrations within the lake (determinants of biomass and biodiversity). While biomass in the two hydrologic regions was comparable, we found that the timing of blooms in lakes with "strong" hydrologic linkages (large allochthonous inputs of nutrients) was dependent on precipitation leading to runoff generating events. In contrast, the timing of cyaonobacterial blooms in lakes with "weak" hydrological linkages (small allochthonous input of nutrients) was dependent on temperature. Furthermore, Anabaena and Microcystis dominated in lakes with "weak" hydrological linkages and Aphanizomenon and Nostoc dominated in lakes with "strong" hydrological linkages. A mechanistic explanation for differences in species based on hydrological linkages is being explored.

Souza, T. A., PUC-Rio, Rio de Janeiro, Brazil, abreu.thaisa@gmail.com
Godoy, **J**. **M**., PUC-Rio, Rio de Janeiro, Brazil, jmgodoy@puc-rio.br
Carvalho, Z. L., IRD/CNEN, Rio de Janeiro, Brazil, zenildo@ird.gov.br
Godoy, M. L., IRD/CNEN, Rio de Janeiro, Brazil, malu@ird.gov.br
Moreira, I. M., PUC-Rio, Rio de Janeiro, Brazil, isabel@puc-rio.br

NATURAL RADIOACTIVE TRACERS AS A TOOL FOR THE QUANTIFICATION OF THE NUTRIENT SUPPLY THROUGH SGD IN COASTAL AREAS

The recent development of the Brazilian coastal towns, in particular, the so-called summer villages, occurs at a very rapid velocity and without planning. Environmental problems, particularly those related to sanitation, are enhanced by the installation of a public water supply network, usually, not followed by a implementation of sewage collection and treatment service. Alternatively, cesspits are installed becoming sources of nutrients such as phosphate and nitrogen to the groundwater. Given the permeability of sandy soils and the construction of homes just at the beach, groundwater becomes a potential source of extra nutrients to the coastal region. The present work shows the results of six sampling campaigns at Arraial do Cabo, a summer destination close to Rio de Janeiro city, conducted on a small bay with a high density of summer residences and restaurants at the shoreline. During these campaigns seawater and groundwater were collected and 228Ra, 226Ra, 224Ra and 223Ra determined as well as U, Ba, Si, nitrate, nitrite, ammonium and fosfate.

Spaulding, **S**. **A**., US Geological Survey, Boulder, USA, sarah.spaulding@colorado.edu

HISTORICAL ABUNDANCE OF DIDYMOSPHENIA GEMINATA

Recent reports suggest that blooms of Didymosphenia geminata (Lyngbe) Schmidt are becoming more common, widespread and persistent in North

America. Although several publications document the presence of this diatom in the early 1900's in North America, there is little, to no published data on the historical abundance of cells, or the biomass of stalks. In sites where lakes are positioned downstream from nuisance blooms, lake sediment cores and paleolimnological techniques offer a powerful tool for reconstructing historical abundance. In order to interpret the ecological impact of current blooms it is necessary to understand the past fluctuations in abundance. For example, chronologic dating and analysis of sediments from a lake in Katmai National Park, Alaska show that populations of D. geminata were relatively constant over the past 800 years. Therefore, it is reasonable to view the current blooms in Alaskan streams as within the normal range of variability. Streams at lower latitudes, however, may be experiencing more of a nuisance/invasive spread of cells. In order to address the historical variability in the state of Wyoming, I report preliminary results on analysis of sediments of two lakes and the change in the number of cells over several hundred years. Cells are indeed present in the historical record and correlated to modern river abundance.

Spooner, **D**. **E**., Trent University, Peterborough, Canada, dspooner45@gmail.com

Xenopoulos, M. A., Trent University, Peterborough, Canada, mxenopoulos@trentu.ca

Arts, M. T., Environment Canada, National Water Research Institute, Burlington, Canada, Michael.Arts@ec.gc.ca

LAND-USE ALTERS THE PHYSIOLOGICAL PERFORMANCE AND FUNCTIONAL RELEVANCE OF CONSUMER TROPHIC PROVISIONING

Understanding the ecological significance of consumer-mediated subsidies requires: (1) adequate null models to evaluates the relative effect of consumers vs abiotic processes; and, (2) knowledge of how environmental factors influence consumer physiological performance, and both the magnitude and subsequent context of their contributions. We compared nutrient cycling of freshwater mussels growing on rocks in 14 rivers along a gradient of agricultural land-use. Increased agricultural land-use negatively impacted mussel performance as measured by nutrient excretion, oxygen consumption, and total lipid content. We also quantified mussel fatty acid profiles in relation to the land-use gradient and found that palmitic acid (marker of food quantity) and alpha-linoleic:linolenic acid ratios (marker of green algae dominance) were associated with agricultural catchments and that arachadonic acid dominanted in forested streams suggesting that mussel diet or food availability shifts with land-use. Our results highlight the importance of land- use on mussel performance and trophic provisioning to benthic foodwebs.

Springer, **M**., Universidad de Costa Rica, San José, Costa Rica, biomonitoreo@gmail.com

Umaña, G., Universidad de Costa Rica, San José, Costa Rica, gerardo.umana@ucr.ac.cr

LIMNOLOGY OF LAKE COTE, A NATURAL LAKE MODIFIED FOR HYDROELECTRICITY IN COSTA RICA

Lake Cote is Costa Rica´s largest natural lake. Since the early 1980's its main outlet was dammed and the outflow diverted for hydroelectricity generation. It was first studied in 1990-1991 and 2001, before it was modified by raising its dam one meter. Since then, it has been monitored twice a year for changes in its limnology, plankton and macroinvertebrate composition. The lake is discontinuous polymictic, and may show a thermocline at 6 m depth and low oxygen levels near the bottom. Since its modification surface temperature has increased and phytoplankton has shown a tendency of more frequent dominance by Cyanobacteria. Copepods and Rotifers have been dominant except for a few occasions when Cladocerans were dominant. 90 genera of macroinvertebrates have been collected since 2001, two species (one amphipod and one hydrobiid snail) being most abundant in all sampling dates. 65% of the taxa collected were found only on one or two sampling dates. Changes in taxonomic richness and faunistic composition were observed since the modification of the lake's water level and subsequent decomposition of its associated vegetation.

Sprules, **W**. **G**., University of Toronto Mississauga, Mississauga, Canada, gary.sprules@utoronto.ca

CAN ZOOPLANKTON ORIENT TO PRODUCTIVITY 'HOTSPOTS' IN NEARSHORE REGIONS OF A MESOTROPHIC LAKE?

While large-scale, wind-driven spatial distributions of lake zooplankton are reasonably well studied, much less is known about smaller-scale patterns in nearshore zones where physical processes can be complex. In low productivity lakes onshore movement of water masses may lead to sediment resuspension that could supplement food web productivity if organisms can spatially orient to such localized events. I measured nearshore spatial patterns of zooplankton with an Optical Plankton Counter in mesotrophic Lake Opeongo, Ontario under a variety of wind conditions, bottom slope, and proximity to the shore. Transects ran perpendicular to the shoreline along both shallow and steep slopes or parallel to shore at depth contours above and below the metalimnion. Preliminary results show weak spatial relationships with transect slope and orientation for total zooplankton. However there were marked differences between small- and large-bodied zooplankton with the latter generally showing stronger spatial patterns at both the small (meters) and large (hundreds of meters) scale, particularly when the wind force was weak. These results suggest that larger-bodied animals may be more able to take advantage of local "hotspots" of productivity.

St. John, **T**., University of Southern Denmark, Biological Institute, Odense M, Denmark, stjohn@biology.sdu.dk

Holste, L., University of Hamburg; Institute for Hydrobiology and Fisheries Science, Hamburg, Germany, linda.holste@uni-hamburg.de

Kanstinger, P., University of Hamburg; University of Hamburg; Institute for Hydrobiology and Fisheries Science, Hamburg, Germany, hyha007@uni-hamburg.de

Bjerregaard, P., University of Southern Denmark, Biological Institute, Odense M, Denmark, poul@biology.sdu.dk

MULTI STRESSOR INFLUENCES ON THE VITAL RATES OF KEY SPECIES: IMPACTS OF COPPER AND TEMPERATURE EMBRYONIC DEVELOPMENT AND SURVIVAL OF BALTIC HERRING.

Organisms in the natural environment are simultaneously exposed to multiple abiotic and biotic stressors influencing vital rates such as growth and survival. However, individual based and structured population models rarely include parameterizations based on multi stressor effects typically using the parameterizations based on single stressors. Here, we present the results of lab studies examining the effects of copper and temperature (both individual and combined) on the development of embryo and yolk sac larvae of the Baltic herring (Clupea harengus). In our experiment developing herring eggs were exposed to environmentally relevant temperatures and copper concentrations following a matrix experimental design. Egg development, survival success, respiration and time to hatch were determined. Our results indicate that prediction of species and ecosystem dynamics based on single stressor parameterizations is flawed. These experiments are a part of the EU program MEECE, (Marine Ecosystem Evolution in a Changing Environment) contributing to the development of coupled ecosystem models including ecotoxicological constraints on ecosystem dynamics.

Staehr, **P**. **A**., University of Copenhagen, Freshwater Biological Section, Hillerød, Denmark, pastahr@bio.ku.dk

Baastrup-Spohr, L., University of Copenhagen, Freshwater Biological Section, Hillerød, Denmark, lbaastrupspohr@bio.ku.dk

Sand-Jensen, K., University of Copenhagen, Freshwater Biological Section, Hillerød, Denmark, ksandjensen@bio.ku.dk

Stedmon, C., National Environmental Research Institute, Dept. Marine Ecology, Roskilde, Denmark, cst@dmu.dk

SCALING OF WHOLE-LAKE METABOLISM

Increasing lake size is linked to greater wind exposure, mean depth, mixing depth and reduced external inputs of nutrients and organic matter, while increasing forest cover is linked to lower wind exposure, mixing depth and external nutrient input and higher input of organic matter. We used a comparative data set for 25 alkaline lakes in Denmark to explore relationships between lake metabolism, lake size, forest cover and the limnological variables using continuous measurements of light, temperature, wind speed and dissolved oxygen collected for one week to calculate whole-lake metabolism and bottle measurements to determine pelagic metabolism. In accordance with predictions we found that: (1) gross primary production (GPP) and community respiration (R) decline with lake size, (2) all lakes, but especially small forest lakes, have negative net ecosystem production (NEP < 0), (3) daily variability of lake metabolism decreases with lake size as a consequence of lower input of nutrients and organic matter per unit water volume, (4) the relative importance of benthic processes declines with lake depth and, thus, with lake area to the extent that lake area and depth are positively correlated, and (5) GPP declines and NEP becomes more negative with increasing forest cover. In conclusion, lake size and land use, are equally strong predictors of lakes metabolism as total phosphorus, algal biomass and DOC that are directly linked to photosynthesis and respiration.

Stammler, **K**. **L**., University of Western Ontario, London, Canada, kstammle@uwo.ca

Yates, A. G., Environment Canada, Burlington, Canada, Adam.Yates@ec.gc.ca

Bailey, R. C., University of Western Ontario, London, Canada, robert_bailey@cbu.ca

SEARCHING FOR BURIED TREASURE: CALCULATING THE EXTENT AND CHARACTERISTICS OF HEADWATER ENCLOSURE AND THEIR EFFECTS ON AQUATIC BIOTA

Headwater enclosure is a common practice in all agricultural areas, and is used to increase the efficiency of farming and reduce soil erosion. The incidence of headwater enclosure came to light in southwestern Ontario during a survey of municipal drains. Several drains appearing on the Ontario Ministry of Natural Resource's GIS flow layer, which shows all stream networks in Ontario, were not physically found during field surveys. Further exploration revealed that the pre-existing open channel at these sites had been buried and replaced with underground tile drains. It is not known the extent to which these headwater enclosures actually occur. The goal of my study is to quantify the occurrence of headwater enclosure and to describe the watershed conditions under which they occur and their effects on downstream ecosystems. ArcGIS has been used to map enclosures and describe their watersheds using available provincial and national data, such as soil type, geology and landuse. This research will help to define the issue of headwater enclosure and is the first step to understanding its potential impacts in stream agro-ecosystems.

Stamp, **J**. **D**., Center for Ecological Sciences, Tetra Tech, Inc., Montpelier, USA, Jen.Stamp@tetratech.com

Hamilton, A., Center for Ecological Sciences, Tetra Tech, Inc., Sante Fe, USA, Anna.Hamilton@tetratech.com

Zheng, L., Center for Ecological Sciences, Tetra Tech, Inc., Owings Mills, USA, Lei.Zheng@tetratech.com

Leppo, E. W., Center for Ecological Sciences, Tetra Tech, Inc., Owings Mills, USA, Erik.Leppo@tetratech.com

USING TRAITS METRICS TO EXAMINE STATE BIOMONITORING DATA FOR CLIMATE CHANGE EFFECTS

As part of the U.S. EPA/Global Change Research Program (GCRP)'s national initiative to examine climate change effects on aquatic ecosystems, we conducted pilot studies on macroinvertebrate data from the Maine, North Carolina and Utah state biomonitoring databases. These studies are among the first to evaluate routine U.S. state biomonitoring data for long-term climate-induced trends, and are valuable because they help further our understanding of climate change effects on aquatic systems, help establish expectations for biological responses to future climatic changes, highlight knowledge gaps and provide a solid foundation for future research. This presentation focuses on responses of ecological trait metrics related to temperature and hydrological preferences. The temperature preference metrics are unique in that they are derived primarily from weighted averaging or maximum likelihood estimates for each state database, and are therefore region-specific. The hydrologic metrics are based on suites of trait modalities expected to confer advantages in surviving projected hydrologic conditions. Overall results showed the temperature preference metrics to be more responsive than the hydrologic trait metrics to existing levels of climate-induced changes in the regions examined.

Stancheva, **R**., California State University, San Marcos, USA, rhristov@csusm.edu

Sheath, R. G., California State University, San Marcos, USA, rsheath@csusm.edu

Fetscher, E. A., Southern California Coastal Water Research Project, Costa Mesa, USA, bettyf@sccwrp.org

Kociolek, J. P., University of Colorado Boulder, Boulder, USA, Patrick.Kociolek@Colorado.EDU

Laslandes, B. S., University of Colorado Boulder, Boulder, USA, berengere.laslandes@free.fr

NITROGEN-FIXING BENTHIC ALGAL COMMUNITIES AS INDICATORS OF STREAM REFERENCE WATER QUALITY CONDITIONS AND NITROGEN AVAILABILITY

In coastal California streams, the diatoms Epithemia and Rhopalodia and heterocystous cyanobacteria frequently co-dominate periphyton assemblages. These taxa are capable of nitrogen fixation under nitrogen limitation. A morphometric analysis of nitrogen-fixing cyanobacterial endosymbionts in Epithemia turgida, E. adnata, E. sorex and Rhopalodia gibba from their stream habitats showed that the endosymbiont biovolume per diatom host cell is strongly negatively correlated to ambient nitrate. Using a modified method for soft-algae enumeration, it was determined that Nostoc verrucosum was the most common and abundant nitrogen fixer with ambient nitrate levels of < 0.007 mg/L. The sites at which both algal groups were recorded had a mean nitrate concentration of 0.0065 mg/L (range 0.0007 – 1.3662 mg/L), mean total N of 0.1028 mg/L (range 0.0014-2.3192 mg/L), and mean total P of 0.0065 mg/L (range 0.0002 – 0.3087 mg/L). In contrast, streams without nitrogen fixers had higher mean nutrient values (nitrate 1.58 mg/L, TN 2.283 mg/L and TP 0.0526 mg/L). Our study demonstrates that nitrogen-fixing cyanobacteria, both free-living and endosymbionts in Epithemia and Rhopalodia, are useful indicators of stream nitrogen limitation and reference water quality conditions.

Stanek, **J**. **E**., Clemson University, Clemson, SC, USA, jse@clemson.edu

Brown, B. L., Clemson University, Clemson, SC, USA, bbrown3@clemson.edu

THE EFFECT OF PREDATION AND IMMIGRATION ON AQUATIC MACROINVERTEBRATE COMMUNITY STRUCTURE: LOCAL VERSUS REGIONAL PROCESSES

A central theme in community ecology is the relative importance of local versus regional processes in determining community structure. In stream ecosystems local processes such as competition and predation have been shown to influence local community structure. In contrast, regional processes such as speciation, extinction, and immigration are more difficult to incorporate into ecological studies since they act on much larger spatial and temporal scales. We used an enclosure/exclosure field experiment in a 2 x 2 factorial repeated measures design to empirically examine how different degrees of predation and immigration affect aquatic macroinvertebrate community composition. Although predation and immigration did not display interactive effects, they both affected community structure. For predation treatment enclosures we increased predation with a large generalist predator (*Corydalus cornutus*). Since increased flows may be the main function of immigration for aquatic macroinvertebrates, we simulated increased immigration rates from flood events by adding macroinvertebrates as well as associated debris. In ecosystems where immigration is inherent, such as streams, it is important to consider both local and regional dynamics when trying to understand communities.

Stanford, **J**. **A**., The University of Montana, Flathead Lake Biological Station, Polson, USA, jack.stanford@umontana.edu

COMPARATIVE BIOPHYSICAL COMPLEXITY OF PACIFIC RIM SALMON RIVERS

A team of American and Russian scientists used a unified sampling protocol at 5 sentinel and 20 synoptic rivers in western USA, British Columbia, Alaska and Kamchatka to examine salmon productivity in relation to physical habitat, food webs, life histories and spawner returns. Measures from this Salmonid Rivers Observatory Network (SaRON) were used to calibrate satellite data that regionalized interpretations concerning influences of harvest and climate change on measured and potential salmon productivity of the North Pacific Rim. Scalable metrics describing geomorphic complexity of 1500 rivers were extracted from a novel satellite remote sensing data base. This biophysical data base also was populated by daily flows and temperatures predicted by a water and heat flux model driven by 5 downscaled IPCC forecasts out to year 2098. The model was 80% accurate in reproducing historical records. The overarching conclusions were a) that rivers with high physical complexity have the highest salmon based biodiversity and productivity, unless overharvested, and b) that major changes in biocomplexity will result from ongoing climate warming, but floodplain rivers, especially in Kamchatka, will be most resilient.

Stanish, **L**. **F**., University of Colorado, Boulder, USA, lee.stanish@colorado.edu

McKnight, D. M., University of Colorado, Boulder, USA, diane.mcknight@colorado.edu

ORANGE VERSUS BLACK: THE ROLE OF TEMPERATURE AND SOIL MOISTURE ON HABITAT PREFERENCES FOR STREAM ALGAL MATS

This study aims at determining influences of temperature and water availability on diatom communities in differing stream habitats. The McMurdo Dry Valleys (DV) comprise the largest ice-free region of Antarctica and are among the coldest, driest ecosystems on earth. During brief polar summers, DV glaciers are close to melting temperatures, making them susceptible to climate change. Aside from monitoring glaciers, ecological indicators of climate change would be useful. Diatoms are reliable ecological indicators and may therefore be useful for DV streams. Diatoms

live within benthic mats present in numerous DV streams. Diatom communities exhibit unique spatial distributions that correspond to different mat types, black (along stream margins) and orange (within the thalweg). Temperature and soil moisture probes were installed within black and orange mats for short durations in three DV streams. Results indicate that temperature and soil moisture regime differ between black and orange mats. Additionally, warmer streams have different temperature and soil moisture profiles than a cooler stream. These results suggest that temperature and soil moisture contribute to diatom community composition and are useful metrics for describing habitat preferences.

Starr, **S**. **M**., University of Alabama, Tuscaloosa, USA, smstarr@crimson.ua.edu
Sponseller, R. A., University of Alabama, Tuscaloosa, USA, rsponseller@as.ua.edu
Benstead, J. P., University of Alabama, Tuscaloosa, USA, jbenstead@bama.ua.edu

SPATIAL AND TEMPORAL PATTERNS OF INVERTEBRATE COMMUNITY STRUCTURE IN FLOODPLAIN HABITATS OF AN UNREGULATED RIVER

Understanding natural river-floodplain connections and their ecological significance remains an important research goal. Here we ask how temporal patterns of invertebrate community structure vary among floodplain features (streams, sloughs, depressions) associated with an unregulated fifth-order Coastal Plain river in the southeastern U.S. (Sipsey River, AL). We identified 23 sampling locations, representing diverse habitats of varying hydrologic permanence and proximity to the river. Sites were sampled for invertebrates seasonally; three representative locations were also sampled monthly to bimonthly as conditions allowed. Preliminary results indicate that invertebrate communities are dominated by Chironomidae, Oligochaeta, and Copepoda. Abiotic variables measured concurrently varied among sites, were linked to flood pulses that temporarily homogenized conditions, and were followed by periods of isolation during which habitat properties diverged. For example, spatial variation in water temperature was lowest during high-water periods in the fall and winter (minimum daily range 14.1-14.4˚C), and greatest in the spring and summer (maximum daily range 20.9-30.3˚C), when habitats became hydrologically disconnected from the river. Results highlight the role of hydrologic linkage to the main channel for spatial structure of floodplain habitats and communities.

Steel, **E**. **A**., PNW Research Station, USDA Forest Service, Olympia, USA, asteel@fs.fed.us
Lucero, Y., NW Fisheries Science Center, NOAA Fisheries, Seattle, USA, yasmin.lucero@gmail.com

LANDSCAPE SCALE DRIVERS OF RIVERINE CONDITION: UNTANGLING HUMAN IMPACTS AND NATURAL GRADIENTS

Aquatic networks are intricately linked to the landscapes through which they flow. Identifying and quantifying relationships among landscape patterns, anthropogenic disturbances, and aquatic ecosystems is a rapidly developing field. However, working over large scales to identify specific mechanisms linking landscape condition to instream responses poses considerable statistical challenges. Both Johnson and Gage (1997) and Allan (2004) identified difficulties caused by the covariation between anthropogenic influences and natural landscape gradients. In this paper, we tackle the inherent covariation between human impacts such as urban and rural residential development and natural landscape gradients such as valley form and geology, all of which impact aquatic networks. We quantify the degree of covariation by directly modeling human impacts across the Oregon Coast, USA. We demonstrate that the strength of correlations among human impacts and natural landscape gradients can vary dramatically with the scale of observation. And, even within a scale of interest, these relationships vary by sub-region. We then consider the implications of these underlying correlation structures for monitoring and understanding indicators of healthy river systems e.g., juvenile coho salmon distribution and abundance. We discuss implications for the design of monitoring programs and for the quantification of statistical models linking landscape-scale stressors and aquatic communities.

Steger, **K**., Uppsala University, Uppsala, Sweden, kristin.steger@ebc.uu.se
Premke, K., Uppsala University, Uppsala, Sweden, katrin.premke@ebc.uu.se
Gudasz, C., Uppsala University, Uppsala, Sweden, cristian.gudasz@ebc.uu.se
Sundh, I., SLU, Uppsala, Sweden, ingvar.sundh@mikrob.slu.se
Tranvik, L. J., Uppsala University, Uppsala, Sweden, lars.tranvik@ebc.uu.se

DYNAMIC MICROBIAL COMMUNITY IN BOREAL LAKE SEDIMENTS

Phospholipid fatty acids (PLFA) were used to determine microbial biomass and community structure in sediments of eight lakes with different concentrations of dissolved organic carbon (DOC) and total phosphorus (TP) during the course of a year. The total concentration of PLFA, an estimate of the microbial biomass, depended more on TP, a proxy for indigenous primary production (autochthonous), than on DOC, a proxy for terrestrial carbon input (allochthonous). However, sediments strongly impacted by allochthonous DOC supported higher microbial biomass only in the littoral zone, whereas in deeper sediments biomass dominated in lakes with lower DOC concentrations. The composition of PLFAs varied considerably over time, indicating rapid turnover of the total biomass. Accordingly, winter and spring samples were similar in microbial biomass within lakes, but community structure differed substantially. Across all lakes, the PLFA profiles revealed a general seasonal succession, i.e. when all lakes and seasons are compared, community composition was more similar within season than within lakes.

Stein, **R**. **A**., Ohio State University, Columbus, USA, stein.4@osu.edu
Hale, R. S., Ohio Division of Wildlife , Columbus, USA, Scott.Hale@dnr.state.oh.us

GIZZARD SHAD, TERMINAL PREDATORS, AND ANGLERS: ATTEMPTING TO FIND THE MAGIC BULLET FOR OHIO RESERVOIRS

Using the partnership between the Ohio Department of Natural Resources and Ohio State University as a backdrop, we describe how experiments across multiple scales provide mechanistic insight into reservoir functioning and successful fish management. In productive, onstream impoundments, gizzard shad reach extremely high densities, suppressing zooplankton, outcompeting early life stages of resident sport fishes, and regulating fish community composition. In an effort to convert gizzard shad biomass into sport fish and perhaps reduce shad numbers (to improve recruitment of resident predators), we combined small-scale experiments with whole-system manipulations using terminal predators including muskellunge, saugeye (a walleye x sauger hybrid), and hybrid striped bass (striped bass x white bass). These predators, while unable to reduce gizzard shad populations (per energetics modeling and acoustics), did generate impressive fisheries. Because gizzard shad recruitment correlates well with reservoir productivity, managers should consider a twofold approach that incorporates stocking predators and managing land use in watersheds. As exemplified by these findings, our long-standing partnership has generated a successful science-based management program, one characterized by mutual respect and a deep appreciation of how aquatic ecosystems work.

Steinbring, **C**. **J**., University of Minnesota Duluth, Duluth, USA, stei0509@d.umn.edu
Kujawinski, E. B., Woods Hole Oceanographic Institution, Woods Hole, USA, ekujawinski@whoi.edu
Minor, E. C., University of Minnesota Duluth, Duluth, USA, eminor@d.umn.edu

ULTRA-HIGH RESOLUTION MASS SPECTROSCOPY FOR MOLECULAR LEVEL CHARACTERIZATION OF DISSOLVED NATURAL ORGANIC MATTER IN THE LAKE SUPERIOR WATERSHED

Recent studies have begun to explore the molecular-level link between terrestrial and aquatic dissolved organic matter (DOM) in rivers and estuaries and their receiving oceans or lakes. This is of interest because of DOM's roles in carbon, nitrogen and phosphorus cycles and its reactivity with trace metals and anthropogenic organic molecules. These recent studies, primarily in brackish or salt-water systems, have shown that allochthonous components of DOM contain more aromatic compounds, while autochthonous components contain more aliphatic compounds. Here we extend these techniques to a temperate oligotrophic large lake (Lake Superior). Samples from the lake and watershed, including swamp, creek, river, near-shore lake, and offshore lake sites are compared using Fourier transform ion cyclotron resonance mass spectroscopy. Results are analyzed using cluster analysis, non-metric multidimensional scaling, and Van Krevelen diagrams. We see that the composition of autochthonous and allochthonous components of DOM vary between sites with intriguing similarities and differences.

Steinweg, C., Iowa State University, Ames, USA, clairest@iastate.edu
Poole, **K**. **E**., Iowa State University, Ames, USA, kpoole@iastate.edu
Downing, J. A., Iowa State University, Ames, USA, downing@iastate.edu

DISSOLVED ORGANIC CARBON IN EUTROPHIC LAKES IS RELATED TO PHYTOPLANKTON, NOT WATERSHED LAND USE

Variations in dissolved organic carbon (DOC) concentrations among lakes are largely thought to result from differences in land use, with bogs, wetlands,

forests, and other organic-matter rich land uses contributing the most substantial quantities. Studies of DOC and carbon evasion are frequently performed in predominantly low-nutrient lakes whereas less is known about the dynamics of DOC in eutrophic ones. We studied the relationship between DOC and watershed and lake characteristics in 137 lakes in a region known for the predominantly agricultural disturbance, highly disturbed organic soils, and extremely high agricultural production. Although we postulated that agriculture might induce high mobility and watershed losses of DOC, we could ascribe little significant variation in DOC concentrations among lakes to land uses of any kind. Instead, DOC concentrations were significantly correlated with phytoplankton biomass (measured as chlorophyll a), volatile suspended solids in the water column, and nutrient concentrations. Independent lake and watershed budgets show that DOC increases as water flows through lakes. These lines of reasoning suggest that much of the DOC in eutrophic lakes is autochthonous.

Stelzer, **R. S.**, University of Wisconsin Oshkosh, Oshkosh, USA, stelzer@uwosh.edu
Bartsch, L. A., United States Geological Survey, La Crosse, USA, lbartsch@usgs.gov
Richardson, W. B., United States Geological Survey, La Crosse, USA, wrichardson@usgs.gov
Strauss, E. A., University of Wisconsin La Crosse, La Crosse, USA, strauss.eric@uwlax.edu

THE DARK SIDE OF THE HYPORHEIC: NITROGEN PROCESSING AND PROFILES IN DEEP STREAM SEDIMENTS

Processes in riparian zones, hyporheic zones, and surface water of lotic ecosystems can remove substantial amounts of nitrogen. Much less is known about nitrogen processing in deep sediments below the hyporheic zone. Our main objective was to determine how nitrate processing changed with depth in stream sediments. We measured denitrification rates and assessed variation in groundwater nitrate concentration in sediments from upwelling locations in a Wisconsin sand plain stream. Sediment cores to 30 cm depth were collected and acetylene inhibition was used to measure denitrification rates of core sections. Peepers and wells to a depth of 70 cm were used to measure gradients in groundwater nitrate concentration. Mean areal denitrification rate was 60.1 mg N2O-N m-2 h-1. Core sections deeper than 5 cm accounted for 66 percent of the areal denitrification rate. Nitrate profiles suggested that nitrate loss occurred along upwelling flow paths at sediment depths between 5 and 45 cm. Our results suggest than nitrate processing can be substantial at depth in groundwater-fed streams. Denitrification estimates based only on shallow sediment cores may underestimate denitrification rates in lotic ecosystems.

Stephen, **M. L.**, University of Notre Dame, Notre Dame, USA, stephen.2@nd.edu
Tank, J. L., University of Notre Dame, Notre Dame, USA, tank.1@nd.edu
Roley, S. S., University of Notre Dame, Notre Dame, USA, Sarah.S.Roley.1@nd.edu

THE INFLUENCE OF TWO-STAGE RESTORATION ON SEDIMENT AND NITROGEN REMOVAL ACROSS A RANGE OF MIDWEST AGRICULTURAL STREAMS

Conventionally managed streams in the agricultural Midwest can be a source of excess nutrients and sediments that pollute downstream ecosystems. Two-stage ditch restoration is a novel strategy that may mitigate these issues through the construction of floodplain benches within formerly incised channels. A demonstration project in Shatto Ditch, IN has shown that 600m of two-stage can reduce sediment export with a 43% decrease in mean daily turbidity in the two-year period post-construction. Two-stage ditch conversion also improved reach-scale N removal via denitrification by increasing bioreactive surface area. Unfortunately, due to very high nutrient loading in Shatto, we could not detect a decrease in water column nitrate concentrations. There were also no differences in reach-scale substrate composition and fine benthic organic matter remained the dominant substrate in the two-stage reach. New monitoring has expanded to a wider range of two-stage streams that vary in median flow (10-70 L/s), two-stage age (2-8yrs), and external loading of sediments and nitrate-N (0.5-10 mg/L) to determine if results from the demonstration project are representative of two-stage efficacy across a range of agricultural streams.

Sterling, **J. L.**, University of Georgia Odum School of Ecology, Athens, USA, sterling@uga.edu
Rosemond, A. D., Univeristy of Georgia Odum School of Ecology, Athens, USA, rosemond@uga.edu
Brown, R. D., University of Georgia Odum School of Ecology, Athens, USA, reiddbrown@gmail.com

VARIATION IN ECOSYSTEM FUNCTION MAY BE MORE TELLING THAN THE MEAN: EVIDENCE FROM WOOD BREAKDOWN RATES IN URBAN STREAMS

Ecosystems respond to disturbance via changes in structure and function, which can respond by shifts in mean values or their variation. We tested whether wood breakdown rates were different in either mean values or their variation in watersheds across 4 classifications of watershed disturbance. We also tested whether biotic and abiotic drivers of breakdown rate were significantly related to aspects of the mean or variation in rates. We found that breakdown rates (k) of white oak wood veneers were significantly higher in suburban vs forested watersheds, with intermediate values in urban and transitional watersheds. Dissolved inorganic nitrogen (DIN) concentrations, conductivity and abrasive flows explained little of the variability in mean breakdown rates among streams. Within-site coefficients of variation (CV) in breakdown rates were greater for impaired vs unimpaired sites, but were not different among disturbance categories. Breakdown CVs were significantly related to DIN concentrations (+). Results suggest that the variability in ecological responses in disturbed systems may reveal more about the stressors impacting disturbed systems than the mean ecological response.

Stets, **E. G.**, U.S. Geological Survey, Boulder, CO, USA, estets@usgs.gov
Striegl, R. G., U.S. Geological Survey, Boulder, CO, USA, rstriegl@usgs.gov
Crawford, C. G., U.S. Geological Survey, Indianapolis, IN, USA, cgcrawfo@usgs.gov
Myers, D. N., U.S. Geological Survey, Reston, VA, USA, dnmyers@usgs.gov

CENTURY-SCALE TRENDS IN STREAM NITROGEN CONCENTRATION IN SELECTED RIVER REACHES OF THE UNITED STATES

The causes of modern nitrogen (N) pollution in rivers have been thoroughly documented but a scarcity of data from the early twentieth century limits our ability to place water quality changes in the proper historical context. Most of the water quality data was collected subsequent to degradation and therefore limits our understanding of the magnitude of change. We compiled historical water quality data from public health surveys, municipal drinking water facilities, U.S. Geological Survey reports, and other sources to create, as completely as possible, century-long water quality records for selected river reaches throughout the United States. We combined this information with ancillary data from U.S. Geological Survey stream gages and the U.S. Census of Agriculture to better understand the timing and magnitude of N pollution on a century timescale. We will present results from three contrasting sites which differ in the degree of agricultural development, urbanization, and N pollution. We find that N yield from watersheds has increased dramatically since the mid-twentieth century, especially in the wettest years, suggesting that nonpoint sources are a primary source of modern N pollution.

Stevenson, **R. M.**, State University of New York College at Oneonta, Oneonta, USA, stevrm77@oneonta.edu
Heilveil, J. S., State University of New York College at Oneonta, Oneonta, USA, heilvejs@oneonta.edu

DEVELOPMENT OF MOLECULAR MARKERS FOR POPULATION ECOLOGY STUDIES IN *SIALIS INFUMATA* NEWMAN (MEGALOPTERA: SIALIDAE).

The ability to track movement of populations, understand historical migrations, and decipher life history traits can be greatly aided by the availability of a range of molecular markers. Unfortunately, few such markers exist for most aquatic insects. *Silais infumata* Newman (Megaloptera: Sialidae) is a widespread aquatic insect for which few specific markers exist. Microsatellite markers have now been developed for the species and using a modification of Suppression Subtractive Hybridization, sex-specific markers are also being developed.

Stevenson, **R. J.**, Michigan State University, East Lansing, USA, rjstev@msu.edu
Zalack, J., Michigan State University, East Lansing, USA, zakack@msu.edu
Wolin, J., Cleveland State University, Cleveland, USA, j.wolin@csuohio.edu

DEVELOPING BIOLOGICAL CRITERIA BY RELATING THRESHOLDS IN BIOLOGICAL RESPONSES TO GRADIENTS OF BIOLOGICAL CONDITION

Metrics characterizing biological diversity are commonly used to assess condition of freshwater ecosystems. Condition can be assessed using a continuous scale, but usually benchmarks are established along gradients of biological condition to assign categorical descriptions of condition (e.g., good, fair, and poor), which can be used as water quality criteria and triggers for management actions. Benchmarks for characterizing biological condition (BCBC) have been established using many methods, but are seldom compared. We compare BCBC that were developed with sedimentary diatom data for the USEPA National Lakes Assessment using the 75th and 95th percentiles of reference condition and using thresholds in biodiversity metrics along the gradients of biological condition. The reference condition approach was easier to use for establishing BCBC, required fewer decisions, and has a history as a standard approach in national assessments of freshwaters in the United States. The threshold approach provided substantially different BCBC than the reference approach, reduced problems with low reference site number by allowing use of all data, generated less statistical artifacts of reference site distributions, and enabled more direct relationship to effects on biodiversity.

Steward, **A. L.**, Griffith University, Brisbane, Australia, a.steward@griffith.edu.au
Bunn, S. E., Griffith University, Brisbane, , s.bunn@griffith.edu.au
Tockner, K., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, tockner@igb-berlin.de
Sheldon, F., Griffith University, Brisbane, Australia, f.sheldon@griffith.edu.au
Choy, S., Department of Environment and Resource Management, Brisbane, Australia, choys@derm.qld.gov.au

COLONIZATION AND USE OF DRY STREAM BEDS BY TERRESTRIAL INVERTEBRATES

Temporary streams that cease to flow and become dry are found on every continent, including Antarctica, and comprise much of the channel network in many river basins, especially those in arid and semi-arid regions. Aquatic and terrestrial habitats in these streams expand, contract, and disappear through time. While much attention has been given to the response of aquatic invertebrates to drying in temporary streams, little attention has been paid to the dry phase. At these times, streams become temporary habitat for terrestrial biota, such as invertebrates. Preliminary results show that dry stream beds contain a diverse, and often abundant, terrestrial invertebrate fauna. Pit-fall traps and an active collection method yielded numerous taxa, particularly of ants, spiders, and beetles. We developed a conceptual model of the invertebrate community in temporary streams, and in this paper focus on the dry stream biota. We test whether dry stream beds are colonised by terrestrial invertebrates from the adjacent riparian zone, or whether they are home to a unique 'dry stream' assemblage. We also explore how the terrestrial invertebrate community changes along a drying gradient.

Stewardson, **M. J.**, eWater CRC, The University of Melbourne, Parkville, Australia, mjstew@unimelb.edu.au
Webb, J. A., eWater CRC, The University of Melbourne, Parkville, Australia, angus.webb@unimelb.edu.au

ANALYSIS OF HUMAN IMPACTS ON SUSPENDED SEDIMENT LOADS IN THE MEKONG RIVER USING A HIERARCHICAL BAYSIAN MODEL

There is concern for the environmental and social Impacts of reduced suspended sediment and nutrient loads delivered to the lower Mekong River as a consequence of sediment trapping in headwater and mainstream dams. This presentation describes a hierarchical Bayesian analysis of suspended sediment data collected along the Mekong River since 1962. The analysis demonstrates statistically significant trends in sediment loads over this period with both increasing and decreasing loads in different portions of the Mekong Basin. Step changes in suspended sediment concentration with construction of mainstream dams in China are less clear with critical gaps in the data set. However there may be a step reduction in sediment loads following completion of the Dachaoshan Dams in June 1993.

Stewart, **M. F.**, West Virginia University, Morgantown, USA, fiona1203@gmail.com
Merovich, G. M., West Virginia University, Morgantown, USA, gmerovic@mix.wvu.edu
Petty, J. T., West Virginia University, Morgantown, USA, jtpetty@wvu.edu

EFFECTS OF ACID PRECIPITATION AND ACID MINE DRAINAGE ON LEAF LITTER DECOMPOSITION RATES IN CENTRAL APPALACHIAN STREAMS

Acid precipitation and acid mine drainage have dramatically altered chemical conditions and biological assemblages in streams throughout the central Appalachians. The objectives of this study were to: 1- quantify differences in organic matter decomposition among reference streams, streams impacted by acid precipitation, and streams impacted by acid mine drainage; and 2- determine if lowered decomposition rates are the result of reduced microbial activity or reduced shredder abundance or both. We quantified water chemistry, organic matter decomposition, microbial activity, and macroinvertebrate community structure in 15 headwater streams in the Allegheny Plateau ecoregion (5 circum-neutral reference, 5 AMD, and 5 acid precipitation). Water chemistry and benthic invertebrate communities were sampled in spring and fall, and decomposition rates were quantified from leaf packs deployed for a period of 120 days. Microbial activity was measured as microbial respiration, ergosterol content, and capillary DNA sequencing. AMD resulted in dramatically altered macroinvertebrate assemblages and reduced overall OM decomposition. Decomposition rates in acid precipitation streams were intermediate to AMD and reference streams. Overall, decomposition rates were correlated with both benthic invertebrate diversity and microbes suggesting a combined role of shredders and microbial activity in these systems.

Stewart, **R. J.**, University of New Hampshire, Durham, USA, rob.stewart@unh.edu
Wollheim, W. M., University of New Hampshire, Durham, USA, wil.wollheim@unh.edu
Lammers, R. B., University of New Hampshire, Durham, USA, Richard.Lammers@unh.edu
Fekete, B. M., The City College of New York, New York, USA, bfekete@ccny.cuny.edu

A PROCESS-BASED APPROACH FOR MODELING GLOBAL WATER TEMPERATURES IN LARGE RIVERS

Freshwater temperature is a fundamental variable that influences key ecosystem processes such as metabolic rates, nutrient uptake, biological production, and habitat. To date, there have been no attempts to predict water temperature at macro-scales using process-based models. Here, a global-scale water temperature model was developed within the Framework for Aquatic Modeling in the Earth System (FrAMES). The model predicts average daily water temperatures at a 30-minute river grid network resolution based on mixing of terrestrial runoff and re-equilibration during discharge routing. The empirical re-equilibration model accounts for variable solar radiation, air temperature, and hydraulic dimensions. Average predicted water temperatures match global daily observations well with an average Index of Agreement of 0.71 for 195 stations (1975 – 2001). Predictions are more accurate at higher latitudes (30 to 70 degrees) and less accurate at lower latitudes (10 to 30 degrees). Longitudinal profiles along large river transects are consistent with the expectation that re-equilibration with ambient air temperature is a dominant influence on water temperatures. This work provides a foundation for ongoing investigations of macro-scale ecosystem processes and energy fluxes to the world's oceans.

Stieglitz, **T. C.**, LEMAR UMR6539, European Institute of Marine Studies, University of Brest , Plouzane, France, thomas.stieglitz@jcu.edu.au
Holliday, D., School of Environmental Science, Murdoch University, Perth, Australia, d.holliday@murdoch.edu.au
Ridd, P. V., School of Engineering and Physical Sciences, James Cook University, Townsville, Australia, Peter.Ridd@jcu.edu.au
Cook, P. G., CSIRO Land and Water & National Centre for Groundwater Research and Training, Urrbrae, Australia, peter.g.cook@csiro.au
Read, W. W., School of Engineering and Physical Sciences, James Cook University, Townsville, Australia, wayne.read@jcu.edu.au

GEOLOGICAL CONTROLS AND TIDAL FORCING OF SUBMARINE GROUNDWATER DISCHARGE FROM A CONFINED AQUIFER, ELIM BEACH, NORTHEAST AUSTRALIA

Discharge of fresh groundwater from large, discrete springs in the intertidal zone is documented at a remote beach in North East Australia. The geologic

and hydraulic controls of this spring discharge were investigated, using a combination of geological, geophysical and hydrological tools. A sharp subsurface gradient of electrical ground conductivity as well as strata recovered from sediment cores indicate the presence of a sandy clay layer providing aquifer confinement ca. 1 m below the seafloor. Spring discharge occurs where this layer is breached. Net hydraulic head and groundwater discharge flux were inversely correlated with tidal water level, but remained positive throughout the tidal cycle. An increase in hydraulic head with increasing tidal water level was observed, which can be explained by a change in hydraulic pressure of the confined aquifer in response to a differential pressure forcing at the seaward limit of the confining sedimentary unit. Long-term time series of discharge volume recorded with purpose-built seepage meters indicate no direct response to rainfall, and rather suggest a substantial lag between recharge and discharge, which is also confirmed by CFC groundwater ages of tens of years. The continuous presence of fresh groundwater in the intertidal zone affects the nearshore vegetation - Melaleuca trees which are usually associated with freshwater swamps are here growing in the intertidal zone, with root inundation occurring at every high tide.

Stoddard, **J**. **L**., U.S. Environmental Protection Agency, Corvallis, USA, stoddard.john@epa.gov

Oelsner, G. P., U.S. Environmental Protection Agency, Corvallis, USA, oelsner.gretchen@epa.gov

SYNCHRONICITY OF LONG-TERM NITRATE PATTERNS IN FORESTED CATCHMENTS ACROSS THE NORTHEASTERN U.S.

Nitrogen movement through minimally-disturbed catchments can be affected by a variety of biogeochemical processes, climatic effects, hydrology and in-stream or in-lake processes. These combine to create dizzying complexity in long-term and seasonal nitrate patterns, with adjacent catchments often exhibiting very different nitrate behavior. We examined long-term (1993-2008) patterns of nitrate concentrations in 60 forested catchments from U.S. EPA's Long-Term Monitoring Project. Normalized and smoothed nitrate patterns exhibit large-scale (i.e., regional) patterns amid all of their complexity. Concentration peaks occur at nearly all sites in 1990 and again in 1997. After 1997, behavior is more varied, but still shows groups of sites with synchronous peaks in concentrations. The 1990 peak has been attributed (Mitchell et al. 1996) to an exceptionally cold winter, with widespread soil freezing. Although climate is an obvious suspect for causing such regional behavior, it is difficult to identify any climatic patterns that explain those of nitrate.

Stoll, **S**., Research Institute Senckenberg, Gelnhausen, Germany, stefan.stoll@senckenberg.de

Haase, P., Research Institute Senckenberg, Gelnhausen, Germany, peter.haase@senckenberg.de

Sundermann, A., Research Institute Senckenberg, Gelnhausen, Germany, andrea.sundermann@senckenberg.de

LOW DISPERSAL CAPABILITIES AND DEPLETED SPECIES POOL IN MACROINVERTEBRATES: LESSONS FROM 24 CASE STUDIES FOR FUTURE RIVER MANAGEMENT PLANS

Previous studies identified dispersal capabilities as a key factor for benthic invertebrate re-colonization of formerly degraded river sections. We analyzed data from 24 hydromorphologically restored sections in Germany as well as 1231 data sets from adjacent river reaches within rings of 0-5, 5-10, and 10-15 km distance to the restored section. We showed that the colonization of the new habitats by an approved set of indicator species for good and bad habitat quality depended on the presence of source populations in the close surroundings. Effective dispersal distances of benthic macroinvertebrates was limited to 0–5 km, while potential source populations further away did not influence the composition of the emerging benthic invertebrate assemblages. In many of the catchments studied, the species pools were overall depleted, and consequently, even though hydromorphological quality of the new habitats was high, only assemblages mainly composed of tolerant taxa materialized. These results underline the importance of integrated management plans on the catchment scale, localizing potential source populations and being aimed at creating well-spaced stepping stones to allow dispersal of target species.

Stome, **M**. **C**., University of New Mexico, Albuquerque, USA, stone@unm.edu

Sada, D., Desert Research Institute, Reno, USA, dsada@dri.edu

Suchocki, G., University of New Mexico, Albuquerque, USA, suchocki@unm.edu

DETECTING IMPACTS OF CLIMATE CHANGE ON ARID LAND SPRING-FED AQUATIC SYSTEMS: AN EXAMPLE FROM A DEATH VALLEY NATIONAL PARK THERMAL SPRING

Substantial attention is given to the impact of climate change on lotic system temperature, hydrographs, and flood frequency, and the concomitant influence on water supplies, fishes, and benthic communities. Less attention is given to groundwater, which supports springs that supply the only surface water over much of the western US arid land. Many are also biodiversity hot spots and support large numbers of obligatory spring-dwelling, rare, aquatic vertebrates and invertebrates that occupy relict aquatic systems. In this study, insight into physicochemical change caused in a thermal spring flowing approximately 340 l/min was examined by incrementally decreasing discharge by 10, 20, 40, and 60 percent for short periods of time. At maximum reduction at transects located 100 m downstream from the source, temperature decreased 4.3oC, mean water column velocity decreased by nearly 43 percent, and aquatic habitat volume decreased by approximately 40 percent. A hydraulic and temperature model was also applied and calibrated to allow for investigations over a wider range of environmental conditions. The results will provide insight into the susceptibility of arid land spring-fed aquatic systems to climate change.

Strandberg, **U**., University of Washington, Seattle, USA, strand4@u.washington.edu

Taipale, S. J., University of Washington, Seattle, USA, sami.taipale@bytl.jyu.fi

Kainz, M. J., Danube University Krems, Lunz am See, Austria, martin.kainz@donau-uni.ac.at

Brett, M. T., University of Washington, Seattle, USA, mtbrett@u.washington.edu

BIOCONVERSION OF OMEGA3 AND OMEGA6 POLYUNSATURATED FATTY ACIDS IN *DAPHNIA MAGNA*

Consumers at higher trophic levels are dependent on the trophic transfer of omega3 and omega6 polyunsaturated fatty acids (ω3 and ω6 PUFA) which are synthesized by primary producers and transferred up in the food chain. Bioconversions of fatty acids potentially change the availability of physiologically important ω3 and ω6 PUFA: eicosapentaenoic acid (EPA; 20:5ω3), arachidonic acid (ARA; 20:4ω6), docosahexaenoic acid (DHA; 22:6ω3) and the corresponding C_{18} precursors for top predators. Examining bioconversion pathways for ω3 and ω6 PUFA we maintained *Daphnia magna* for 5 days on ^{13}C enriched *Scenedesmus obliquus* which was supplemented with liposomes (lipid vesicles) containing one of the following PUFA: linoleic acid (18:2ω6), ω6docosapentaenoic acid (ω6DPA; 22:5ω6), stearidonic acid (SDA; 18:4ω3) or DHA. GC-FID and GC-SIRMS analyses of fatty acid composition and compound specific stable isotope ratios showed that *Daphnia* retroconverted C_{22} PUFA to C_{20} PUFA, i.e DHA was retroconverted to EPA and ω6DPA to ARA. Retroconversion of C_{22} to C_{20} PUFAs was also more efficient than bioconversion (involving elongation and desaturation) of C_{18} to C_{20} PUFA, suggesting compound specific preferences for PUFA conversion.

Strauss, **E**. **A**., University of Wisconsin - La Crosse, La Crosse, USA, strauss.eric@uwlax.edu

Richardson, W. B., USGS - Upper Midwest Environmental Sciences Center, La Crosse, USA, wrichardson@usgs.gov

Bartsch, L. A., USGS - Upper Midwest Environmental Sciences Center, La Crosse, USA, lbartsch@usgs.gov

Kreiling, R. M., USGS - Upper Midwest Environmental Sciences Center, La Crosse, USA, rkreiling@usgs.gov

Cavanaugh, J. C., NRCS, St. Peter, MN, USA, Jennifer.Cavanaugh@mn.usda.gov

SPATIOTEMPORAL PATTERNS AND EFFECTS OF NITROGEN CYCLE PROCESSING IN THE UPPER MISSISSIPPI RIVER: A SYNTHESIS OF A DECADE OF INVESTIGATION.

Annually, the Mississippi River transports 1.57 Tg of nitrogen to the Gulf of Mexico. Modeling studies of nitrogen flux in large rivers, including the Mississippi River, suggest that much of the nitrogen that enters rivers is conserved and exported. We began investigating Navigation Pool 8 of the Upper Mississippi River in 1999 and have found patterns of nitrogen concentrations and cycling (e.g., nitrification and denitrification) to be complex and vary with habitat type and season. Processing rates were highest during warmer months and in depositional zones away from areas of consistently high discharge. Connectivity (i.e., delivery) of water among the different habitats appears to be a critical factor for supporting nitrogen processing. An extrapolation of our results to the Mississippi River from Minneapolis, Minnesota to the Atchafalaya

River diversion in Louisiana suggested a system-wide in-stream nitrogen loss of ~9.5% of the total nitrogen load. Overall, our studies support high throughput of nitrogen, but indicate that habitat diversity and channel complexity are driving factors that influence retention time, depth, and other physical/chemical variables that lead to increased riverine nitrogen processing.

Strayer, **D**. **L**., Cary Institute of Ecosystem Studies, Millbrook, USA, strayerd@caryinstitute.org
Malcom, H. M., Cary Institute of Ecosystem Studies, Millbrook, USA, malcomh@caryinstitute.org

RECRUITMENT FAILURE IN FRESHWATER MUSSEL (UNIONIDAE) POPULATIONS

Elliptio complanata is the most widespread and abundant unionid mussel in streams and rivers of northeastern North America. However, many of its populations have not recruited regularly or at all in recent years, and may soon disappear. We quantitatively documented the size- and age-structure of 13 populations of Elliptio in southeastern New York, and found highly varied age-structures, including populations with no evidence of any recruitment in the last few decades. Surprisingly, other mussel species at these sites have been recruiting, suggesting that the recruitment failure is species-specific. We tested three possible causes of recruitment failure in Elliptio: excessive un-ionized ammonia in interstitial waters, excessive loading of fine sediments, and recent outbreaks of the invasive rusty crayfish throughout the region. At this point, we are unable to attribute Elliptio's recruitment failure to any single cause.

Strecker, **A**. **L**., University of Washington, Seattle, USA, angelast@uw.edu
Olden, J. D., University of Washington, Seattle, USA, olden@uw.edu
Whittier, J., Kansas State University, Manhattan, USA, whittier@ksu.edu
Paukert, C. P., Kansas Cooperative Fish and Wildlife Research Unit, Manhattan, USA, cpaukert@ksu.edu

SETTING CONSERVATION PRIORITIES FOR NATIVE FISHES IN THE LOWER COLORADO RIVER BASIN

Anthropogenic impacts to freshwater ecosystems may be particularly severe given the influence of upstream disturbances on downstream habitats and biota. In the American Southwest, the combined influence of river regulation, non-native species, land use changes, and climate change have had significant effects on the native fish community, especially highly endemic fauna. Our objective was to create a robust conservation plan for native fishes in the Lower Colorado River Basin that incorporates connectivity of river systems, influences of non-native species, and future climate and land use scenarios. To do this, we first modelled the distribution of fishes using multivariate adaptive regression splines. This technique allows non-linear responses to environmental variables and can be used in a multivariate context. Using recent advancements in conservation planning methodologies, we generated several landscapes of conservation priorities with differential emphasis on native species endemic to the basin, expansions on existing conservation structures, as well as minimizing threats associated with non-native fishes, climate change and population projections. This research will yield insight into the complexities of conservation planning in multiple stressor environments of the American Southwest.

Striebel, **M**., WasserCluster Lunz, Lunz, Austria, striebel@limnology.eu
Andersen, T., University of Oslo, Oslo, Norway, tom.andersen@bio.uio.no
Stibor, H., European Institute for Marine Studies, Plouzan, France, Herwig. Stibor@univ-brest.fr

PHYTOPLANKTON BIODIVERSITY AND ITS IMPACT ON ZOOPLANKTON GROWTH AND DIVERSITY

Phytoplankton with high biomass carbon to phosphorus (C:P) ratios are considered to be low quality food for cladoceran zooplankton such as Daphnia. Although the stoichiometry of Daphnia varies somewhat with algae and diet, they maintain a relatively homeostatic composition with low C:P biomass composition compared to their food. Increasing phytoplankton biodiversity can result in increasing carbon assimilation, but not in a comparable increase of phosphorus uptake, and thus in increasing biomass C:P ratios. Phytoplankton biodiversity could therefore also have consequences for freshwater phytoplankton-zooplankton interactions and can thereby have an impact on pelagic food web dynamics: (i) High C:P ratios of phytoplankton implicate low food quality for zooplankton, and can slow down the zooplankton growth and thereby stabilize fluctuations in zooplankton population dynamics. (ii) High C:P ratios of phytoplankton may also reduce the strength of concurrence interactions between different zooplankton species and thereby allow coexistence. In this case a higher phytoplankton biodiversity would result in higher zooplankton diversity. We investigated the effects of phytoplankton biodiversity on phytoplankton-zooplankton interactions, on zooplankton growth and diversity.

Striegl, **R**. **G**., USGS National Research Program, Boulder, USA, rstriegl@usgs.gov
Dornblaser, M. M., USGS National Research Program, Boulder, USA, mmdornbl@usgs.gov
Rover, J. A., USGS EROS Science Center, Sioux Falls, USA, jrover@usgs.gov
Walvoord, M. A., USGS National Research Program, Denver, USA, walvoord@usgs.gov
Wylie, B. K., USGS EROS Science Center, Sioux Falls, USA, wylie@usgs.gov

LARGE SCALE ASSESSMENT OF CARBON GAS EXCHANGE WITH RIVER SYSTEMS - THE YUKON RIVER BASIN EXAMPLE

Streams and rivers are global sources of greenhouse gases to the atmosphere. On an annual time scale, carbon gas emissions by some river systems can equal or exceed their lateral flux of aqueous carbon species to coastal margins. Assessment of these gas fluxes is, however, difficult to accurately quantify due to temporal and spatial heterogeneity of aqueous carbon dioxide and methane partial pressures, gas transfer velocities, and the surface area dynamics of ice and water. Consequently, a variety of field measurement, modeling, and remote sensing methods are needed to conduct large-scale assessments of river gas fluxes. The Yukon River is an example of such a system. It is one of the largest unregulated rivers in the world; receiving water from many tributaries having different geochemistries, flow conditions and seasonal ice covers. We discuss the field, modeling and remote sensing approaches used to quantify carbon dioxide and methane fluxes from streams and rivers in the basin, compare gas emissions to lateral carbon fluxes, and speculate on changes in gas emission that may occur in response to permafrost thaw throughout the basin.

Stringer, **S**. **M**., Center for Ecological Sciences, Tetra Tech, Santa Fe, NM, USA, shann.stringer@tetratech.com
Davis, A., , Albuquerque, NM, USA, a.davis@comcast.net
Dentino, C., New Mexico Environment Department, Surface Water Quality Bureau, Santa Fe, NM, USA, charles.dentino1@state.nm.us
Schiffmiller, G., New Mexico Environment Department, Surface Water Quality Bureau, Santa Fe, NM, USA, gary.schiffmiller@state.nm.us

WATER QUALITY MONITORING OF THE MIDDLE RIO GRANDE, NEW MEXICO

The New Mexico Environment Department, Surface Water Quality Bureau (SWQB) conducted water quality sampling in the the Middle Rio Grande (MRG) from Bosque del Apache National Wildlife Refuge north to the Angostura Diversion, upstream of Bernalillo, New Mexico, covering approximately 290 km of river. Efforts included monthly sampling of water between March and November during 2005, quarterly sampling of water and sediment between 2006 and 2008, annual sediment toxicity sampling, and fish tissue collections, at as many as twenty stations. The SWQB also solicited and compiled water chemistry data for sites on the MRG within the study area from other sources, including the USGS and UNM. In general the results of the water, sediment, and fish tissue analyses performed for this study identified several water quality issues. The results indicate that Rio Grande silvery minnow are exposed to conditions that may impact behavior, reproduction, and respiration.

Stubbington, **R**., Loughborough University, Loughborough, United Kingdom, R.Stubbington@lboro.ac.uk
Wood, P. J., Loughborough University, Loughborough, United Kingdom,
Reid, I., Loughborough University, Loughborough, United Kingdom,

BENTHIC AND HYPORHEIC INVERTEBRATE COMMUNITY INTERACTIONS AT SITES WITH CONTRASTING ANTECEDENT FLOW PERMANENCE

The River Lathkill is a second order temperate stream in which flow permanence varies over small spatial scales due to karst geology and underlying mining drainage levels. We examined changes in benthic and hyporheic invertebrate community composition at historically intermittent and perennial sites, during a four-month flow recession. A decline in discharge was accompanied by reductions in water depth, wetted width and flow velocity, resulting in partial drying of the surface sediments, whilst the reduction in the extent

of the hyporheic zone was minimal. Changes in the benthic invertebrate community, including significant increases in the abundance of the dominant amphipod *Gammarus pulex*, were similar at sites with differing antecedent flow permanence. Increased population densities may have increased biotic pressures in the surface sediments. The abundance of predominantly benthic invertebrates in the hyporheic zone increased throughout the flow recession, particularly at sites with intermittent antecedent flow. It is hypothesized that the hyporheic zone provided refuge from increased biotic pressures in the surface sediments, and that this refugial capacity was most pronounced at intermittent sites where downwelling water dominated hydrologic exchange.

Suckow, J. B., Red Lake Dept. of Natural Resources, Red Lake, USA, jbsuckow@gmail.com

ALTERNATIVE REGIME THRESHOLDS IN SHALLOW LAKES OF NORTHERN MINNESOTA WETLANDS AND NORTHERN LAKES AND FORESTS ECOREGIONS OF CENTRAL NORTH AMERICA

Many studies have demonstrated that shallow lake ecosystems tend to exhibit one of two alternative regimes: a clear regime dominated by submerged aquatic vegetation (SAV), or a turbid regime dominated by phytoplankton. Little is known about the stability of each regime or thresholds at which a lake will shift from one to the other. We studied 24 lakes in the Northern Minnesota Wetlands and Northern Lakes and Forests ecoregions of MN, USA during the summers of 2008 and 2009 to determine the regime thresholds by comparing chlorophyll A concentrations with SAV biomass. Once regime thresholds are determined, we will compare invertebrate and fish community structure, as well as physical and chemical parameters of lakes with the established threshold levels to determine what variables might affect the stability of each regime.

Sudduth, **E. B.**, Duke University, Durham, NC, USA, esudduth@duke.edu
Hassett, B. A., Duke University, Durham, NC, USA, bhassett@duke.edu
Somers, K., Duke University, Durham, NC, USA, kayleigh.somers@gmail.com
Wang, S., Duke University, Durham, NC, USA, siyi.wang@duke.edu
Urban, D. L., Duke University, Durham, NC, USA, deanu@duke.edu
Bernhardt, E. S., Duke University, Durham, NC, USA, ebernhar@duke.edu

URBANIZATION ALTERS STREAM ORGANIC MATTER DYNAMICS AND SUPPRESSES MICROBIAL RESPIRATION

In streams with food webs dependent on allochthonous input, the impacts of urbanization would be expected to affect ecosystem function through the alteration of decomposition of organic matter. Although previous studies have found less organic matter (OM) and faster leaf decomposition in urban streams, our research in the Piedmont of North Carolina has found similar ranges of OM in urban and forested streams and reduced rates of leaf decomposition in urban streams in both surface and buried leafpacks, with decreased microbial respiration in the buried leafpacks. To test the hypothesis that this alteration was due to suppression of microbial activity in urban streams, we conducted a study of 70 streams across a rural-urban gradient, measuring wood veneer decomposition rate, water quality, microbial activity, and sediment metals concentrations. We found that microbial activity was positively correlated with sediment % OM ($R^2 = 0.3525$, $p < 0.0001$) and that sediment % OM was significantly positively correlated with % forest in the watershed ($R^2 = 0.1832$, $p = 0.001$). However, wood veneer decomposition was not correlated with watershed land-use or microbial activity alone.

Sullivan, **M. S.**, The Ohio State University, Columbus, OH, USA, sullivan.191@osu.edu
Kautza, A. R., The Ohio State University, Columbus, OH, USA, kautza.1@osu.edu
Cianfrani, C. M., Hampshire College, Amherst, MA, USA, ccn@hampshire.edu
Vierling, K. T., University of Idaho, Moscow, ID, USA, kerriv@uidaho.edu

A MULTISCALAR PERSPECTIVE OF ENVIRONMENTAL INFLUENCES ON STREAM-RIPARIAN BIOTA

Numerous variables operating across different spatial scales are known to affect stream ecosystems. However, the relative influence of these variables on stream-riparian biota, as well as the relationships among these predictors, present unique challenges to our current understanding of both structural and functional components of stream networks. The operational spatial scale (e.g., local/patch, watershed/landscape, regional) of these variables is also particularly important in understanding biotic-habitat riverscape connections and in developing effective management strategies. From research in Vermont, Ohio, and Idaho, USA, we present an intergeographic perspective of the influences of environmental characteristics across spatial scales on multiple taxa (macroinvertebrates, fish, and birds), considering community characteristics as well as measures of energy flux (C and N). Results from a variety of modeling techniques suggest that watershed landscape characteristics may be the most-widely influential, both geographically and taxonomically. Regional characteristics appear to be more critical in watersheds in relatively unimpacted settings, whereas local characteristics dominate at the upper end of the disturbance gradient. The varied biotic-environmental relationships of the three taxonomic groups underscore the unique way in which different organisms integrate the stream-riparian environment, and reinforce the complexity of spatial associations in stream networks.

Sullivan, **S. P.**, University of Montana, Missoula, USA, sean1.sullivan@umontana.edu

COMMUNITY COMPOSITION ANALYSIS AND TRACE METALS CONCENTRATIONS IN BENTHIC BIOTA:A PRE-RESTORATION DESCRIPTION OF THE UPPER BLACKFOOT MINING COMPLEX, MONTANA.

Mining in the headwaters of the Blackfoot River Montana has resulted in contamination of groundwater and surface water resources. The area known as the Upper Blackfoot Mining Complex is scheduled for remedial activities and subsequent instream restoration beginning in 2011. In an effort to quantify pre-restoration bioavailability of contaminants whole body analysis of benthic invertebrates was conducted for the trace metals Arsenic, Cadmium, Copper, Zinc and Total Mercury. In addition to quantifying benthic biotic metal availability community composition samples were processed to describe the pre-restoration resident communities and densities at several sites along the contamination gradient and nearby reference sites. Results have indicated that invertebrate densities are affected downstream of the Mike Horse Mine and depauperate communities exist within the contaminated areas. Metal bioavailability analysis shows metals enrichment within the Upper Blackfoot Mining Complex as compared to nearby reference streams. Restorative success depends highly on the ability to demonstrate significant reductions in target metals and increases in benthic integrity; this analysis provides the keystone from which the remedial activities in the area will be measured.

Sundermann, **A.**, Senckenberg, Gelnhausen, Germany, Andrea.Sundermann@senckenberg.de
Gerhardt, M., Biodiversity and Climate Research Center (BiK-F), Gelnhausen, Germany,
Haase, P., Senckenberg, Gelnhausen, Germany, Peter.Haase@senckenberg.de

WATER POLLUTION OR HYDROMORPHOLOGICAL DEGRADATION - WHICH ENVIRONMENTAL VARIABLES AFFECT BENTHIC INVERTEBRATE ASSEMBLAGES MOST?

Our understanding of the interactive effects of different anthropogenic stressors on benthic invertebrate assemblages in rivers is still limited. It is often expected that hydromorphological degradation has an overriding importance, especially in the context of river restoration. Therefore, we asked whether physicochemical, hydromorphological variables, or a combination of both can explain species assemblages best. We analyzed the composition of benthic invertebrate assemblages at 83 sites in Germany, using five biocoenotic indices, as well as 14 physicochemical and six hydromorphological variables. Statistical analyses and model approaches revealed that among the individual variables, conductivity and total organic carbon (TOC) explained the highest proportion of the variability in the benthic invertebrate assemblages. Using models that consider more environmental variables, physicochemical and hydromorphological variables in combination yielded the best correlations. Our results clearly indicate that hydromorphology is not the primary factor controlling benthic invertebrate diversity. Instead, multiple stressors are the driving forces in water ways. Thus, future restoration measures should not solely focus on hydromorphological improvements of rivers, but encompass all stressors, water pollution and hydromorphological degradation.

Sutherland, **K**. **R**., California Institute of Technology, Pasadena, USA, krsuth@caltech.edu

Stocker, R., Massachusetts Institute of Technology, Cambridge, USA, romans@mit.edu

Madin, L. P., Woods Hole Oceanographic Institution, Woods Hole, USA, lmadin@whoi.edu

FILTRATION OF SUBMICROMETER PARTICLES BY PELAGIC TUNICATES

Pelagic tunicates, or salps, are common in oceanic waters and have higher individual filtration rates than most other planktonic filter feeders. Though salps are centimeters in length, particle capture occurs at relatively low velocities on a mucous filtering mesh with micron-scale openings (mean width = 1.4 &microm). Therefore, filtration is a low Reynolds number process and mechanisms other than simple sieving are expected to govern particle encounter. Using a model of particle capture efficiency by a rectangular mesh, we estimated particle capture rates on the salp filtering mesh based on realistic oceanic particle concentrations. We then performed particle feeding experiments using 0.5, 1 and 3 &microm fluorescent polystyrene microspheres. Results from both the model and from experiments showed that smaller particles are captured at considerably higher rates than larger particles. Though particles smaller than mesh openings (1.4 &microm) are expected to supply substantially less carbon than larger particles, they can still completely satisfy salp energetic needs. By removing different sized particles with nonuniform efficiency, salps have the potential to structure oceanic particle size spectra.

Swan, **C**. **M**., University of Maryland, Baltimore County, Baltimore, USA, cmswan@umbc.edu

RIPARIAN SPECIES LOSS INTERACTS WITH A DOMINANT IN-STREAM CONSUMER TO REGULATE LITTER BREAKDOWN: AN EXPERIMENTAL TEST OF THE FOUNDATION SPECIES CONCEPT

Foundation species loss is predicted to result in fundamental changes to community structure and ecosystem processes. Riparian forests often have a few dominant tree species that serve as energy sources to adjacent stream ecosystems. Given interspecific variation in leaf litter influences breakdown rate, and in-stream consumers accelerate this process by reacting to tissue quality, loss of a dominant tree species could change carbon processing in small stream environments. To test the interaction between overstory species loss and feeding by detritivore consumers on leaf breakdown, we manipulated *in situ* the loss of each of four dominant riparian tree species adjacent to a small stream, with and without the presence of a dominant consumer (*Pycnopsyche guttifer*). We found a strong, interactive effect of leaf species loss on breakdown rate, and the magnitude of the effect differed depending on which species was removed and only in the absence of the consumer. Our results highlight that the potential for riparian foundation species loss to influence in-stream carbon processing depends on ecological context, in this case the interaction with a dominant detritivore consumer.

Swarzenski, **P**. **W**., US Geol. Survey, Santa Cruz, USA, pswarzen@usgs.gov

Cox, S. E., USGS, Tacoma, USA, secox@usgs.gov

Dinicola, R. S., USGS, Tacoma, USA, dinicola@usgs.gov

Grossman, E. E., USGS, Santa Cruz, USA, egrossman@usgs.gov

Sheibley, R. W., USGS, Tacoma, USA, sheibley@usgs.gov

TOWARDS A SUBMARINE GROUNDWATER DISCHARGE TYPOLOGY FOR NEARSHORE PUGET SOUND, WA: DRIVERS AND IMPACTS

Submarine groundwater discharge (SGD) measurements from diverse sites in Puget Sound will be discussed in terms of marine and terrestrial forcings on SGD magnitudes and SGD-derived loadings. To develop an intra-Sound SGD typology, sites were chosen based on a range of estuarine sub-environments: river-dominated (Skagit River), urbanized (Liberty Bay), and a tide-dominated (Lynch Cove) where SGD may be focused and large. Tracers and other tools used include: radon, radium, and electromagnetic seepmeters. A multi-channel resistivity system characterized the freshwater/saltwater interface and provided an estimate of lateral and vertical SGD zonation. Results indicate that SGD varies widely in Puget Sound, depending on nearshore geologic and geomorphologic (SGD focusing), hydrologic (precipitation and recharge rates), and oceanographic (tides, water levels, and currents) controls. Such results, when compared to traditional nutrient inputs, suggest that the persistent delivery of subsurface nutrients and select trace elements to the nearshore can be highly sensitive to local controls. As a result, such SGD-derived inputs should be carefully evaluated, especially in terms of potential environmental change brought about by new climate change predictions and expected coastal population forecasts.

Sweeney, **B**. **W**., Stroud Water Research Center, Avondale, USA, sweeney@stroudcenter.org

Funk, D. H., Stroud Water Research Center, Avondale, USA, dhfunk@stroudcenter.org

Jackson, J. K., Stroud Water Research Center, Avondale, USA, jkjackson@stroudcenter.org

AQUATIC INSECT RESPONSE TO DIEL CHANGE IN TEMPERATURE: DOES IT MATTER HOW FAST THE TEMPERATURES CHANGE?

We know that internal temperature of aquatic macroinvertebrates matches their environment, most life history traits are temperature sensitive, and most rate functions (metabolism, growth, etc) exhibit a sigmoid response over a broad range of temperatures. Thus, a change in temperature of a certain magnitude can change a rate function differentially depending on where that change falls in the range of temperatures supporting life for a species. What remains unclear is whether a rate response to a change in temperature depends on "how fast the change happens" and "where in the range of life supporting temperatures" it falls. This is relevant because both natural and anthropogenic factors can induce diel and seasonal temperature change in most aquatic environments. We tested the response of egg development, growth, metabolism, adult emergence, fecundity and drift of 6-10 species of aquatic insects to three 8ºC diel changes (4-12ºC, 20-28ºC , 24-32ºC) with up and down rates varying at 0.8,1.1,2.2,4.4ºC /h. Results suggest that 4.4ºC /h may be stressful for some species especially at higher temperatures but that slower rates of change are benign.

TABATCHNICK, **M**. **D**., Wright State University, Dayton, USA, melissa.tabatchnick@gmail.com

HAMMERSCHMIDT, C. R., Wright State University, Dayton, USA, chad.hammerschmidt@wright.edu

FOLIAR CYCLING OF METHYLMERCURY IN SOUTHWEST OHIO

Cycling of mercury (Hg) and monomethylmercury (MMHg) in forest ecosystems can affect exposures of terrestrial and aquatic wildlife within the watershed. Litterfall has been posited to be a major source of MMHg to the forest floor; however, the origin of MMHg associated with tree foliage is largely unknown. We tested the hypothesis that leaf MMHg is controlled principally by root uptake from soil. Viable leaves and associated soil samples were sampled from nine tree species (deciduous and coniferous) at 30 locations spanning a 1145 km2 area in southwest Ohio, a region presumed to have relatively homogeneous atmospheric deposition of Hg and MMHg. Preliminary results indicate no relationship between MMHg in leaves and either MMHg or total Hg in soil. Leaf MMHg does not vary substantially among tree species. Among maples, leaf MMHg is correlated positively with trunk diameter, a proxy for age, which implies that trees bioaccumulate MMHg. This suggests that, via litterfall, terrestrial and aquatic ecosystems associated with older forests may be more susceptible to MMHg exposure.

Tamayo, **M**., University of Washington, Seattle, USA, mtamayo@uw.edu

Olden, J. D., University of Washington, Seattle, USA, olden@uw.edu

NEW INSIGHT INTO THE ECONOMIC IMPACTS OF AQUATIC INVASIVE SPECIES: DOES EURASIAN MILFOIL DECREASE LAKE PROPERTY VALUES IN WASHINGTON STATE?

The ecological impacts of Eurasian milfoil (*Myriophyllum spicatum*) invasions are well recognized and range from the loss of native plant and fish diversity to changes in water quality. However, our understanding of the potential economic impacts of this invasive species, with the exception of control costs, is incomplete. In the present study, we apply a hedonic framework to quantify the economic damage of Eurasian milfoil invasions on lake property values. Specifically, we compare 1,900 lakeshore property sales of single family homes in King County, Washington over a 12-year period (1995-2006) for 40 lakes of which 16 support Eurasian milfoil. Factors related to property characteristics (e.g., lot size, number of bedrooms, assessed value) and lake attributes (e.g., lake area, Secchi depth, public boat access) are included in the analysis. Results from the hedonic analysis provide the first insight in the potential bioeconomic effects of milfoil invasions on waterfront properties in Washington State. Ultimately, these values will be integrated with ecological niche models to forecast the risk of Eurasian milfoil invading new lakes and the likely economic impacts in the future.

Taniguchi, **M**., Research Institute for Humanity and Nature, Kyoto, Japan, makoto@chikyu.ac.jp
Nakano, T., Research Institute for Humanity and Nature, Kyoto, Japan,
Hosono, T., Kumamoto University, Kumamoto, Japan,
Ono, M., Kumamoto University, Kumamoto, Japan,
Burnett, W. C., Florida State University, Tallahassee, USA,

SEASHELL ECOSYSTEM FED BY SUBMARINE GROUNDWATER DISCHARGE

Submarine groundwater discharge (SGD) is recognized as an important pathway from land to the ocean, not only for water and dissolved material transports but also for ecosystem in the coastal zone. In this study, several methods are used for evaluating relationships between SGD and coastal ecosystem in Yuza, at the foot of Mt Chokai, Japan. Strontium isotope ratios of the seashell (oysters) in Yuza, Japan, were analyzed to evaluate the ratio of fresh water component of SGD in several bays with and without rivers. The seepage meters, piezometers, thermometers, and resistivity measurements had been made to evaluate the flux and quality of the SGD for point, transect line, and bay scales. The Rn measurements had also been done to evaluate SGD for bay and basin scales. The SGD flux decreased with the distance from the coast and lava deposit. SGD also decreased with increasing the sea bed temperature and with increasing seabed resistivity. The Rn data shows the SGD signal up to 5 km offshore and the difference in bay with or without rivers. The relationships between the fresh water component of SGD and Sr isotope ratio of the shell of oyster have been examined. The higher Sr ratio of the shell in the Mega and Kamaiso bays without river agreed well with the higher fresh component of SGD, thus SGD may be one of the important geophysical and geochemical factors for the seashell ecosystem in the coastal zone.

Tant, **C**. **J**., University of Georgia, Athens, USA, ctant@uga.edu
Rosemond, A. D., University of Georgia, Athens, USA, rosemond@uga.edu
Benstead, J. P., University of Alabama, Tuscaloosa, USA, jbenstead@bama.ua.edu

NOT ALL DETRITIVORES ARE CREATED EQUAL: FUNCTIONAL GROUP-SPECIFIC THRESHOLD ELEMENTAL RATIOS AND EFFECTS OF NUTRIENT ENRICHMENT ON RESOURCE QUALITY

Nutritional quality of food resources, particularly of low-quality detritus, plays an important role in regulating growth of consumers in aquatic ecosystems. Nutrient enrichment may affect the stoichiometry of food resources differentially, and thus, the degree of nutrient limitation of specific consumer assemblages. Threshold elemental ratios (TERs) estimate the resource nutrient ratio at which limitation of consumer growth shifts from one element to another and are therefore useful for estimating elemental imbalances between consumers and their food. We determined carbon:nitrogen (C:N) and carbon:phosphorus (C:P) TERs for two functional groups of detritivore, shredders and collectors, and evaluated changes in food nutrient content that occurred due to a long-term stream enrichment. Collectors were more C vs. N or P limited, while shredders were more N and P vs. C limited under reference conditions. Comparisons of food nutrient content to TERs under enriched conditions indicated that enrichment may reduce the severity of P limitation for shredders but may exacerbate C limitation for collectors. These data highlight the functional differences between consumers in food acquisition and stoichiometry and thus their unique responses to nutrient enrichment.

Taylor, **B**. **W**., Dartmouth College, Hanover, USA, brad.taylor@dartmouth.edu

A NATIVE GONE WILD: REGIME SHIFTS IN RIVERS CAUSED BY A SINGLE SPECIES, DIDYMOSPHENIA GEMINATA

I investigated the effects of Didymosphenia on ecosystem structure and function in Colorado streams. Using in situ removal experiments and comparisons among 8 streams, I discovered that Didymosphenia caused major shifts in invertebrate density and composition but not biomass. Chironomids and a caddisfly increased 10-fold and 3-fold respectively, large-bodied mayflies decreased 5-fold, and one predatory stonefly increased 2-fold. Trends in insect growth rates were similar to trends in abundance. Predation experiments revealed that a mechanism for the increase in chironomids was increased refuges provided by Didymosphenia. In contrast, the decrease in large-bodied mayflies was due to greater susceptibility to predation. Trout growth rates were 2-fold lower in streams with Didymosphenia blooms and could not be explained by other factors. Bioenergetics modeling suggest that changes in invertebrate composition and size can explain the reduce trout growth. Additionally, Didymosphenia caused striking shifts in ecosystem metabolism, and particulate organic matter biomass and transport. The data show that this diatom is dramatically shifting the structure and functioning of Rocky Mountain streams to a new regime.

Taylor, **J**. **M**., Baylor University, Dept. of Biology, Center for Reservoir and Aquatic Systems Research, Waco, USA, jason_taylor1@baylor.edu
Back, J. A., Baylor University, Dept. of Biology, Center for Reservoir and Aquatic Systems Research, Waco, USA, jeff_back@baylor.edu
Valenti, T. W., Baylor University, Institute for Ecological, Earth and Environmental Science , Waco, USA, ted_valenti@baylor.edu
King, R. S., Baylor University, Dept. of Biology, Center for Reservoir and Aquatic Systems Research, Waco, USA, Ryan_S_King@baylor.edu

EXPERIMENTAL EVIDENCE FOR FISH-MEDIATED NUTRIENT RECYCLING IN STREAMS

There is increasing awareness of the importance of fish-mediated nutrient recycling in stream ecosystems, yet its role is difficult to quantify in flowing waters. We quantified the effect of nutrient recycling by central stonerollers (*Campostoma anomalum*) on downstream periphyton communities in twelve nitrogen (N) poor, flow-through stream mesocosms. We manipulated fish occurrence and dissolved N concentrations in shallow run habitats to establish four experimental treatments (Control, Fish, +N, Fish +N). We assessed fish-mediated nutrient recycling by comparison of nutrient content and algal biomass between tiles placed upstream and downstream of fish enclosures in each stream. Downstream periphyton C:N ratios responded positively in fishless streams for both Control and +N treatments indicating nitrogen depletion along the stream course. There was no downstream periphyton C:N response in Fish treatments suggesting a recycling effect. Periphyton C:N ratios decreased significantly and algal biomass responded positively downstream of fish enclosures in Fish +N streams. These experimental results demonstrate that fish-mediated nutrient recycling is an important factor in nutrient cycling of streams and can interact with nutrient subsidies to relieve nutrient limitation of periphyton communities.

Taylor, **P**. **G**., University of Colorado, Boulder, USA, philip.taylor@colorado.edu
Townsend, A. R., University of Colorado, Boulder, USA, alan.townsend@colorado.edu

STOICHIOMETRIC CONTROL OF ORGANIC CARBON-NITRATE-PHOSPHORUS RELATIONSHIPS FROM SOILS TO THE SEA

Human creation of reactive nitrogen has risen an order of magnitude since the dawn of the Industrial Revolution. This dramatic reorganization of a global biogeochemical cycle has brought substantial benefits, but increasingly causes detrimental outcomes for both people and ecosystems. One such problem is the accumulation of nitrate and bioavailable phosphorus (P) in aquatic ecosystems. Here we establish that ecosystem nitrate and P accrual exhibits consistent and negative nonlinear correlations with organic carbon (C) availability along a hydrologic continuum from soils, through freshwaters and coastal margins, to the open ocean. Across this diversity of environments, we find evidence that resource stoichiometry (organic C:nitrate and organic C:P) strongly influences nitrate and P accumulation by regulating a suite of microbial processes which couple DOC and nutrient cycling. Collectively, these microbial processes express themselves on local to global scales by restricting the threshold ratios underlying nitrate and P accrual to a constrained stoichiometric window. Our findings help explain the fate of nitrate and P across disparate environments, which has significant implications for the management of a rapidly changing N cycle.

Teichert, **S**., The University of Western Ontario, London, Canada, steiche@uwo.ca
Bailey, R. C., The University of Western Ontario, London, Canada, robert_bailey@cbu.ca

THE ROLE OF COMMUNITY BASED MONITORING IN FRESHWATER ECOSYSTEM MANAGEMENT BY ONTARIO'S CONSERVATION AUTHORITIES

Community Based Monitoring (CBM) of freshwater ecosystems is when community members, government agencies, industry, academia, community groups, and local institutions collaborate to carry out monitoring and assessment programs. Although there are many, well-recognized benefits of CBM, it does not often achieve its full potential in practice. Ontario's 36 Conservation Authorities (CAs) are watershed-based, quasi-governmental agencies responsible for watershed management activities including monitoring,

stewardship and environmental advisory services. CAs could make extensive use CBM in decision-making since they regularly collaborate with municipal governments, private industry, and community members. There is a gap in our current knowledge of how, and how often, Ontario CAs use CBM in collecting and using benthic invertebrate data in monitoring and assessment. I will report on the incidence of use of CBM by Ontario CAs, and examine factors influencing the number and nature of such partnerships. Preliminary results indicated that while CAs partner with communities to promote stewardship activities, much of the data about the status and trends of freshwater ecosystem health is collected and interpreted by CA staff.

Teske, **A.**, Department of Marine Sciences, Univ. North Carolina-Chapel Hill, Chapel Hill, USA, teske@email.unc.edu

Durbin, A., Department of Marine Sciences, Univ. North Carolina-Chapel Hill, Chapel Hill, USA,

Ziervogel, K., Department of Marine Sciences, Univ. North Carolina-Chapel Hill, Chapel Hill, USA, ziervoge@email.unc.edu

Cox, C., Department of Marine Sciences, Univ. North Carolina-Chapel Hill, Chapel Hill, USA,

Arnosti, C., Department of Marine Sciences, Univ. North Carolina-Chapel Hill, Chapel Hill, USA,

EXTRACELLULAR ENZYME ACTIVITIES AND MICROBIAL COMMUNITY COMPOSITION IN PERMANENTLY COLD SEAWATER AND SEDIMENTS FROM AN ARCTIC FJORD OF SVALBARD

The composition and capabilities of heterotrophic microbial communities in seawater and sediments from the same site have seldom been examined, although they are critical for carbon cycling. To compare these factors, we measured the extracellular enzymatic hydrolysis rates of eight substrates (polysaccharides and algal extracts) in surface seawater and bottom water as well as in surface (oxidized) and anoxic (sulfate-reducing) sediments of an Arctic fjord. Bacterial community composition was assessed via clone libraries of the 16s rRNA gene. Patterns of enzyme activities differed greatly between seawater and sediments: the sedimentary microbial communities hydrolyzed a wider range of substrates at faster rates than the seawater communities. Likewise, the bacterial communities of the Svalbard water column and sediment samples diverged strongly in composition, on phylogenetically deep levels of bacterial phyla and classes. Changes in bacterial communities from water column to sediment were reflected in the disappearance of major groups (Alphaproteobacteria), in a changing taxonomic profile within major groups (Bacteroides and Gamma-Proteobacteria), and in the emergence of sediment-typical bacteria, especially the Deltaproteobacteria. Differences in community composition have functional consequences for carbon cycling.

Tesoriero, **A. J.**, U.S. Geological Survey, Portland, USA, tesorier@usgs.gov

Duff, J. H., U.S. Geological Survey, Menlo Park, USA, jhduff@usgs.gov

Puckett, L. J., U.S. Geological Survey, Reston, USA, lpuckett@usgs.gov

USING GROUNDWATER AGE AND REDOX CHEMISTRY TO ASSESS THE VULNERABILITY OF STREAM ECOSYSTEMS TO LEGACY NITRATE SOURCES

Groundwater age and water-chemistry data along flow paths from recharge areas to streams at 20 networks from across the United States were used to evaluate the trends and transformations of nutrients. Results from this analysis indicate that median nitrate concentrations in recharge in these agricultural areas have increased markedly over the last 50 years from 4 mg N/L in groundwater recharged before 1983 to 7.5 mg N/L in groundwater recharged after 1983. The effect that nitrate accumulation in shallow aquifers will have on stream ecosystems is dependent on the rate of redox reactions along flow paths and on the age distribution of water discharging to streams. First-order oxygen reduction rates were determined by relating measured dissolved oxygen concentrations to groundwater age. Streams are vulnerable to groundwater nitrate sources in watersheds where oxygen reduction rates along groundwater flow paths in upland and riparian zones are low (e.g., <0.05 per year). Deleterious consequences of high nitrate concentrations may be observed in these watersheds in the future as the proportion of discharging groundwater is increasingly from the period of intensive N application.

Testa III, **S.**, USDA-ARS-NSL Water Quality and Ecology Unit, Oxford, USA, Sam.Testa@ars.usda.gov

Shields Jr., F. D., USDA-ARS-NSL Water Quality and Ecology Unit, Oxford, USA, doug.shields@ars.usda.gov

Cooper, C. M., USDA-ARS-NSL Water Quality and Ecology Unit, Oxford, USA, charliecooper@peoplepc.com

Knight, S. S., USDA-ARS-NSL Water Quality and Ecology Unit, Oxford, USA, scott.knight@ars.usda.gov

Lizotte Jr., R. E., USDA-ARS-NSL Water Quality and Ecology Unit, Oxford, USA, richard.lizotte@ars.usda.gov

Bryant, C. T., USDA-ARS-NSL Water Quality and Ecology Unit, Oxford, USA, charles.bryant@ars.usda.gov

A RESTORATION ODYSSEY: LITTLE TOPASHAW CREEK, MISSISSIPPI

We examined the community response to placement of seventy-two large wood structures in a 2-km reach of a severely incised fourth-order warmwater stream in north-central Mississippi. Five 200-meter sites were sampled on six dates over a three-year period centered on structure deployment. Numbers of macroinvertebrates overall remained nearly unchanged following addition of wood; however, large increases were observed in representation of filtering and gathering collectors. Density of invertebrates on large wood following structure placement was less than half of pre-treatment levels despite larger available wood area, likely due to increased predation by fish associated with the structures. Total catch weight of insectivorous fish was greater in treated sites following wood addition. Major environmental determinants of macroinvertebrate community structure were antecedent discharge, large wood density and water width. Leaf packs, dependent to a large degree on large wood structures, were noted to be highly influential to the make-up of the aquatic macroinvertebrate community. Limited biological response and failure of large wood structures to provide long-term channel stability point to multiple stressors on the system that still need to be addressed.

Thomas, **R. L.**, The Academy of Natural Sciences Patrick Center for Environmental Research, Philadelphia, PA, USA, Thomas@ansp.org

Smith, A. J., New York State Department of Environmental Conservation, Troy, NY, USA, ajsmith@gw.dec.state.ny.us

Nolan, J. K., Watershed Assessment Associates, Schenectady, NY, USA, jkn@rwaa.us

Klein, S., The Academy of Natural Sciences Patrick Center for Environmental Research, Philadelphia, PA, USA, Klein@ansp.org

Duffy, B. T., New York State Department of Environmental Conservation, Troy, NY, USA, btduffy@gw.dec.state.ny.us

NEW YORK STATE WADEABLE STREAM NUTRIENT CRITERIA PROJECT

Previous work on developing nutrient criteria for NYS wadeable streams involved analyses of data collected during ambient water quality monitoring. These historical data lacked several response variables essential for establishing effective nutrient criteria. Using water chemistry, algal and benthic macroinvertebrate community data, effects-based nutrient criteria are being developed. One hundred sites were sampled statewide within the four nutrient ecoregions located in NYS. Sites were selected using percent forest cover, background water chemistry and biological monitoring data for predicting increased nutrient concentrations. At each site, water chemistry parameters and nutrient response variables, including nitrogen, phosphorus, chlorophyll-a, secchi transparency, turbidity, and total suspended solids, were measured. Benthic macroinvertebrates and periphytic algae for diatom analyses were also collected from each site. Multiple lines of evidence were used to define nutrient endpoints protective of aquatic life. A percentile analysis suggested thresholds of 13µg/l TP, 390µg/l TN, and 140µg/l $NO3^-$. Non-parametric Changepoint Analysis (nCPA) suggested thresholds of 17µg/l TP, 550µg/l TN, and 189µg/l $NO3^-$. Conditional Probability suggested thresholds related to biological community metrics at 35µg/l TP, 1788µg/l TN, and 1097µg/l $NO3^-$.

Thomas, **S. A.**, University of Nebraska, Lincoln, USA, sthomas5@unl.edu

FURTHER ADVENTURES OF ATOM X: A CONTEMPORARY REVIEW OF STREAM TRACER APPROACHES TO ECOLOGICAL RESEARCH

The use of conservative and reactive tracers has substantially contributed to our understanding of stream ecosystems. Measuring and modeling the movement of conservative tracers has improved our knowledge of stream flow, surface water- groundwater exchange, gas exchange and their links to geomorphology.

Similarly, coincident use of reactive tracers allows researchers to quantify nutrient uptake, cycling and fate at scales that would otherwise be impossible. Since the Stream Solute Workshop was published, use of tracers has accelerated and major advances have been made. However, confusion remains regarding the use of tracers and in the interpretation of tracer data. For example, the design and analysis of nutrient enrichment experiments have not been consistent. Similarly, there is often uncertainty in knowing when new hydrological approaches improve ecological research and when simplifying assumptions are appropriate. In this presentation, new and published data are used to clarify these topics and identify promising directions for future research.

Thomas, K. E., University of Waterloo, Waterloo, Canada, k2thomas@uwaterloo.ca
Hall, R. I., University of Waterloo, Waterloo, Canada, rihall@sciborg.uwaterloo.ca
Haggarty, D., Nahanni National Park Reserve, Parks Canada, Fort Simpson, Canada,
Scrimgeour, G. J., Western and Northern Service Centre, Parks Canada, Calgary, Canada,

BENTHIC ALGAL BIOASSESSMENT IN ARCTIC RIVERS, EMPHASIZING THE USE OF PIGMENT ASSESSMENTS USING HPLC: A CASE STUDY OF MINING IMPACTS IN THE SOUTH NAHANNI RIVER

Climatic variations and human disturbances increasingly threaten northern aquatic resources, consequently improved monitoring tools are required to track changes in ecological integrity. The objective of this project is to develop and evaluate benthic algal biomonitoring protocols for use in Arctic rivers. To do this, we evaluated four levels of assessment; including, diatom community composition and quantification of pigments by HPLC. Quantification of pigments by HPLC is novel for monitoring programs, but is attractive because it provides high-information -content data rapidly and cost-effectively. We sampled rivers in the South Nahanni River watershed (2008, 2009), including upstream and downstream of two mines, to assess if the methods detect impairment. Multivariate analyses showed that pigments and diatom communities differed significantly ($P < 0.05$) upstream versus downstream of the mines and were related to changes in concentrations of heavy metals and nutrients. The results from this study indicate that benthic algal metrics provide useful information for northern monitoring programs, and future research will be used to recommend a best practice for agencies ranging from national government to local First Nations organizations and conservation groups.

Thompson, M., Monash University, Melbourne, Australia, ross.thompson@sci.monash.edu.au

PREDATORS AS INTEGRATORS ACROSS FOOD WEBS AT PATCH SCALES

Food webs have traditionally been collected at patch scales, ignoring the inherent variation between environmental patches and the way in which predators move across patches. Using food webs gathered from pond food webs, I show that ways in whcih predators integrate across space in patchy environments.

Thoms, M. C., The University of New England, Armidale, Australia, Martin.Thoms@une.edu.au
Parsons, m. e., The University of New England, Armidale, Australia,

VEGETATION VIGOUR IN A LARGE, LOWLAND RIVER FLOODPLAIN IN RAIN, FLOOD AND DRY RESOURCE EVENTS

Water is a predominant driver of vegetation productivity in semi-arid floodplains. The input of water to floodplains occurs as rain, flood and dry events, but the character of vegetation response to such events is unknown at large scales. The vigour of vegetation in the Lower Balonne floodplain (>10 000 km2), Australia, during flood, rain and dry resource events was examined. The Normalized Difference Vegetation Index (NDVI) was calculated monthly for two flood, rain and dry events separated by one decade. Vegetation vigour was examined at two spatial scales: the landscape (whole floodplain) and geomorphic unit (riparian and floodplain) scales. At the landscape scale the greatest differences in vegetation vigour occur between resource events rather than between decades or months. During a dry event >90 % of the landscape has no vegetation vigour. During a rain event vegetation vigour increases, but these increases are made up of low NDVI, or low vigour. During a flood event more of the landscape increases in vigour, and these increases are made up of higher-NDVI. At the geomorphic unit scale vegetation vigour is contributed in dry resource events by riparian areas, but by the floodplain during rain and flood events. These results indicate that vegetation productivity is not uniform at a large scale in floodplains. Management processes that aim to enhance vegetation health should be cognizant of this heterogeneity.

Thomson, R. E., University of Minnesota, St. Paul, USA, thom1514@umn.edu
Holzenthal, R. W., University of Minnesota, St. Paul, USA, holze001@umn.edu

PHYLOGENY OF THE MICROCADDISFLIES BASED ON GENE SEQUENCE DATA: A PRELIMINARY ASSESSMENT (TRICHOPTERA: HYDROPTILIDAE)

Hydroptilidae is the largest family in the order Trichoptera, including 68 genera and ~2,000 species, distributed among 6 subfamilies. Currently, many relationships within the family are not well defined and have not been addressed since 1979. Recently, the subfamily Ptilocolepinae was elevated to family status, creating additional uncertainty about relationships. Using gene sequence data, the first hydroptilid phylogeny based on a modern molecular-based approach was inferred. COI and D1-3 rRNA sequences were obtained for a subset of the genera representing the taxonomic diversity in the family. Data were analyzed using Bayesian inference, maximum parsimony, and maximum likelihood; results were similar under all 3 methods. In this and previous analyses, Ptilocolepinae grouped with other hydroptilids. Although sampling at this point was limited, preliminary results showed support for the monophyletic status of several genera and subfamilies. Some anomalies were observed with one species of the genus *Oxyethira*; there were also very short branch lengths observed within the genus *Ugandatrichia*, perhaps indicating rapid speciation. The next phase is to collect additional gene sequences and to gather additional important species from the field.

Thrush, S. F., NIWA, Hamilton, New Zealand, s.thrush@niwa.cri.nz
Hewitt, J. E., NIWA, Hamilton, New Zealand, j.hewitt@niwa.cri.nz
Townsend, M., NIWA, Hamilton, New Zealand, m.townsend@niwa.cri.nz
Lohrer, A. M., NIWA, Hamilton, New Zealand, d.johrer@niwa.cri.nz
Chiantore, M., University of Genoa, Genoa, Italy, chiantor@diptris.unige.it

ECOLOGICAL FEEDBACKS HIGHLIGHT THE POTENTIAL FOR MULTIPLE STRESSORS TO IMPACT ON THE RESILIENCE OF ESTUARINE COMMUNITIES

Many of the major challenges facing estuarine ecosystems are associated with human-induced changes in the frequency, magnitude and extent of natural disturbance or stress effects. While detecting synergistic or antagonistic interactions between specific stressor combinations is important, identifying and predicting the responses of species to stressors is complicated by variations in the sensitivity of a species to a stressor across environmental gradients, which are usually strong in estuaries. In most estuaries there are many potential stressors and disturbance agents that could affect resilience. Simple, mechanistic, cause and effect studies resolving these issues become problematic when considered in isolation, as they tend to view ecological systems as purely response variables and ignore the potential for feedbacks between biota and their environment. However, there is growing support for the idea that interactions between intrinsic ecological dynamics and chronic, cumulative multiple stressor effects can lead to the loss of resilience. Illustrating the feedbacks that play particularly important roles in estuaries and identifying their susceptibility to change profoundly influences the advice we can offer to managers.

Tiegs, S. D., Oakland University, Rochester, USA, tiegs@oakland.edu
Stephens, J. P., Oakland University, ROchester, USA, jpsteph2@oakland.edu
Berven, K. A., Oakland University, Rochester , USA, berven@oakland.edu

EFFECTS OF NATIVE AND EXOTIC PLANT LITTER ON THE GROWTH OF RANID FROG LARVAE

Human activities commonly alter plant-community compositions, and concomitant changes in litter quality may be of consequence for ecosystems based on detritus. We examined the influence of litter originating from 10 plant species (7 native, 3 invasive) common in the Great Lakes region of North America on the development of larval green frogs (Rana clamitans). Frog larvae were reared in aquaria that contained a weak aqueous solution of leachate obtained from the litter of each species. Larval growth rates ranged widely among treatments with some litter being associated with positive growth (Acer rubrum, Quercus alba, Salix nigra) and others (Carex stricta, Typha latifolia) resulting in negative growth, including each of the three invasive species examined (Rhamnus frangula, Phalaris arundinacea, and Phragmites australis). Larval frog metabolism (as

oxygen consumption) also varied among litter treatments, but was only weakly associated with growth rates. Collectively our results suggest that changes in plant communities, such as the proliferation of some exotic species, have the potential to influence the development and physiology of larval frogs, with potential consequences for survivorship and adult recruitment.

Tietjen, **T**. **E**., Southern Nevada Water Authority, Las Vegas, USA, todd.tietjen@snwa.com

QUAGGA MUSSELS AND ENHANCED WASTEWATER TREATMENT: ASSESSING THE DRIVING FORCE BEHIND WATER QUALITY IMPROVEMENTS IN LAKE MEAD, NEVADA-ARIZONA, USA

Quagga mussels were first reported in Lake Mead in 2007 and since that time they have been found both as juvenile veligers and as adult mussels throughout the lake. During the first 2 years following detection the abundance of veligers has followed a similar pattern each growing season with 2 peaks in abundance; one in the late spring and a second in the fall. Veliger abundance is generally similar during both peaks, but their proportional representation is greater during the fall period as the abundance of the zooplankton community overall is lower. General measures of water quality in Lake Mead have been improving due to enhanced wastewater treatment that has reduced phosphorus loading to the lake. Determining the relative importance of filter feeding by quagga mussels and nutrient loading reductions in structuring the observed changes in chlorophyll concentrations, phytoplankton species composition and water clarity has been difficult, but the evidence suggests that initial and substantial improvements were produced by improved wastewater management and that the quagga mussels have, to date, simply reduced low concentrations slightly lower.

Timm, **A**. **L**., USDA Forest Service, NRS, Grand Rapids, MN, USA, altimm@fs.fed.us

Dolloff, C. A., USDA Forest Service, SRS, Blacksburg, VA, USA, adolloff@fs.fed.us

Nislow, K., USDA Forest Service, NRS, Amherst,MA, USA, knislow@fs.fed.us

Kolka, R. K., USDA Forest Service, NRS, Grand Rapids, MN, USA, rkolka@fs.fed.us

NATURAL BARRIERS AND POPULATION GENETICS OF BROOK TROUT

Natural barriers to fish movement can cause stream habitat fragmentation for populations within a stream network. The goal of my research was to evaluate measures of population genetics as indicators of barrier effects on brook trout populations. I used electro-fishing techniques to collect 30 brook trout fin-clips above and below 18 natural barrier sites ranging in height from 0.91 to 91.44 meters. I extracted DNA and amplified microsatellites at eight loci using PCR technology. I gentotyped individuals using an Applied Biosystems, Inc., 3100-avant autoanalyzer and GeneMapper software. I applied Arlequin 3.11 (Excoffier et al. 2005) software to quantify genetic differentiation (FST), expected heterozygosity (He), and number of alleles (A). Wilcoxon sign rank tests showed no significant difference in number of alleles (A) (P = 0.985), and expected heterozygosity (He) (P = 1.000) for the above and below barrier samples. Linear regression identified a statistically significant relationship between barrier height and FST values (P=0.005). Results suggest that measures of population genetics may be useful indicators of barrier effects on brook trout populations.

Timoner, **X**., Catalan Institute for Water Research, Girona, Spain, xtimoner@icra.cat

von Schiller, D., Leibniz - Institute of Freshwater ecology and Inland Fisheries , Berlin, Germany,

Acuna, V., Catalan Institute for Water Research, Girona, Spain,

Tockner, K., Leibniz - Institute of Freshwater ecology and Inland Fisheries , Berlin, Germany,

Sabater, S., Catalan Institute for Water Research, Girona, Spain,

FUNCTIONAL RESPONSE OF STREAM BIOFILMS TO INTERMITTENCY

Streams in Mediterranean regions typically show predictable summer droughts and unpredictable floods. Drought severity is however increasing due to Climate Change, and an increase in the intermittency extent is expected. This study aimed to characterize how different stream biofilms respond to intermittency. Accordingly, functional and structural responses of 3 stream biofilm compartments (epilithic, episammic and hyporheic) were characterized in an intermittent Mediterranean stream. Samples were taken along a yearly cycle. Biofilm response was assessed by changes in bacterial and algal community structure (abundance and biomass) and functioning (enzymatic activities, live cell percentage and photon yield). The epilithic biofilm appeared to be more sensitive to intermittency, showing the highest enzymatic activities during stable flow conditions but the lowest during no-flow conditions (75% decrease). In contrast, episammic and hyporheic biofilms experienced a decrease of only 50% during the no-flow period. Different temporal patterns were however not the case of all measured processes, as differences were observed among enzymatic activities, as well as between heterotrophic and autotrophic processes. Overall, results revealed different sensitivities among processes and compartments in this Mediterranean stream.

Tobias, **C**., University of Connecticut, Groton, CT, USA, craig.tobias@uconn.edu

Bohlke, J. K., US Geological Survey, Reston, VA, USA, jkbohlke@usgs.gov

Harvey, J. W., US Geological Survey, Reston, VA, USA, jwharvey@usgs.gov

INCORPORATING 18O ISOTOPES INTO AQUATIC METABOLISM ESTIMATES: APPROACHES, TRADE-OFFS, AND ADVANTAGES

In an effort to improve stream reach-scale metabolism estimates, we combined O2-change measurements with simultaneous SF6 gas transfer measurements and isotopic (18O) analyses of dissolved O2. In-stream tracer experiments and measurements were done in a first-order stream in an agricultural watershed. Closed-system water and sediment incubation experiments were also conducted to determine stream-specific isotope fractionation factors for O2 consumption. Estimates of P, R, and P:R derived from the open channel diurnal O2 change method that lacked isotopes were compared against steady state, and exact solution mass balances that incorporated O2 and 18O2. Results of the isotopic and non isotopic approaches were further compared with numerical simulations that account for non-steady-state conditions such as gas transfer, temperature, and reaction rates. The incorporation of 18O into metabolism measurements was limited in its steady state application and required a good estimate of system specific isotope fractionation for respiration. It did not yield a radically different total metabolism estimate than that calculated without isotopes for this system during the study period, but did deliver a clear picture of time-variable respiration, which was unattainable otherwise.

Tockner, **K**., IGB, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, tockner@igb-berlin.de

Pusch, M., IGB, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, pusch@igb-berlin.de

Wolter, C., IGB, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, wolter@igb-berlin.de

Sukhodolov, A., IGB, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, alex@igb-berlin.de

Gessner, J., IGB, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, sturgeon@igb-berlin.de

LARGE RIVERS UNDER STRESS

Large rivers are human-dominated ecosystems impacted through multiple stressors such as land reclamation, floodplain drainage, navigation, water pollution, and species invasion. Today, large rivers are novel, domesticated ecosystems - with no analogous state in the past. Native aquatic communities are being rapidly replaced by exotic-dominated assemblages leading to a homogenization of the biota. Because of these drastic alterations it is becoming evident that most management strategies probably do not achieve their goals because of non-linear relationships and time-lags between the causes and the effects of biodiversity change; similar to what is observed for human demographic development and CO2 increase. Concurrently, restoration targets compete with other targets and directives implemented at national, continental, and global scales. In this presentation, we will discuss the formation and establishment of novel large river assemblages and its related ecosystem services. Innovate ideas and concepts are presented on how to potentially manage large rivers as cultural freshwater ecosystems and to develop synergies among presently competing targets such as biodiversity conservation, navigation, water use, and flood control.

Todd, **D**. **B**., U.S. EPA and University of Cincinnati, Cincinnati, USA, todd.brooke@epamail.epa.gov

Harwood, J., Tennessee Technological University, Cookeville, USA, JHarwood@tntech.edu

CAUSAL ASSESSMENT AND LESSONS LEARNED FROM THE CADDIS STRESSOR IDENTIFICATION ANALYSIS OF PIGEON ROOST CREEK, TN

The Causal Analysis/Diagnosis Decision Information System (CADDIS) provides a defensible method for identifying stressors in polluted surface waters. A causal assessment of impaired benthic invertebrate assemblage was completed for Pigeon Roost Creek, Tennessee. Inconsistent data collected over a five year period suggested sedimentation as a probable cause of biological impairment. However, the temporal, spatial, and nature of samples at the site and the inability to compare stressor-response relationships to similar streams in the region reduced the confidence in the assessment. Future studies at Pigeon Roost Creek and other rivers in TN will benefit from better selection of internal reference sites, access to regionally developed stressor-response relationships, and availability of consistent data sets. The CADDIS process should be viewed as an iterative process without the expectation that the first causal assessment will be sufficient for clear decision making, but undertaking the first assessment will lead to more sophisticated and confident assessments.

Tolley-Jordan, **L**. **R**., The University of Alabama, Tuscaloosa, USA, tolle004@gmail.com

Bogan, A. E., 2North Carolina State Museum of Natural Sciences, Raleigh, USA, arthur.bogan@ncdenr.gov

Huryn, A. D., The University of Alabama, Tuscaloosa, USA, huryn@bama.ua.edu

USING SHELL MORPHOLOGY FROM NOMINAL SPECIES DESCRIPTIONS TO ASSESS *ELIMIA* (GASTROPODA: PLEUROCERIDAE) TAXONOMY IN THE CAHABA RIVER, ALABAMA, USA.

The 414 synonyms surrounding the 156 species of *Elimia* (Gastropoda: Pleuroceridae) in North America attest to the difficulties in identifying these animals. In the Cahaba River, Alabama, USA, the currently recognized 13 species of *Elimia* were selected from 53 nominal species (9 species include at least 1 and up to 10 synonyms). Phylogenetic analyses were used to test if relationships of nominal species based on shell morphology validate the current taxonomic structure of *Elimia* in the Cahaba River. Species relationships were based on 21-unique, external morphological characters derived from taxonomic descriptions for each of the 53 nominal species. Results of neighbor-joining and parsimony analyses showed very few, well-supported clades. Our data suggests that the current *Elimia* taxonomy is not based on morphological data available in original species descriptions. In addition, the use of external morphological characters did not sufficiently discern relationships within *Elimia*. Further analyses that include molecular markers and internal morphological characters (e.g., radula) are necessary to elucidate species relationships, and to determine if revisions to the current *Elimia* taxonomy in the Cahaba River are necessary.

Tonolla, **D**., IGB, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, tonolla@igb-berlin.de

Acuña, V., ICRA, Catalan Institute of Water Research, Girona, Spain, vicenc.acuna@icra.cat

Tockner, K., IGB, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, tockner@igb-berlin.de

THERMAL CHARACTERIZATION OF RIVER LANDSCAPES USING IR-THERMOGRAPHY

Temperature is a key property driving ecological processes and controlling the composition and distribution of biota of river-landscape ecosystems. However, given the size and complexity of river-landscapes, ground surveys based on point measurements are spatially limited. Here we applied infrared (IR) thermography to quantify surface temperature patterns over 24 h cycles in two river floodplains. Furthermore, vertical temperature distribution was measured in unsaturated gravel sediment deposits. Each floodplain habitat type exhibited a distinct thermal signature creating a complex thermal mosaic. The diel temperature pulse and maximum daily temperature were the main thermal components that differentiated habitat types. Vertically, in the top unsaturated sediment layers, the spatiotemporal variation of temperature was about as high as horizontally across the entire floodplain surface. This study emphasized that IR-thermography is a powerful non-invasive method to quantitatively assess surface temperature of complex river-landscape ecosystems at a resolution required to understand ecosystem processes. In addition, we present further applications of IR-thermography including the identification of thermal refugia for fish and the effects of flow regulation on thermal heterogeneity in a river network.

Torgersen, **C**. **E**., U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Seattle, USA, ctorgersen@usgs.gov

Likens, G. E., Cary Institute of Ecosystem Studies, Millbrook, USA, likensg@ecostudies.org

Buso, D. C., Cary Institute of Ecosystem Studies, Campton, USA, dbuso@worldpath.net

McGuire, K. J., Virginia Tech, Blacksburg, USA, kevin.mcguire@vt.edu

Lowe, W. H., University of Montana, Missoula, USA, winsor.lowe@umontana.edu

LINKING NETWORK PATTERNS AND PROCESSES OF STREAMWATER CHEMISTRY ACROSS SCALES IN HUBBARD BROOK VALLEY

Linkages between physico-chemical patterns and landscape processes are typically evaluated by relating upstream catchment characteristics to stream chemistry measured at the outlet of the catchment. This approach assumes that (1) the gradient from ridgetop to outlet is the dominant scale of variation, (2) 'hotspots' resulting from point sources and stream network structure are of limited importance, and (3) the response at the outlet effectively integrates landscape processes throughout the watershed. We tested these assumptions by examining multi-scale variation in streamwater chemistry throughout a catchment (~33 km^2) using data from an exhaustive valley-wide survey, in which samples were collected every 100 m along 32 tributaries in spring (n = 625) and fall (n = 761) of 2001. Multiple spatial scales of variation in streamwater chemistry (pH, acid-neutralizing capacity, Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, SO_4^{2-}, NO_3^{-}, Cl^{-}, dissolved silica, Al^{n+}, dissolved organic carbon, and dissolved inorganic carbon) were quantified using semi-variograms based on hydrologic distance along the stream network. Preliminary results indicate that patchiness in streamwater chemistry was present at multiple scales ostensibly associated with interactions between the surficial landscape, catchment structure, and groundwater processes.

Torres, **P**. **J**., University of Georgia, Athens, USA, pjtorres@uga.edu

Pringle, C. M., University of Georgia, Athens, USA, cpringle@uga.edu

LANDSCAPE-SCALE EFFECTS OF DAMS ON ECOSYSTEM PROCESSES: NATIVE FAUNAL EXTIRPATIONS DECREASE RATES OF LEAF LITTER BREAKDOWN IN HIGHLAND STREAMS OF PUERTO RICO

Indirect upstream effects of dams on ecosystem processes are little-known, outside of research on changes in nutrient cycling in north temperate streams (i.e. loss of nutrient subsidies by migratory salmonids. Here we examine regional indirect effects of dams on the ecosystem process of leaf decomposition in Puerto Rican streams. Highland streams are dominated by shrimps which can exert strong top-down control on decomposition and other ecosystem processes. These migratory shrimps have been extirpated above dams which block their access to upstream reaches. We ran leaf decomposition experiments in dammed (n=7) and undammed (n=7) streams, island-wide, and found that mean leaf breakdown rate was significantly higher (p=0.0031) in undammed streams compared to dammed streams. We also conducted in-situ macroconsumer exclusion experiments using an electric-exclosure technique in a dammed and undammed stream. We found that percentage leaf mass loss over time was significantly greater (p<0.001) in macroconsumer access versus *exclusion* treatments in the undammed stream but not significantly different in the dammed stream. Our findings indicate that extirpation of native fauna results in significantly reduced decomposition rates above dams in streams island-wide.

Torres-Ruiz, M., Fordham University, Louis Calder Center - Biological Field Station, Armonk, USA, monicatorres5@hotmail.com

Wehr, **J**. **D**., Fordham University, Louis Calder Center - Biological Field Station, Armonk, USA, wehr@fordham.edu

Perrone, A. A., Fordham University, Louis Calder Center - Biological Field Station , Armonk, USA, aperrone@fordham.edu

CHANGES IN FATTY ACID PROFILES OF NET-SPINNING CADDISFLIES WHEN FED CONTROLLED DIETS

We conducted laboratory experiments using controlled diets (fish food, oats, the alga *Cladophora glomerata*, conditioned leaves) to clarify fatty acid (FA) assimilation and metabolism by net-spinning caddisfly larvae (*Hydropsyche* sp.), and to determine if animals could synthesize essential FAs (18:2n6, 18:3n3, 20:4n6 and 20:5n3) de novo, elongate them from precursors, or must acquire them from their diet. Caddis FAs consistently matched their diets; the animals had limited abilities to synthesize and elongate EFAs. Concentrations of linoleic (18:2n6) and linolenic (18:3n3) acid declined in caddisflies fed diets depleted in these FAs. Using a diet deficient in arachidonic acid (20:4n6), but

rich in precursor 18:2ω6, we show that the ability of caddis larvae to elongate 18:2n6 to 20:4n6 is limited or absent. Caddisflies accumulated 20:5n3 at greater assimilation efficiencies than for any other FA, suggesting a key importance of this FA. Caddisflies gained mass and/or total FAs with all food sources, except when fed leaf litter. Data show that terrestrial detritus is not an adequate source of EFAs and that stream-dwelling caddisflies must obtain these EFAs from algal material or from predation.

Townsend, **S.**, Charles Darwin University, Darwin, Australia, simon.townsend@cdu.edu.au

Webster, I., CSIRO, Canberra, Australia, ian.webster@csiro.au

Schult, J., Department of Environment, Darwin, Australia, julia.schult@nt.gov.au

THE TIGHT COUPLING OF PHOTOSYNTHESIS AND RESPIRATION DURING BASE FLOW IN THE AUSTRALIAN WET-DRY TROPICS

The rates of photosynthesis (P) and respiration (R) were calculated at 4 high order river sites during the dry season in tropical Australia when discharge is supplied by groundwater. The rivers were shallow, clear, and had low concentrations of nutrients. Increased irradiance at the riverbed, warmer water temperatures, and an increase in primary producer biomass over the dry season contributed to an approximate doubling of P. We surmise that most photosynthesis resulted in the production of dissolved organic carbon, rather than the growth of primary producer biomass which was nutrient limited. Respiration exceeded photosynthesis (P/R ~0.5), and increased approximately linearly with P (r2 =0.79–1.00). Bacterial metabolism of photosynthetically produced dissolved organic carbon (PDOC) could partially explain the tight coupling of respiration and photosynthesis, though cannot account for the river's overall net heterotrophy. The co-metabolism of recalcitrant dissolved organic carbon, such as humic acids, by bacteria, which is made possible by the presence of readily degraded PDOC, provides an explanation for the river's heterotrophy and the tight coupling between P and R.

Traister, **E. M.**, University of New Hampshire, Durham, USA, elena.traister@mcla.edu

McDowell, W. H., University of New Hampshire, Durham, USA, bill.mcdowell@unh.edu

STREAM ECOSYSTEM RESPONSE TO AN EXTRAORDINARY FLOOD EVENT: A WINDOW INTO THE FUTURE OF TEMPERATE STREAMS?

The Suncook River in New Hampshire dramatically changed course on May 15, 2006 after eight inches of rain fell over a two-day period. This avulsion created one entirely new stream reach, dewatered a second reach, and delivered large amounts of suspended sediments to an otherwise un-impacted downstream reach. Dramatically higher concentrations of suspended sediment were found in the first few months in and downstream of the new channel, and persistently higher concentrations were observed in these reaches throughout the 17-month study period. Reduced substrate size in the new channel and the channel downstream of the flood was associated with reduced macroinvertebrate abundance, altered fish communities, and reduced whole-stream respiration that persisted throughout the study period. Dewatering led to long-term changes in water chemistry, as well as changes to the fish community and reduced whole-stream respiration. Understanding the geomorphic conditions that precede avulsions, as well as the ecosystem effects that result, is important for managing water resources under changing climate conditions that favor increased avulsion frequency due to greater flooding frequency, and increased drought due to greater variation in precipitation levels.

Tremblay, **A.**, Hydro-Québec, Montréal, Canada, tremblay.alain@hydro.qc.ca

Demarty, M., Environnement Illimité Inc., Montréal, Canada, maud.demarty@envill.com

Bastien, J., Environnement Illimité Inc., Montréal, Canada, julie.bastien@envill.com

METHANE AND NITROUS OXIDE EMISSIONS FROM CANADIAN RESERVOIRS

The growing concern regarding the long-term contribution of freshwater reservoirs to atmospheric greenhouse gases (GHG), led Hydro-Québec and Manitoba Hydro, to study GHG emissions from their reservoirs. The major greenhouse gases (GHGs) are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). In order to take into account spatial and temporal variability of the GHG emissions, we have used floating chambers (spatial resolution) and automated systems (temporal resolution). The results of CH4 and N2O fluxes and dissolved gas measurement campaigns carried out during the open-water and ice cover periods in several reservoirs are presented, and compared to those obtained in the natural aquatic environments. Generally, CH4 emissions increased after flooding by 3 to 5 times the values measured in natural lakes. Rapidly, within 2 or 3 years after flooding CH4 emissions are comparable to natural aquatic environments. No changes were observed in the emissions before and after flooding. CH4 and N2O emissions will also be compared with CO2 emissions.

Nguyen, T. Q., McGill University, Montreal, Canada, tri.nguyen-quang@mcgill.ca

Frederic Guichard, F. G., McGill University, Montreal, Canada, fred.guichard@mcgill.ca

A COUPLED ECOLOGICAL-PHYSICAL THEORY OF PLANKTONIC POPULATIONS: INTEGRATING HYDRODYNAMICS, SPECIES INTERACTIONS AND COLLECTIVE MOBILITY

This paper investigates hydrodynamic processes of suspended microorganism population within a thermal stratification, using a model of coupled equations: Navier-Stokes' equation for the fluid dynamic motion, Fisher's equation for the microorganism population, energy conservation equation for thermal effects and the Boussinesq's approximation for the dependence on mass density of microorganisms. The microorganism population is assumed to be slightly denser than the fluid and growing by logistic law. A numerical investigation is conducted to study patterns of microorganism distribution under thermal stratification. It is found that thermal stratification constrains the feedback between hydrodynamic and microorganism dynamics. Thermal stratification can dampen bioconvective pattern which could be generated by mobile microorganism population and induce oscillatory dynamics if microorganism diffuses faster than temperature. In the same context of 'double-diffusion,' a further study is also presented focusing on the hydrodynamic and collective mobility effects on predator-prey model.

Trice, **A. E.**, University of Georgia/ Odum School of Ecology, Athens, USA, amytrice@gmail.com

Rosemond, A. D., University of Georgia/ Odum School of Ecology, Athens, USA, rosemond@uga.edu

Milanovich, J. R., University of Georgia/Warnell School of Forestry and Natural Resources, Athens, USA, milanovichj@warnell.uga.edu

Maerz, J. C., University of Georgia/Warnell School of Forestry and Natural Resources, Athens, USA, jmaerz@warnell.uga.edu

ASSESSING THE TROPHIC ROLE OF SALAMANDERS IN STREAM ECOSYSTEMS: SEASONAL, SPECIES-SPECIFIC AND INDIVIDUAL VARIATION

Amphibians are known to be dominant in both abundance and biomass in some ecosystems and, therefore, are presumed to influence ecosystem processes. Relatively little is known about the trophic ecology of larval salamanders beyond basic diet snapshots. Seasonal $\delta^{13}C$ and $\delta^{15}N$ of individual larvae were determined for three common species of salamander in four southeastern headwater streams (GA, USA). Trophic distances of salamander species from basal resources were estimated to be similar to those of macroinvertebrate predators. Isotopic signatures ($\delta^{13}C$ and $\delta^{15}N$) were compared with snout-vent length (SVL) to assess size effects on individual variation in data sets that included both Piedmont and Blue Ridge physiographic regions. Larvae became depleted in $\delta^{15}N$ as SVL increased, although relationships were species-specific. Sources of size-specific variation may be related to physiological changes within animals such as size-specific growth rates, or may reflect ontogenetic changes in diet. The latter possibility suggests ontogenetic variation should be incorporated into our understanding of the trophic role of salamanders in stream ecosystems.

Trichet, **E.**, Cemagref of Lyon, Lyon, France, evelyne.trichet@cemagref.fr

Archaimbault, V., Cemagref of Lyon, Lyon, France, virginie.archaimbault@cemagref.fr

Roger, M. C., Cemagref of Lyon, Lyon, France, marie-claude.roger@cemagref.fr

FUNCTIONAL RESPONSES OF MACROINVERTEBRATE COMMUNITIES TO CHEMICAL RECOVERY : THE EXAMPLE OF THE VISTRE RIVER (FRANCE)

Most of streams suffered from anthropogenic pollution, such as untreated wastewater or insufficiently cleaned effluents of wastewater treatment plants (WWTP). The Vistre river is one of these hardly damaged streams. In 2008 the

WWTP closed and a new one, equipped with modern techniques and respecting the Europeans standards, was built 1 km downstream. The building of these efficient WWTP resulted in an enhanced purification of wastewater, leading to an improvement of stream water quality. The present study investigated the recovery of the aquatic ecosystem functioning after such modifications. Our objective was to assess the effects of the point source on the structure and functional organization of the macrobenthic community. Invertebrates and environmental parameters were collected upstream and downstream of the old and new point source inputs during the last 3 years (September 2007 to September 2009). Analysis carried out indicates that water quality and invertebrate abundance rapidly increase just after the old WWTP cessation whereas community structure is slower modified. Observed modifications in the functional structure suggest that traits could be useful to assess the effect of restoration management.

Troedsson, **C**., Uni Research, Bergen, Norway, christofer.troedsson@bio.uib.no
Lobon Rius, C., Universidad de Oviedo, Oviedo, Spain, carlalobon.uo@uniovi.es
Bouquet, J. M., Uni Research, Bergen, Norway, jean-marie.bouquet@sars.uib.no
Sundelof, A., University of Gothenburg, Gothenburg, Sweden, andreas.sundelof@marecol.gu.se
Reeve, M., Uni Research, Bergen, Norway, magnus.reeve@sars.uib.no
Novac, A., University of Bergen, Bergen, Norway, aliona.novac@bio.uib.no
Thompson, E. M., Uni Research, Bergen, Norway, eric.thompson@bio.uib.no

POPULATION REGULATION OF THE PELAGIC TUNICATE APPENDICULARIAN OIKOPLEURA DIOICA

Tunicate appendicularians play a central role in pelagic food webs as primary consumers and in vertical carbon transport. However, factors controlling these two pathways are still poorly described. Recent data indicate that size and shape of prey particles will significantly effect ingestion and house trapping rates. These data also suggest that although bloom conditions will trap more particles and increase the vertical carbon shunt, increase particle load in the house might decrease ingestion rates and therefore exceed a bottom-up regulation of appendicularians. To test this hypothesis we performed a series of population dynamic experiments, including measurements of fecundity, hatching success and mortality at different quantity and quality of food. Similar to other studies, food level and fecundity was positively correlated. However, although there was no effect of food on adult mortality, higher food levels significantly decreased hatching success. The life history data was fed into a Lagrangian correlated random walk model generating hypotheses on the regulating mechanisms of population dynamics. This can help assess the impact appendicularians have on the pelagic food webs.

Troelstrup, **N**. **H**., South Dakota State University, Brookings, USA, Nels.Troelstrup@sdstate.edu
Vander Vorste, R. W., South Dakota State University, Brookings, USA,
Rasmussen, E. J., South Dakota State University, Brookings, USA,

INVERTEBRATE BIOTIC INTEGRITY OF HEADWATER STREAMS AND ITS RELATIONSHIP TO WATERSHED CONDITION IN THE NORTHERN GLACIATED PLAINS

Headwater streams contribute the largest share of drainage systems and provide the greatest interaction with riparian management. However, little is known regarding the biotic integrity of our headwaters or its relationship to watershed condition. The objectives of this effort were to characterize invertebrate biotic integrity of Northern Glaciated Plains (NGP) headwaters and quantify the relationship between invertebrate IBI scores and GIS-based watershed assessment. Monthly invertebrate samples were collected from 59 headwater streams throughout the NGP using EMAP Western Pilot protocols. Counts of invertebrate taxa were used to generate 72 community metrics for the estimation of IBI scores. Insect richness, Coleoptera richness, shredder richness and sprawler richness were found to pass all metric screens. IBI scores ranged from 0 to 91.7 (on a scale of 0-100). Targeted streams in poor condition had significantly lower scores than random, targeted good and reference sites. Watershed condition scores generated from GIS-based ATtILLA analysis explained 31 percent of the variation in invertebrate IBI scores. Headwater communities varied by level IV ecoregion and displayed similar biotic integrity to perennial streams of other western states.

Trowbridge, **W**., University of Nevada, Reno, Reno, USA, wtrowbridge@cabnr.unr.edu
Chandra, S., University of Nevada, Reno, Reno, USA, Sudeep@cabnr.unr.edu
Henery, R., University of Nevada, Reno, Reno, USA, renehenery@gmail.com
Goldman, C., University of California,Davis, Davis, ,

THE CONTRIBUTION OF CLIMATE AND CARBON SOURCE TO PELAGIC PRIMARY CONSUMER PRODUCTION IN A SMALL SUBALPINE LAKE

Understanding the factors driving pelagic primary consumer production is of growing interest in limnology. Previous research has utilized both laboratory experiments and whole lake manipulations to determine the extent of allochthonous carbon contributions to production. In this study we used long-term limnological data from subalpine, oligotrophic Castle Lake (USA) to create structural equation models to test the contribution of allochthonous and autochthonous (pooled mixed layer and deep chlorophyll maxima productivity) carbon source contributions to the production of two dominant species of zooplankton, Daphnia spp. and Diaptomus spp. Daphnia biomass was negatively correlated with ice out date and both shallow and deep chlorophyll primary productivity but not with allochthonous carbon. In years with early ice out and strong Daphnia production there was less primary productivity at both depths. Diaptomus biomass was also negatively correlated with shallow primary productivity but not with deep primary productivity or ice out date. In addition, Diaptomus was negatively correlated with autochthonous carbon. If autochthonous carbon were a major carbon source for primary consumer production we would expect there to be a positive correlation.

Troxler, **T**. **G**., Florida International University, Miami, USA, troxlert@fiu.edu
Coronado-Molina, C., South Florida Water Management District, West Palm Beach, USA, ccoron@sfwmd.gov
Rondeau, D. N., Everglades National Park, Homestead, USA, ronomad@gmail.com
Krupa, S., South Florida Water Management District, West Palm Beach, USA, skrupa@sfwmd.gov
Sklar, F., South Florida Water Management District, West Palm Beach, USA, fsklar@sfwmd.gov

INTERACTIONS OF BIOLOGICAL AND HYDROGEOCHEMICAL PROCESSES FACILITATE PHOSPHORUS DYNAMICS IN AN EVERGLADES TREE ISLAND

Nutrient concentration within and transfers between ecosystems are complex because they are often mediated by the interaction of a specific set of biological and geochemical conditions that operate at different temporal and spatial scales. Forest patches in semi-arid and wetland landscapes have been shown to exemplify some of these complex biogeochemical patterns and processes in nature. We investigated biological and geochemical factors suggested to contribute to P accumulation in an Everglades tree island. We characterized spatial and temporal variability in tree island evapotranspiration, local and regional hydraulic and geochemical patterns in ions and nutrients among four tree island plant communities and adjacent slough. We found complex patterns showing highest accumulation of Na and Cl in the driest plant community and lateral transport of TDP to downsteam plant communities that varied seasonally and inter-annually depending on regional hydrologic conditions. The availability of TDP in downstream communities was associated with distinctly stratified water types along a gradient of chemical saturation relative to calcite and aragonite with pH suggesting reprecipitation of P. We illustrate how these processes interact at multiple scales and are contingent upon space and time. The persistent interactions of these processes are thus critically important for maintaining tree island function and biogeochemical heterogeneity within the Everglades wetland landscape.

Tsang, **Y**., Stroud Water Research Center, Avondale, USA, ytsang@stroudcenter.org
Kaplan, L. A., Stroud Water Research Center, Avondale, USA, lakaplan@stroudcenter.org
Newbold, J. D., Stroud Water Research Center, Avondale, USA, newbold@stroudcenter.org

FLOW PATHS FOR WATER AND CARBON DURING STORMS REVEALED BY MONITORING GROUNDWATER ELEVATIONS IN A THIRD ORDER PENNSYLVANIA PIEDMONT WATERSHED

Dissolved Organic Carbon (DOC) is an important source of C and energy for aquatic organisms and is derived primarily from terrestrial sources in forested watersheds. In White Clay Creek, DOC concentrations increase from

approximately 1.5 mg C/L at baseflow to 5 to 12 mg C/L during storms, and these high concentrations diminish more slowly than the stream flow recession. We monitored groundwater levels in five wells spanning hillslopes to the riparian zone, and compared those dynamics with stream discharge. Additionally, groundwater was sampled hourly during a storm for DOC concentrations. Groundwater elevations rose in the riparian zone but not on hillslopes. The recession of riparian groundwater elevations declined slower than stream flow recession and mirrored the decline of stream water DOC concentrations. DOC concentrations in the groundwater showed the same increasing trend as the stream water throughout the storm. Our data indicate that riparian groundwater rises during storms, captures DOC from C-rich soil horizons, and continues to provide C to the stream as the groundwater elevation slowly subsides, extending elevated stream water DOC concentrations during the return to baseflow.

Tsatsaros, **J**. **H**., James Cook University, Australian Centre for Tropical Freshwater Research, Townsville, Australia, julie.tsatsaros@jcu.edu.au
Brodie, J. E., James Cook University, Australian Centre for Tropical Freshwater Research, Townsville, Australia, jon.brodie@jcu.edu.au
Bohnet, I., Commonwealth Scientific and Industrial Research Organization (CSIRO),Tropical Forest Research Centre, Cairns, Australia, iris.bohnet@csiro.au
Valentine, P., James Cook University, School of Earth and Environmental Sciences, Townsville, Australia, peter.valentine@jcu.edu.au

REFINING WATER QUALITY OBJECTIVES IN THE TULLY BASIN, AUSTRALIA THROUGH A COMMUNITY BASED APPROACH

The Wet Tropics in northeast Queensland contains the highest biological diversity in Australia, has outstanding environmental values (EVs), and is economically important. This project focuses on engaging local stakeholders in a tropical rainforest basin in the development of a water quality framework for freshwaters draining to the Great Barrier Reef (GBR). The development of a comprehensive water quality framework can provide a template for use in other tropical rainforest basins. The Tully basin in northeast Queensland was chosen as a case study for this research as it is biophysically and economically representative of other Wet Tropics basins in the region, and is in close proximity to the GBR. Increasing agricultural and urban growth within this basin is likely to degrade water quality to freshwaters, estuarine and marine environments. Main research goals include explaining a process for obtaining EVs from all user groups in the basin, outlining the steps needed to interpret these EVs into the development of a Water Quality Objectives (WQOs) framework, and describing a methodology that incorporates biophysical data and local traditional/ecological knowledge into Wet Tropics WQOs.

Tsui, **M**. **T**., University of Minnesota, Saint Paul, USA, tsuix010@umn.edu
Finlay, J. C., University of Minnesota, Saint Paul, USA, jfinlay@umn.edu

WHAT CONTROLS METHYLMERCURY CONCENTRATIONS IN STREAM BIOTA?

Prediction of methylmercury concentrations (or [MeHg]) in biota is an essential tool for managing mercury contamination. Dissolved [MeHg] is widely considered as a positive predictor of [MeHg] in biota but the relationships between dissolved [MeHg] and [MeHg] in biota can vary widely across ecosystems. In this study, we examined possible factors associated with MeHg accumulation in stream biota by comparing streams with contrasting land cover patterns and sources of dissolved organic matter. The relationship between dissolved [MeHg] and [MeHg] in a ubiquitous insect larvae (hydropsychid caddisflies) was assessed for 27 streams across % wetland gradient in eastern Minnesota and in 10 streams without wetland coverage in northern California. The bioaccumulation factor of MeHg, defined as [MeHg] in biota divided by dissolved [MeHg], was much higher in California streams (mean = $4.1 \times 10^6 \pm 5.8 \times 10^5$ L/kg) compared to Minnesota streams (mean = $7.6 \times 10^5 \pm 1.2 \times 10^5$ L/kg). Therefore, the animal consumers in this study accumulated disproportionately more MeHg in California streams, suggesting that other biological/chemical factors such as organic matter quality may also be important in mediating MeHg bioaccumulation, in addition to dissolved [MeHg].

Tuck, **C**. **M**., Dalhousie University, Halifax, Canada, ctuck@dal.ca
Romanuk, T. N., Dalhousie University, Halifax, Canada, tromanuk@gmail.com

THE EFFECT OF TEMERATURE VARIATION ON FOOD-WEB TOPOLOGY, BODY SIZE, AND BIOMASS DISTRIBUTIONS IN AQUATIC MODEL SYSTEMS ACROSS A LATITUDINAL GRADIANT

Global losses of biodiversity have brought the question of how reductions in species diversity will affect the dynamics of populations and the communities in which they are embedded into the forefront of ecological interest. However, species loss does not occur in isolation. In many natural systems species loss is accompanied by changes in the environment. The potential consequences of changes in temperature regime are of particular interest due to global warming, and the widespread effects increasing temperature will have at all levels of biological organization. Using a model aquatic system, I conducted an experiment using aquatic zooplankton communities from sub-arctic, temperate, and tropical regions, and increased temperatures to 4 and 8 degrees Celsius above the local mean to simulate the effects of global warming. Effects on abundance, variability, persistence and body size at the species and population level, and species richness, evenness, and diversity at the community level were analyzed over time. Significant changes in individual, population, and community structure were seen with increasing temperature.

Tuckett, **Q**. **M**., University of Maine, Orono, USA, quenton.tuckett@umit.maine.edu
Simon, K. S., University of Maine, Orono, USA, kevin.simon@umit.maine.edu
Kinnison, M. T., University of Maine, Orono, USA, michael.kinnison@umit.maine.edu
Saros, J. E., University of Maine, Orono, USA, jasmine.saros.umit.maine.edu

EVOLUTIONARY DIVERGENCE OF CONSUMER STOICHOMETRY IN LAKES SPANNING A TROPHIC GRADIENT

Ecological stoichiometry theory provides a framework relating nutrient release by aquatic consumers to the balance between the stoichiometry of consumers and prey. Because of the mismatch between the availability of certain limiting elements and consumer demand, evolutionary and ecological processes are expected to interact in shaping the "stoichiometric phenotype" of consumers. We examined white perch to determine if colonization of lakes spanning a trophic gradient results in differing stoichiometric phenotypes and excretion among populations. Perch populations in nine lakes spanning a trophic gradient were analyzed for body carbon, nitrogen, and phosphorus content and excretion rates of nitrogen and phosphorus. Stomach contents, body shape, and growth rate were analyzed as covariates. Body phosphorus and nitrogen content increased with trophic state. Correlations were found between phosphorus body content and excretion (positive) and nitrogen body content and excretion (negative). The observed stoichiometric relationships were related to diet, body shape, and growth rate, features often shaped by evolution. This work suggests local resource availability can lead to stoichiometric divergence of consumer populations and supports an emerging synthesis between ecological stoichiometry theory and evolution.

Turner, **A**. **M**., Clarion University, Clarion, USA, aturner@clarion.edu
Chislock, M. F., Auburn University, Auburn, USA, MFC0002@auburn.edu

EUTROPHICATION AND INFO-DISRUPTION: ELEVATED PH IMPAIRS PERCEPTION OF PREDATION RISK BY FRESHWATER SNAILS

The acquisition of sensory information is central to all species interactions. Most aquatic organisms use chemical cues to assess predation risk and other key ecological factors, but chemoreception may be disrupted in systems with elevated pH. Elevated pH in lakes and rivers is often associated with eutrophication. We used laboratory and mesocosm experiments to test whether elevated pH impairs perception of predation risk by the freshwater snails *Physa acuta* and *Helisoma trivolvis*. Nutrients additions to outdoor mesocosms resulted in mid-afternoon pH values of 8.5 to 9.7. Both snail species moved to avoid fish in water with pH < 9.0 but showed no avoidance at higher pH. In a laboratory study, we used buffers to establish six pH treatments ranging from 7.5 to 10.0. At lower pH, both snail species responded to fish cues by moving into safer habitats, but avoidance behavior became impaired at a pH of 8.8 to 9.4. Given the diversity of aquatic organisms that depend on reception of chemical cues and the broad extent of eutrophication, chemosensory impairment is likely a common occurrence in nature.

Turner, **T**. **F**., University of New Mexico, Albuquerque, USA, turnert@unm.edu
Krabbenhoft, T. J., University of New Mexico, Albuquerque, USA, krabbent@unm.edu
Collyer, M. L., Stephen F. Austin State University, Nacogdoches, USA, collyerml@sfasu.edu
Love, C. A., University of New Mexico, Albuquerque, USA, clove1@unm.edu

A NEW HYPOTHESIS TESTING FRAMEWORK FOR STABLE ISOTOPE RATIOS IN ECOLOGICAL STUDIES WITH EXAMPLES FROM THE RIO GRANDE

We present a new framework for hypothesis testing of stable isotope ratios in ecological studies. Statistical procedures are based on nested linear models and a residual permutation procedure (RPP) that is employed to evaluate probabilities associated with test statistics. First, we developed a test for differences in centroid location and dispersion of δ13C and δ15N values within and among groups of isotopic data. Second, we evaluated magnitude and direction of change in centroid position (termed 'path') of a pair of isotopic samples separated in space/time relative to paths of other paired sample sets. Third, we compared attributes of path trajectories (size, direction, and shape) over sample sets containing more than two samples to provide a quantitative description of how patterns of isotopic ratios change in response to spatial and temporal gradients. We illustrated the utility and generality of the method by analyzing a fish community dataset from the Rio Grande, New Mexico. Examples are limited to analysis of δ13C – δ15N biplots, but our approach can readily be applied to univariate and multivariate cases.

Twining, **B**. **S**., Bigelow Laboratory for Ocean Sciences, W. Boothbay Harbor, USA, btwining@bigelow.org

Nunez-Milland, D., University of South Carolina, Columbia, USA, nunez-milland@mail.chem.sc.edu

Baines, S. B., Stony Brook University, Stony Brook, USA, sbaines@ms.cc.sunysb.edu

OBSERVATIONS OF INTRAPOPULATION VARIABILITY IN THE ELEMENTAL QUOTAS OF PHYTOPLANKTON

Phytoplankton play significant ecological and biogeochemical roles in aquatic and marine systems. The elemental content of phytoplankton cells is needed to understand the cycling of bioactive elements in pelagic environments and to assess the importance of trophic interactions for the accumulation of metals in aquatic food webs. We have utilized synchrotron x-ray fluorescence microscopy to measure the elemental composition of phytoplankton collected from a number of different laboratory cultures and natural environments. In each case, the samples analyzed are thought to represent a common population, yet the cells often demonstrate significant intrapopulation variability (exceeding an order of magnitude in some cases). We will present a systematic comparison of intrapopulation variability in cell quotas of the biomass elements P and S and the micronutrients Mn, Fe and Zn in both cultured and field collected populations of cyanobacteria and diatoms. Variations in Si quotas of diatoms will also be examined. Variability in cell quotas will be compared to variability in biovolume- and biomass-normalized element stoichiometries. The implications of this variability for our understanding of cell physiology and aquatic biogeochemistry will be discussed.

Twiss, M., Clarkson University, Potsdam, USA, mtwiss@clarkson.edu

Wilhelm, S. W., University of Tennessee, Knoxville, USA,

McKay, R. M., Bowling Green State University, Bowling Green, USA,

Bourbonierre, R. A., Environment Canada, Burlington, Canada,

Bullerjahn, G. S., Bowling Green State University, Bowling Green, USA,

Carrick, H. J., Pennsylvania State University, University, USA,

Smith, R. E., University of Waterloo, Waterloo, Canada,

CACHEs: UNIQUE LIMNOLOGICAL FEATURES IN ICE COVERED LAKE ERIE

Every February since 2007, we have documented discrete accumulations of elevated phytoplankton biomass, termed CACHEs (Concentrated Algal Community and Heterotrophic Ecosystems), dominated by the filamentous diatom, *Aulacoseira*. CACHEs are present throughout the central basin of this Great Lake and vary from several meters to hundreds of meters in diameter. A remarkable characteristic of CACHEs is the high Chl-a content (20-100ug/L) meters away from water containing 2-4 ug/L. The conditions that cause the formation of CACHEs are unknown however we present several hypotheses to explain their occurrence. A conceptual positive feedback model of CACHE formation that recognizes the physical and biological constraints on *Aulacoseira* growth explains the appearance of discrete accumulations of *Aulacoseira* biomass under the ice, through isopyncnal water flow, rather than as a widespread dispersed bloom. A more physically driven model of CACHE formation relies on frazzle ice formation and subsequent ice dispersion. CACHEs are hyposthesized to have significant impacts on the annual summer hypoxia in Lake Erie and on ice albedo and strength.

Tzilkowski, **C**. **J**., National Park Service, University Park, PA, USA, caleb_tzilkowski@nps.gov

Marshall, M. R., National Park Service, University Park, PA, USA, matt_marshall@nps.gov

BENTHIC MACROINVERTEBRATE MONITORING IN THE NATIONAL PARK SERVICE INVENTORY AND MONITORING PROGRAM: A "VITAL SIGN" OF ECOSYSTEM CONDITION

Knowing the condition of natural resources is fundamental to the National Park Service (NPS) mission to manage parks "unimpaired for the enjoyment of future generations." As part of the NPS Inventory and Monitoring Program, "Vital Signs Monitoring" of ecosystems will provide the minimum infrastructure needed to identify and implement long-term monitoring of the highest-priority measurements of resource condition. More than 270 national park system units were organized into 32 ecoregional Inventory and Monitoring Networks. This poster summarizes and compares benthic macroinvertebrate monitoring protocols used by networks in the Inventory and Monitoring Program. Networks are in the early stages of developing protocols for vital signs monitoring, and of those (N = 30) with significant freshwater resources, 67% plan to monitor benthic macroinvertebrates in lotic and/or lentic systems. Because networks are in preliminary stages of development, only five networks have finalized and approved monitoring protocols. Although most protocols are based on existing (primarily federal) protocols, standardization has been poor thus far among networks.

Ulseth, **A**. **J**., University of Wyoming, Laramie, USA, aulseth@uwyo.edu

Hall, R. O., University of Wyoming, Laramie, USA, bhall@uwyo.edu

Kennedy, T. A., Grand Canyon Monitoring & Research Center, USGS, Flagstaff, USA, tkennedy@usgs.gov

SOURCES OF DISSOLVED ORGANIC CARBON IN THE COLORADO RIVER, GRAND CANYON

Dissolved organic carbon (DOC) is a large component of organic matter in rivers and quantifying sources of DOC is critical for accurately describing riverine C-cycling. Autochthonous organic C is more labile than allochthonous organic C, which is likely to be exported downstream. We measured the sources of DOC in the Colorado River, Grand Canyon. DOC originates from Lake Powell, autochthonusly-derived DOC from Glen Canyon Dam (GCD) tailwater, and DOC leached from buried terrestrial organic matter. We quantified the contribution of autochthonously derived DOC from the productive tailwater of GCD using short-term organic matter budgets. While DOC concentration increases only 0.1 mg C L^{-1} within the tailwater, this amount equals to 2% of the daily DOC flux which is $9.5X10^5$ g C day^{-1} of autochthonous DOC. This flux equates to a contribution of 0.3 g C m^{-2} day^{-1} from the tailwater reach of GCD. Although this DOC is a relatively small contribution to the DOC pool relative to Lake Powell input, bioavailability experiments have indicated that it is labile and potentially subsidizes microbial production in downstream reaches of the Colorado River.

Umek, **J**. **W**., University of Nevada, Reno, Reno, USA, umekj@unr.nevada.edu

Chanrda, S., University of Nevada, Reno, Reno, USA, sudeep@cabnr.unr.edu

Henery, R., University of Nevada, Reno, Reno, USA, renehenery@gmail.com

Buktenica, M., U.S. National Park Service, Crater Lake National Park, Crater Lake, USA, Mark_Buktenica@nps.gov

Girdner, S., U.S. National Park Service, Crater Lake Park National Park, Crater Lake, USA, Scott_Girdner@nps.gov

POTENTIAL IMPACTS OF CRAYFISH ON THE BENTHIC INVERTEBRATE COMMUNITY IN CRATER LAKE OREGON, USA

Crayfish (Pacifastacus leniusculus) populations in Crater Lake, a large, deep terminal lake in Central Oregon, have been expanding in recent years. These invasive species are an increasing concern for managers as they compete and prey on native invertebrate communities, decreasing biodiversity and altering ecosystem functions. Once established, crayfish can dominate freshwater ecosystems regulating the flow of energy and nutrients throughout the system. Currently crayfish are only found at two locations around Crater Lake, providing an opportunity to determine their impacts on the benthic invertebrate community as populations expand in the lake littoral zone. We document the seasonal distribution of crayfish at depth and in eulittoral zone of Crater Lake. Both soft and hard substrates were sampled at multiple eulittoral locations with and without crayfish. Maximum crayfish densities, determined by baited trapping at multiple depths and sampling periods, were found at 3 and 10 meters during July and August. Biodiversity and biomass was significantly higher in areas without crayfish

in both soft and hard substrate areas. Snails and amphibians were completely absent in areas with crayfish presence. This data indicates that crayfish are impacting native invertebrate communities in Crater Lake, altering the biomass and diversity through both resource competition and predation.

Valdez, **R**. **A**., SWCA Environmental Consultants, Logan, UT, USA, valdezra@aol.com

AN OVERVIEW OF THREATS TO THE ENDANGERED RIO GRANDE SILVERY MINNOW AND PROSPECTS FOR RECOVERY

The endangered Rio Grande silvery minnow is threatened by modified river functions, including habitat reduction and fragmentation, altered stream flow, nonnative fishes, and prolonged drought. The Middle Rio Grande Endangered Species Collaborative Program has supported numerous projects since 2000 to offset these threats, and to better understand the life history and ecology of the species. The Upper Rio Grande Water Operations Model was developed to simulate and better provide water for conservation of the silvery minnow while meeting flood control, water delivery and interstate compact requirements. The model is part of a Population and Habitat Viability Assessment being used to inform relationships of the fish population to threats and management actions. Advancements in breeding and rearing of silvery minnow have led to releases of over 1 million fish to augment the middle Rio Grande population and 430,000 into historic habitat in Texas as a 10(j) nonessential experimental population. Population numbers appear to be annually dynamic, and estimates for the middle Rio Grande show an increase to about 2.3 million fish in 2008 as positive evidence of the effectiveness of these management actions.

Valett, **H**. **M**., Flathead Lake Bio Station, Univ of Montana, Polson, USA, maury.valett@umontana.edu

Sponseller, R. A., University of Alabama, Tuscaloosa, USA, rasponseller@bama.ua.edu

McGuire, K. J., Virginia Tech, Blacksburg, USA, kevin.mcguire@vt.edu

Stanley, E. H., CFL University of Wisconsin, Madison, USA, ehstanley@wisc.edu

Hamilton, S. K., KBS Michigan State, Hickory Corners, USA, hamilton@kbs.msu.edu

STREAMS, WATER RESIDENCE TIMES, AND NUTRIENT PROCESSING DOMAINS

Flow-through wetlands, fens, and streams distribute along a continuum of openness where the influence of flow becomes increasingly dominant. We use the nutrient processing domain (NPD) concept to understand the biogeochemical character of flow-through systems. We define a NPD as a realm in functional space occupied by ecosystems that share similar magnitude (absolute), efficiency (percent of inputs), and character (dominant fate) of biogeochemical processing. For nitrogen we propose that water residence time, nitrogen abundance, and plant biomass determine the domains to be occupied by any given system. We used the LINX2 data set to address NPDs among 69 streams occupying landscapes dominated by native vegetation, agriculture, or urban influences. Across streams water residence times varied from 1.2 min to 44 hrs and rate constants for N removal ranged from undetectable to 0.05 per meter. Most streams lacked true plants; plant biomass was recorded in only 19% of streams. Assessment of the magnitude, efficiency, and character of N processing helps place streams in the wider context of ecosystem behavior and contributes to a robust heuristic model relevant to all open ecosystems.

Vallis, **K**. **L**., Loyola University Chicago, Chicago, USA, kvallis@luc.edu

Rosi-Marshall, E. J., Cary Institute of Ecosystem Studies, Millbrook, USA, rosimarshalle@caryinstitute.org

Baxter, C. V., Idaho State University, Pocatello, USA, baxtcold@isu.edu

Davis, J. M., Idaho State University, Pocatello, USA, jmdavis@isu.edu

PAST AND PRESENT AQUATIC INVERTEBRATE DIETS AS INDICATORS OF CLIMATE CHANGE: THE RIVER CONTINUUM REDUX

Predicted effects of climate change will likely include changes to riparian vegetation that may alter organic matter inputs into streams and the degree of shading. The Salmon River basin drains primarily wilderness areas and is relatively unchanged, apart from consequences of greater frequencies of beetle kill and fire, both likely influenced by climate change. Such climate-induced shifts in disturbance regimes likely reduce canopy cover, which may increase stream autotrophic production and decrease allochthonous inputs. We predicted that macroinvertebrate diets would track these changes in resource availability and provide a useful indicator of climate change. We compared diets of aquatic macroinvertebrates collected during summer 1976 to specimens collected during summer 2009. Headwater macroinvertebrates, including *Simulium*, *Yoraperla*, and *Baetis*, consumed more autochthonous and less allochthonous resources in 2009 relative to 1976 (44% and 10%, compared with 37% and 47%). As river size increased, macroinvertebrates consumed less allochthonous resources and more autochthonous resources in both years. Over the past 30 years, there may have been a shift in diets of headwater macroinvertebrates, possibly due to changes in riparian vegetation associated with climate change.

Valois, **A**. **E**., University of New Brunswick, Fredericton, Canada, avalois@unb.ca

Graham, B. S., , Fredericton, Canada,

Curry, R. A., , Fredericton, Canada,

DENSITY-DEPENDENT REGULATION OF SMALLMOUTH BASS POPULATIONS AT THE NORTHERN LIMIT OF THEIR RANGE

Smallmouth bass growth is temperature-limited in Atlantic Canada, as this species is at the northern limit of its distribution. Growth in the first year is critical and fry must reach an adequate size by the end of the summer to survive winter. A variety of density-dependent factors can influence growth including predation, prey type, and inter- or intra-specific competition; however, the relative significance of these variables is largely unknown. Our objectives were to examine the structure of smallmouth bass populations in lakes with similar limnological characteristics but with known differences in growth. Growth was greatest in lakes with a high abundance of prey fish and reduced in lakes with a high abundance of potential competitors. Stable isotope analysis revealed evidence of resource overlap between white sucker and possibly driven by bass predation. The results suggest prey availability and competition can be isolated as factors determining the size and trophic structure of these communitites.

Van den Wyngaert, **S**., Swiss Federal Institute of Aquatic science and Technology (EAWAG), Dübendorf, Switzerland, silke.wyngaert@eawag.ch

Gsell, A., Netherlands Institute of Ecology (NIOO-KNAW), Nieuwersluis, Netherlands, a.gsell@nioo.knaw.nl

Vanholsbeeck, O., University of Zurich, Zurich, Switzerland, olivier@totus.ch

Spaak, P., Swiss Federal Institute of Aquatic science and Technology (EAWAG), Dübendorf, Switzerland, spaak@eawag.ch

Ibelings, B. W., Netherlands Institute of Ecology (NIOO-KNAW), Nieuwersluis, Netherlands, b.ibelings@nioo.knaw.nl

EFFECTS OF ANTHROPOGENIC POLLUTION ON HOST-PARASITE INTERACTIONS

In nature, organisms experience simultaneously multiple biotic and abiotic stressors. When exposed to chemical stressors, organisms may lack energy for mounting defenses against parasite attack and therefore become more susceptible to infection. However, interactions between stress and disease may be much more complex. Environmental stressors may reduce host density and/or host quality and thus have negative effects on parasite transmission and/or parasite reproduction respectively. Also, hosts may harbor high genotypic variation in traits relevant for infection and pollution resistance. Positive or negative correlations of these traits will affect the impact of multiple stressors on population dynamics. To investigate these complex interplays we use simultaneously an experimental and multilayered cellular automaton (ML-CA) modeling approach based on the aquatic model system *Asterionella formosa* (diatom host) and *Zygorhizidium planktonicum* (chytrid parasite). A cross infection experiment in laboratory batch cultures was set up with a sublethal concentration of the herbicide Diuron. First results indicate that parasite fitness is enhanced when the host is exposed to a chemical stressor. Model simulations match the experimental results closely indicating that ML-CA is a valid tool to assess the impact of multiple stressors.

van der Heide , **T**., University of Groningen, Haren, Netherlands, t.van.der.heide@rug.nl

van Nes, E. H., Wageningen University, Wageningen, Netherlands,

van Katwijk, M. M., Radboud University Nijmegen, Nijmegen, Netherlands,

Olff, H., University of Groningen , Haren, Netherlands,

Smolders, A. J., Radboud University Nijmegen, Nijmegen, Netherlands,

MULTIPLE STRESSORS AND FEEDBACKS IN SEAGRASS ECOSYSTEMS

The worldwide-observed seagrass decline is typically ascribed to a multitude of,

often interacting, environmental stressors. However, although multiple stressors may explain global seagrass decline, they do not explain why these ecosystems may collapse without clear warning. Recent studies indicate that seagrass collapse is often associated with human disturbances of feedback mechanisms. These feedbacks arise from the ability of seagrasses to modify their environment ("ecosystem engineering"). Ecosystems with such feedbacks typically demonstrate complex, highly non-linear behavior in response to environmental changes. As a result, any increase in environmental stress may push the ecosystem beyond a critical threshold, causing a sudden collapse. Such ecosystem shifts are very hard to predict, especially in seagrass dominated systems where many stressors may affect feedbacks. To increase success of seagrass conservation and restoration, there is a critical need for new approaches to quantify interactive effects of multiple stressors and feedback mechanisms. We propose a combination of 1) Structural Equation Modeling to identify key-stressors and feedbacks and 2) use of general indicators for ecosystem health like spatial vegetation patterns and/or slow recovery after perturbations ("critical slowing down").

Van Horn, **D**. **J**., University of New Mexico, Albuquerque, USA, vanhorn@unm.edu
Sinsabaugh, R. L., University of New Mexico, Albuquerque, USA, rlsinsab@unm.edu
Takacs-Vesbach, C. D., University of New Mexico, Albuquerque, USA, cvesbach@unm.edu
Dahm, C. N., University of New Mexico, Albuquerque, USA, cdahm@sevilleta.unm.edu

LINEAR AND NONLINEAR RESPONSES OF STREAM BIOFILM COMMUNITIES TO A RESOURCE GRADIENT

The metabolism and biogeochemical cycles of aquatic ecosystems are largely mediated by microbial communities, with biofilm assemblages dominating in stream ecosystems. To determine the effects of resource availability on the structure and function of heterotrophic stream biofilms, we created an enrichment gradient by amending darkened stream channel mesocosms with a stochiometrically balanced solution of glucose, NH_4, and PO_4. A total of ~2000 high quality bacterial partial 16S rRNA gene sequences yielded 479 operational taxonomic units (>97% similarity) and showed significant differences ($p<0.005$) between communities from all treatments, with increasing enrichment resulting in greater community divergence and decreased diversity. Biofilm community productivity and function responded exponentially to enrichment, with exponents of 1.1 for areal mass, 2 for live cell density, and 2.5-4 for the activities of 5 extracellular enzymes. The observed nonlinear increase in functional capacity suggests biofilms are highly responsive to resource availability. This response is likely due to the physical structures and synergistic social interactions found in biofilm assemblages that promote efficient recycling and reuse of nutrients, energy yielding materials, and extracellular enzymes.

Van Sickle, **J**., US Environmental Protection Agency, Corvallis, OR, USA, vansickle.john@epa.gov

MULTIMETRIC INDICES: HOW MANY METRICS?

Multimetric indices (MMI's) often include 5 to 15 metrics, each representing a different attribute of assemblage condition such as species diversity, tolerant taxa, and nonnative taxa. Is there an optimal number of metrics for MMIs? To explore this question, I created 1000 9-metric MMI's by randomly choosing 1 metric representing each of 9 attributes of condition, from 113 candidate metrics estimated for 161 aquatic vertebrate assemblages sampled during the 2000-2004 EPA-EMAP survey of Western USA streams. Over all 1000 cases, average MMI performance declined when metrics were removed at random from the 9-metric MMIs. Mean performance increased slightly, but at a declining rate, as metrics were added to the 9-metric MMIs. However, among the top 10% of 9-metric MMI's, mean performance stayed flat or declined as metrics were added. Similar results were seen for 5 other MMI-development data sets. Results suggest that best-performing MMI's can be built using a single metric for each attribute of assemblage condition, and that performance is unlikely to be improved by adding more metrics.

van Zuidam, **J**. **P**., Wageningen University, Wageningen, Netherlands, jeroen.vanzuidam@wur.nl
Peeters, E. T., Wageningen University, Wageningen, Netherlands, edwin.peeters@wur.nl

BIOMASS BASED VEGETATION TYPOLOGY AND RELATED NUTRIENT LEVELS FOR AQUATIC VEGETATIONS IN DRAINAGE DITCHES.

Drainage ditches are worldwide known for their contribution to biodiversity of the agricultural landscape. Increased input of nutrients from surrounding areas caused dominance of floating plants and disappearance of submerged vegetation in many ditches, lowering biodiversity to a large extent. To restore the submerged vegetation, more knowledge is needed on the relationship between aquatic vegetation types and nutrient conditions. This study focuses on different vegetation types that can be distinguished in drainage systems based on biomass development and their relationship with nutrient levels during the growing season. Field data from 84 drainage ditches in the Netherlands was used to identify and characterize vegetation types, followed by relating those types to nutrient levels in sediment and water. Analyses of biomass data from spring and autumn resulted in 7 vegetation types that show clear differences in biomass development. Preliminary analyses of nutrient data indicate that both water and sediment P levels are mainly determining the vegetation types. Multinomial logistic regressions are used to define nutrient ranges at which the different vegetation types are likely to be found.

Vandermyde, **J**. **M**., Southern Illinois University / Department of Zoology and Center for Ecology, Carbondale, USA, jvandermyde@hotmail.com
Whiles, M. R., Southern Illinois University / Department of Zoology and Center for Ecology, Carbondale, USA, mwhiles@zoology.siu.edu

MACROINVERTEBRATE RESPONSES TO REMOVAL OF RIPARIAN WOODY VEGETATION ALONG TALLGRASS PRAIRIE STREAMS

Woody vegetation encroachment along tallgrass prairie streams is increasing because of human activities such as fire suppression. The effects of these changes are poorly understood, but resources presumably shift from autochthonous to allochthonous with increasing canopy cover, which should ultimately alter consumer communities. We removed woody vegetation from 35m reaches of two headwater prairie streams on the Konza Prairie Biological Station in order to assess the effects of woody expansion on stream ecosystem structure and function. Macroinvertebrate samples were collected from the manipulated and two naturally open stream reaches monthly for one year before and one year after the manipulation. Biomass of shredders (>100x), gatherers (7x), scrapers (3x), and predators (2x) increased and filterers decreased after the removal in one manipulated site. There was a similar, but less dramatic response in the other removal site, possibly because it naturally receives less light. Macroinvertebrates responded to the removal. However, manipulated sites had >2x the biomass of naturally open reaches. Results suggest that woody removal from prairie streams has a strong influence on consumers, but does not immediately restore natural conditions.

Vanderploeg, **H**. **A**., GLERL/NOAA, Ann Arbor, USA, henry.vanderploeg@noaa.gov
Nalepa, T. F., GLERL/NOAA, Ann Arbor, USA, Thomas.Nalepa@noaa.gov
Fahnenstiel, G. L., GLERL/NOAA Lake Michigan Field Station, Muskegon, USA, gary.fahnenstiel@noaa.gov
Pothoven, S. A., GLERL/NOAA Lake Michigan Field Station, Muskegon, USA, steve.pothoven@noaa.gov
Liebig, J. R., GLERL/NOAA, Ann Arbor, USA, jim.liebig@noaa.gov
Cavaletto, J. F., GLERL/NOAA, Ann Arbor, USA,
Madenjian, C. P., USGS Great Lakes Science Center, Ann Arbor, USA, cmadenjian@usgs.gov
Bunnell, D. B., USGS Great Lakes Science Center, Ann Arbor, USA, dbunnell@usgs.gov

RECENT DRAMATIC DREISSENID-INDUCED CHANGES IN OFFSHORE PELAGIC FOOD WEBS OF THE GREAT LAKES: MECHANISMS AND IMPLICATIONS

There have been large decreases in chlorophyll, certain zooplankton, and forage fishes in offshore regions of most of the Great Lakes in recent years. Of particular note was disappearance of the spring phytoplankton bloom that was important to the whole food web. As the quagga mussel replaced the zebra mussel and expanded into deep zones of the Great Lakes, we wondered if populations were high enough in offshore regions to explain these changes based on filtering, nutrient excretion, and ecosystem engineering. Experiments on mussel filtering in combination with mussel biomass estimates indicated that their filtering impact was high enough to explain the loss of the spring bloom. Water clarity in the offshore increased in all seasons, and examination of zooplankton time series suggested that increased water clarity had a negative impact on the zooplankton, possibly through the agency of increased visual predation from Bythotrephes longimanus, an invasive predatory cladoceran.

Previous to expansion of the mussel into deep water, zooplankton dynamics were controlled by forage fishes. Now the bottom-up effects from reduced phytoplankton may be driving zooplankton dynamics.

Vanderstukken, **M**., Catholic University Leuven, Kortrijk, Belgium, maarten.vanderstukken@kuleuven-kortrijk.be
Declerck, S., Catholic University Leuven, Leuven, Belgium, steven.declerck@bio.kuleuven.be
Mazzeo, N., Universidad de la República, Montevideo, Uruguay, mazzeobeyhaut@yahoo.com
Muylaert, K., Catholic University Leuven, Kortrijk, Belgium, koenraad.muylaert@kuleuven-kortrijk.be

THE ROLE OF BIOLOGICAL INTERACTIONS BETWEEN MACROPHYTES AND PHYTOPLANKTON IN THE STABILISATION OF THE CLEARWATER STATE IN SHALLOW LAKES

By suppressing phytoplankton blooms, submerged macrophytes can buffer shallow lakes against eutrophication. This is often attributed to stronger zooplankton grazing in the presence of macrophytes. Besides this indirect mechanism, submerged macrophytes can directly suppress phytoplankton biomass through shading, enhanced sedimentation, nutrient competition or allelopathic activity. These direct mechanisms have received considerably less attention. We performed a series of mesocosm experiments both in temperate and subtropical regions to study the potential importance of these direct mechanisms. Our experiments showed that submerged macrophytes from both regions can suppress phytoplankton biomass over a period of several weeks, even when zooplankton is absent. These direct macrophyte effects were comparable in magnitude to top-down control by *Daphnia*. The importance of nutrient competition varied among macrophytes but all species continued to suppress phytoplankton when nutrient concentrations were saturating, suggesting that they resulted from allelopathic activity. These direct effects of macrophytes on phytoplankton are probably not negligible in natural ecosystems, particularly in subtropical regions where zooplankton grazing is not enhanced by the macrophytes.

Vanni, **M. J**., Miami University, Oxford, USA, vannimj@muohio.edu

NUTRIENT CYCLING BY FISH: FROM INDIVIDUALS TO ECOSYSTEMS

Fish modulate nutrient cycling through a variety of mechanisms. These include direct regulation of nutrient fluxes via feeding, excretion and egestion; storage of nutrients in their bodies; translocation of nutrients across habitat and ecosystem boundaries; effects on nutrient cycling via physical habitat modification (ecosystem engineering); and indirect regulation of nutrient cycling via selective predation. Jim Kitchell recognized the potential importance of these mechanisms over 30 years ago, and the ideas he and his colleagues put forth have stimulated a large body of work. I will highlight recent research and relate it to Kitchell's groundbreaking ideas. Key findings are that ecological stoichiometry and metabolic ecology can explain interspecific variation in nutrient cycling, even in the field; that fishes can act as nutrient sources or sinks, functional roles that vary with spatial and temporal scale; that fishes play unique roles, compared to other heterotrophs, in translocating nutrients across ecosystem and habitat boundaries; and that fishes can moderate temporal variance in nutrient supply rates. Currently, the major challenge lies in understanding and predicting variability in the importance of fish at the ecosystem scale.

Varadharajan, **C**., Massachusetts Institute of Technology, Cambridge, USA, charuv@mit.edu
Tcaciuc, A., Massachusetts Institute of Technology, Cambridge, USA, paty@mit.edu
Borja, E. USA,
Hemond, H. F., Massachusetts Institute of Technology, Cambridge, USA, hfhemond@mit.edu

METHANE EXPORT FROM A EUTROPHIC TEMPERATE FRESHWATER LAKE

The methane biogeochemistry of the eutrophic, stratified, Upper Mystic Lake located in Massachusetts, US was examined in this study, conducted in 2007 and 2008. About 70% of total methane export from the lake occurred through bubbling, with average lake-wide ebullition fluxes ranging from 0.5 to 0.8 mmol/m^2/d. Bubbling episodes tended to be synchronous throughout the lake and were triggered by falling hydrostatic pressures. By contrast, although concentrations in the upper mixed layer were relatively low for the entire sampling period (~1 μM) the diffusive methane flux from the lake surface was significant, ranging from 0.2 to 0.3 mmol/m^2//d. The total methane emitted from the lake during the open water season of 2007 and 2008 was estimated to be ~6-11 kg/d. Dissolved hypolimnetic methane was ~200-800 μM near the lake bottom, with concentrations increasing over the summer and fall. A significant amount of this accumulated methane (~6000 kg) was lost from the hypolimnion between December 2007 and April 2008. Mass balance calculations suggest that much of this methane may have been lost to oxidation during the fall turnover, and that the methane released to the atmosphere through diffusive air-water exchange from the lake surface may have originated primarily in the epilimnion. The results from this research confirm that freshwater lakes can be important natural sources of methane.

Varma, **S**., CSIRO Earth Science and Resource Engineering, Perth, Australia, sunil.varma@csiro.au
Turner, J., CSIRO Land and Water, Perth, Australia, Jeffrey.Turner@csiro.au
Underschultz, J., CSIRO Earth Science and Resource Engineering, Perth, Australia, James.Underschultz@csiro.au

SUBMARINE GROUNDWATER DISCHARGE ESTIMATES FOR GEOGRAPHE BAY, WESTERN AUSTRALIA

A study of submarine groundwater discharge into Geographe Bay in the south west of Western Australia was carried out for the aquifers of the Southern Perth Basin. The study focused on quantification of SGD using Darcy's equation and numerical modeling. The total offshore groundwater discharge into Geographe Bay was estimated at 80 Gigalitres/year. Satellite images and nearshore bathymetry were used to obtain evidence of the possible geographic distribution of significant SGD. ASTER thermal infrared images showed a low-temperature plume (21°C) in the southwest of the study area near Dunsborough Fault, possibly groundwater discharge, extending in an easterly direction and surrounded by seawater of about 23°C. Similar cooler zones were observed along the coastline indicating groundwater discharge from the superficial aquifer. The nearshore bathymetry for Geographe Bay revealed a series of ridges and troughs running sub-parallel to the present-day beach. The hillshade rendition shows a sub-parallel trough feature located about 4-5 km offshore. The bathymetric features identified offshore and the low-temperature plume as observed in the satellite images provide target areas for further investigation and actual measurement of SGD fluxes.

Vaughn, **C**. **C**., University of Oklahoma, Norman, USA, cvaughn@ou.edu
Spooner, D. E., Trent University, Peterborough, Canada, dspooner45@gmail.com
Allen, D. E., University of Oklahoma, Norman, USA, dallen@ou.edu
Atkinson, C. L., University of Oklahoma, Norman, USA, carlalatkinson@gmail.com

USING FRESHWATER MUSSEL COMMUNITIES TO EXAMINE HOW CHANGES IN COMMUNITY STRUCTURE AND ENVIRONMENTAL GRADIENTS INTERACT TO INFLUENCE ECOSYSTEM FUNCTION

We are studying freshwater mussel communities to quantify the linkages between the ecological domains of individual species traits, community composition, environmental gradients, and ecosystem function. We have found that mussel species traits (primarily temperature-specific filtration and excretion rates) are correlated with phylogeny, but expression varies with both abiotic (river hydrological and thermal regimes) and biotic conditions (other species in the community). For example, mussels subsidize stream food webs through nutrient excretion that stimulates primary and subsequently secondary production. The amount of nutrients contributed by mussels depends on mussel biomass, species composition, temperature, discharge, and local nutrient conditions. Overall nutrient contributions from the mussel community depend on which species are dominant. However, even common mussel species are declining, leading to shifts in species dominance patterns and thus nutrient recycling. Examining these linkages requires using multiple approaches: small-scale laboratory experiments, mesocosm experiments, field experiments, large-scale, comparative field studies, and models.

Vaz, **P**. **G**., Institute of Agronomy - Centre for Applied Ecology Prof. Baeta Neves, Lisbon, Portugal, zasvaz@gmail.com
Pinto, P. G., University of Evora - Institute of Mediterranean Agricultural Sciences, Evora, Portugal, ppinto@uevora.pt
Rego, F. C., Institute of Agronomy - Centre for Applied Ecology Prof. Baeta Neves, Lisbon, Portugal, frego@isa.utl.pt
Robinson, C. T., Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dubendorf, Switzerland, christopher.robinson@eawag.ch

IMPACT OF COARSE WOODY DEBRIS INPUT IN CONTRASTING BURNED FORESTS ON STREAM PHYSICAL ATTRIBUTES: A MEDITERRANEAN PERSPECTIVE OF THE LONG-TERM ROLE OF FIRE

This study assessed long-term effects of wildfires on aquatic ecosystems in the Mediterranean Basin, Portugal. Among Mediterranean countries, Portugal is prominently targeted by wildfires. Since 1990, more than 25% of the country burned and in 2003 and 2005 the burnt area was maximal and created the need and opportunity for this ongoing study. In Central Portugal, 9 sub-basins burnt between 2003 and 2007, dominated by eucalyptus (euc), maritime pine (mpn) and cork oak (cok) were selected and 27 reaches of first to third order streams were sampled for coarse (>0.05 m diameter) woody debris (CWD). Line Intersect Sampling and Census techniques were used along burned valleys and corresponding streams, respectively. First results indicate differences on potential debris delivery to streams according to tree species, whether in relation to log lengths (mpn>euc>cok), diameters (cok>mpn>euc) and number (euc>mpn>cok). Output and retention of CWD to the stream channel are filtered by valley characteristics (shape and flow path ways), evidences of wildfire severity, post-fire vegetation recovery and retention features (e. g. fences and roads).

Veach, **A**. **M**., Ball State University, Muncie, USA, amveach@bsu.edu
Bernot, M. J., Ball State University, Muncie, USA, mjbernot@bsu.edu

TEMPORAL VARIATION OF PHARMACEUTICALS IN AN URBAN AND AGRICULTURALLY INFLUENCED STREAM

Pharmaceuticals enter freshwater ecosystems via multiple sources. Previous studies demonstrate the prevalence of pharmaceuticals in freshwater but we do not yet know how concentrations vary over time within a given system. Two sites in central Indiana with varying land use in the surrounding watershed were sampled monthly for pharmaceutical concentrations and stream physiochemical parameters. Significant differences in pharmaceutical compounds detected and total concentrations were identified both between sites (spatial variation) and within each site (temporal variation). Pharmaceutical compounds detected included acetaminophen (2.1-460 ng/L), carbamazepine (1.1-2.7 ng/L), caffeine (11-400 ng/L), cotinine (2.1-12 ng/L), DEET (23-150 ng/L), ibuprofen (1.8-42 ng/L), sulfamethoxazole (1.4-15 ng/L), and triclosan (9.1-22 ng/L). Across sites, water column dissolved oxygen correlated with caffeine (p=0.026), carbamazepine (p=0.006), cotinine (p=0.026), and sulfamethoxazole (p=0.056) concentrations. Overall, total pharmaceutical concentrations within the agriculturally influenced site were highest in winter whereas the urban site had the higher concentrations in summer. Pharmaceuticals present in freshwater may not only affect aquatic organisms, but may also enter drinking water intakes resulting in unintentional consumption by humans. A more comprehensive understanding of spatial and temporal variability of these contaminants is needed to mitigate potential effects.

Venarsky, **M**. **P**., University of Alabama, Tuscaloosa, USA, mpvenarsky@crimson.ua.edu
Huryn, A. D., University of Alabama, Tuscaloosa, USA, huryn@bama.ua.edu
Kuhajda, B. R., University of Alabama, Tuscaloosa, USA, bkuhajda@bama.ua.edu
Benstead, J. P., University of Alabama, Tuscaloosa, USA, jbenstead@bama.ua.edu

LIFE HISTORY PLASTICITY IN THE OBLIGATE CAVE CRAYFISH, ORCONECTES AUSTRALIS.

An organism's evolutionary history constrains its ability to locate, utilize, and compete for resources. K-selected life history characteristics and reduced metabolic rates have evolved in cave taxa, because they provide an advantage in energy-limited cave ecosystems. However, it is unknown if any plasticity is built into these adaptations. Here we present preliminary results from an ongoing mark-recapture study on the obligate cave crayfish, Orconectes australis, from three separate cave systems with varying levels of standing crop organic matter (53, 63, and 132 g dry mass m-2). Using measurements of individuals recaptured more than one year after initial marking, preliminary growth models estimating annual growth increment were developed for each cave. Water temperature among the three caves was similar (~13.5oC), but crayfish in the system with the highest amount of average standing crop organic matter had the highest growth rate and shortest time-to-maturity (e.g. females: 3-9 years as opposed to 8-17 years). These data suggest O. australis has the ability to exploit food resources when they are plentiful, but can also survive and reproduce in systems with lower amounts of resources.

Venkiteswaran, **J**. **J**., University of Waterloo, Waterloo, Canada, jjvenkit@uwaterloo.ca
Schiff, S. L., University of Waterloo, Waterloo, Canada, sschiff@uwaterloo.ca

A CONFOUNDING EFFECT OF DAYTIME RESPIRATION: IS ISOTOPIC FRACTIONATION DURING O_2 CONSUMPTION PARTLY A FUNCTION OF CONCENTRATION?

Based on direct and indirection observations of community respiration resulting from modelling diel O_2 and $\delta^{18}OO_2$ data, there is often a requirement for higher respiration rates during the day accompanied by stronger isotopic fractionation. This may be indicative of higher daytime respiration including photorespiration and/or the Mehler–peroxidase reactions or may be indicative of greater analytical and modelled error at high O_2 and low $\delta^{18}OO_2$ values. The results of respiration incubations with a wide range of initial O_2 suggest that ecosystem-level respiration and fractionation may be affected by O_2 concentration as a daytime effect. These results will be interpreted within three (spring, summer, and autumn) longitudinal samplings of O_2 and $\delta^{18}OO_2$ completed at 23 locations at base-flow conditions in a seventh-order river affected agricultural and urban nutrients.

Veraart, **A**. **J**., Wageningen University, Wageningen, Netherlands, annelies.veraart@wur.nl
Kosten, S., Wageningen University, Wageningen, Netherlands, sarian.kosten@wur.nl
Lacerot, G., Wageningen University, Wageningen, Netherlands, gige.fcien.edu.uy
de Klein, J. J., Wageningen University, Wageningen, Netherlands, jeroen.deklein@wur.nl

EFFECTS OF WARMING AND MACROPHYTE PRESENCE ON DENITRIFICATION IN TEMPERATE AND SUBTROPICAL LAKES.

In temperate lakes and streams denitrification rates may greatly increase with rising temperature. However, in subtropical lakes, where temperatures are higher throughout the year, these rates are likely limited by available resources rather than temperature. We used a new method to examine the response of denitrification to warming in 6 temperate and 4 subtropical lakes. As macrophyte presence may change with global warming, and macrophytes influence denitrification rates, we studied the combined effects of warming and macrophyte presence. Denitrification rates were measured *in situ* at lake edges in denitrification chambers, using the ^{15}N isotope pairing technique. Temperature in half of the denitrification chambers was adjusted to 3 degrees above ambient. Denitrification rates were mainly determined by trophic status of the lake. None of the subtropical lakes showed a response of denitrification to warming, whereas in some of the temperate lakes denitrification was significantly higher in the warmed than in the un-warmed chambers. This effect was stronger when macrophytes were present. Our study shows that denitrification rates are more likely to be affected by global warming in lakes at higher latitudes.

Verb, **R**. **G**., Ohio Northern University, Ada, USA, r-verb@onu.edu
Rubino, D. L., Hanover College, Hanover, USA, rubino@hanover.edu

CHARACTERIZATION OF THE PHYSICOCHEMICAL PROPERTIES AND PERIPHYTON COMMUNITIES OF TIP-UP POOLS FROM A SOUTHEASTERN INDIANA FLATWOODS

The forests of the Illinoian tillplain in southeastern Indiana are characterized by unique hydrology, soil features, and woody species composition and are typified by their poor drainage and lack of topography. Topographic variation is limited to pit-and-mound topography resulting from tree falls, with the pits representing a unique microhabitat in the forest matrix. In June 2009, nine tip-up pools from an old-growth remnant forest in Jennings County, Indiana, USA were visited to determine their algal composition and their corresponding physicochemical conditions. These systems were analyzed for environmental parameters and for benthic algae residing on leaf litter and loose sediments. Water chemistry between these sites was slightly acidic and of low specific conductance. Physical pool characteristics displayed variation between locations. Sediment samples had sparse algal taxa but were dominated by motile diatom genera such as *Pinnularia* and *Navicula*. In contrast, the leaf litter communities were more species rich. Despite the isolated nature and relative small size of these vernal systems, they do provide a viable habitat for algae within the forest matrix.

Verberk, **W**., University of Plymouth, Plymouth, United Kingdom, wilco.verberk@plymouth.ac.uk

Bilton, D. T., University of Plymouth, Plymouth, United Kingdom, D.Bilton@plymouth.ac.uk

THERMAL NICHES IN AQUATIC MACROINVERTEBRATES AND OXYGEN LIMITATION: A MISMATCH BETWEEN OXYGEN SUPPLY AND OXYGEN DEMAND

Stream invertebrates display a range of adaptations related to respiration and oxygen is considered a key factor structuring species assemblages. Furthermore, as water temperatures rise, aquatic ectotherms face the double problem of reduced oxygen concentrations and increased oxygen demand. Therefore, oxygen deficiency may be an important mechanism setting limits to thermal optima. Not all species will be equally at risk, depending on their physiology (metabolic rate, thermal limits) and other traits (e.g. body size, type of respiration). Integrating information on a species' physiological and biological traits may yield a comprehensive mechanistic understanding of its thermal sensitivity.

Verburg, **P**., National Institute of Water and Atmospheric Research, Hamilton, New Zealand, p.verburg@niwa.co.nz

Howard-Williams, C., National Institute of Water and Atmospheric Research, Christchurch, New Zealand,

Gibbs, M., National Institute of Water and Atmospheric Research, Hamilton, New Zealand,

Vant, B., Environment Waikato, Hamilton, New Zealand,

ORGANIC CARBON FLUXES AND HYPOLIMNETIC OXYGEN CONSUMPTION IN LAKE TAUPO

Lake Taupo, a large volcanic lake (616 km^2, maximum depth 180 m) in New Zealand, is stratified most of the year. Oxygen concentrations in the hypolimnion decrease during the stratified season. The lake is oligotrophic but in recent decades epilimnetic chlorophyll concentrations and hypolimnetic oxygen consumption rates have increased. Hypolimnetic oxygen depletion is considered a useful indicator of trophic status in lakes. An understanding of the drivers of hypolimnetic oxygen depletion is relevant to the management of trophic enrichment of the lake.We examined hypolimnetic oxygen consumption since 1987, and autochthonous and allochthonous sources of organic carbon to explain the seasonal rates of hypolimnetic oxygen depletion. Autochthonous production was the largest source of oxidisable matter. For most years mean chlorophyll concentrations in the stratified season were correlated with hypolimnetic oxygen consumption. However, inputs of organic carbon could not fully explain the rate of oxygen depletion in the hypolimnion. Oxidation of reduced sulphur may explain part of the oxygen consumption in the hypolimnion of Lake Taupo, with large inputs by geothermal vents in some years.

Verdonschot, **P**. **F**., Alterra, Wageningen, Netherlands, piet.verdonschot@wur.nl

PREDICTING THE EFFECTS OF CLIMATE CHANGE ON MACRO-INVERTEBRATES IN LOWLAND STREAMS USING DISCHARGE DYNAMICS CHARACTERISTICS

Despite the uncertainties in the rate of climate change it is commonly believed that in the Atlantic zone of North-West Europe winters will become warmer and wetter, and summers will be wetter than at present. The latter change will likely depend on short heavy rain showers between dry periods. Changes in the amount, frequency and intensity of precipitation are expected to change stream discharge patterns, especially in rainwater-fed lowland streams, which will shift towards more dynamic flow regimes. Indices of discharge dynamics were used to assess the effect of changes in climate, through changes in hydrology, and in land and water use, on natural lowland stream macroinvertebrate communities. Discharge dynamics were significantly correlated with macroinvertebrate community structure, rheophily and saprobity. The results demonstrate important influences of dynamic discharge regimes and extreme flows on macroinvertebrate community structure. Predictions of the ecological effects of climate change and of changes in land and water use, pointed towards impaired ecological conditions in lowland streams of the Atlantic zone of North-West Europe. Scenario tests involving different land use options suggest that current restoration practices and planned restoration activities can positively interact to reduce effects of climate change on lowland stream ecosystems.

Villamarín, **C**., FEM (Freshwater Ecology and Management Research Group). University of Barcelo, Barcelona, Spain, cvillamarínf@ub.edu

Rieradevall , M., FEM (Freshwater Ecology and Management Research Group). University of Barcelo, Barcelona, Spain, mrieradevall@ub.edu

Prat , N., FEM (Freshwater Ecology and Management Research Group). University of Barcelo, Barcelona, Spain, nprat@ub.edu

MACROINVERTERTEBRATE COMMUNITIES OF THE ANDEAN HIGHLANDS RIVERS: CHANGES ALONG THE LATITUDINAL GRADIENT

Changes in macroinvertebrates' communities composition and structure attributes at family level along a latitudinal gradient were explored in 56 reference condition andean highlands rivers (between 2500 to 3800asl). The 8 studied basins covered a wide latitudinal and altitudinal gradient from north Ecuador to south Peru, including sites of the Atlantic and the Pacific slopes. Localities were sampled during the dry season (between October 2007 and November 2008) using quantitative Surber samples. Physicochemical, hydrological and fluvial habitat quality information were also recorded. As expected, macroinvertebrate communities registered significant differences along the altitudinal gradient. Also differences were found between North Ecuador and South Peru samples with families only present and abundant in the south area (eg. Grypopterygidae) or in the north (eg. Ptylodactilidae).

Vimos, **D**., Laboratorio de Ecología Acuática. Universidad San Francisco., Quito, Ecuador, diego_v02@yahoo.com

Encalada, A., Laboratorio de Ecología Acuática. Universidad San Francisco., Quito, Ecuador, aencalada@usfq.edu.ec

Ríos, B., Laboratorio de Ecología Acuática. Universidad San Francisco., Quito, Ecuador, brios@ub.edu

Ordoñez, V., Laboratorio de Ecología Acuática. Universidad San Francisco., Quito, Ecuador, sire_ordonez@hotmail.com

Prat, N., Departamento de Ecología, Universidad de Barcelona, Barcelona, Spain, nprat@ub.edu

EFFECTS OF INTRODUCED RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) AND BROWN TROUT (*SALMO TRUTTA*) IN ANDEAN STREAM COMMUNITIES

The introduction of trout, its establishment, and potential impacts on aquatic ecosystems are poorly understood in South America. We studied the abundance of trout (*Salmo trutta* and *Oncorhynchus mykiss*) in high-altitude Andean streams in northern Ecuador, and surveyed its potential impacts on macroinvertebrate and algal communities. Trout density varied greatly among the 16 streams surveyed. Our results suggest that the impacts of trout in macroinvertebrate and algal communities is minor, as reflected in the lack of relationships between trout density in one hand, and invertebrate density and algal productivity in the other. These parameters seem to depend more on the characteristics of terrestrial and riverine habitats, and the presence of organic inputs from surrounding areas (i.e. cattle raising).Gut content analysis revealed that medium-sized trout ingest the highest proportion of aquatic macroinvertebrates, Anomalopsychidae and Chironomidae being the most frequent prey. Although we did not find a clear influence of trout on the structure of invertebrate and algal communities, they might have an impact on the behavior and morphological responses of aquatic biota. More studies on these indirect effects are needed.

VINEBROOKE, **R**. **D**., UNIVERSITY OF ALBERTA, EDMONTON, Canada, rolf@ualberta.ca

LYONS, D., UNIVERSITY OF ALBERTA, EDMONTON, Canada, dlyons@ualberta.ca

GRAHAM, M. D., UNIVERSITY OF ALBERTA, EDMONTON, Canada, mdgraham@ualberta.ca

MACLENNAN, M., UNIVERSITY OF ALBERTA, EDMONTON, Canada, mmmaclen@ualberta.ca

GLOBAL CHANGE AND AQUATIC MULTI-TROPHIC SYSTEMS: THE STRESSOR-SIZE CONTINUUM CONCEPT

Climate warming and other anthropogenic stressors drive the adverse effects of global change on aquatic ecosystem functioning. Yet, our ability to generalize the cumulative impact of multiple stressors across freshwater and marine ecosystems lacks a common conceptual framework. The Stressor Size Continuum Concept (SSCC) provides testable hypotheses regarding how multiple stressors affect the size-structure of multi-trophic systems, resulting in predictable changes in species diversity and production. Past stressors

have often generated a net shift towards smaller body size, an attribute that is correlated with several other ecological traits (e.g., trophic rank, local species diversity, functional compensation potential, dispersal of tolerant species) that influence the responses of communities to subsequent stressors. The key SSCC hypothesis states that exposure to a stressor favors smaller organisms at lower, more diverse trophic levels, thereby inducing greater tolerance to additional stressors associated with climate change. Several lines of empirical evidence reveal that past exposure of multi-trophic systems to various stressors dampen antagonistically the ecological impacts of rapid warming.

Viso, **R**. **F**., Coastal Carolina University, Conway, USA, rviso@coastal.edu
McCoy, C. A., Coastal Carolina University, Conway, USA, cmccoy@coastal.edu
Peterson, R. N., Coastal Carolina University, Conway, USA, rpeters2@coastal.edu
Lewis, B., Coastal Carolina University, Conway, USA, blewis@coastal.edu

INFLUENCE OF SUBMARINE GROUNDWATER DISCHARGE ON NEARSHORE HYPOXIA IN LONG BAY, SC

Long Bay is an open embayment home to the Grand Strand region of SC which hosts >10 million visitors annually and experiences episodes of degraded water quality including development of hypoxic conditions in summer months. Relative to riverine and inlet exchange, submarine groundwater discharge (SGD) is potentially the most significant contributor of fluids to nearshore waters in the study area. The goals of this study were to characterize radon activities across the subterranean salinity gradient on the beachface and to estimate SGD contributions to the nearshore environment. Observations of physical and meteorological conditions suggest that migration of an offshore, cold, dense water front across the inner shelf prevented coastal mixing. Higher than normal radon activities during this period indicate that anoxic groundwater accumulated in the nearshore environment. Increased SGD rates during the hypoxic event are likely a function of a large tidal range and thermal stratification which increased tidal pumping and increased bottom water residence times by limited water column exchange. In the absence of anomalous biological activity (e.g algal blooms), SGD may provide an alternative mechanism for hypoxic development.

Voelker, **J**., Helmholtz Centre for Environmental Research-UFZ, Magdeburg, Germany, jeanette.voelker@ufz.de
Kattwinkel, M., Helmholtz Centre for Environmental Research-UFZ, Leipzig, Germany, mira.kattwinkel@ufz.de
Borchardt, D., Helmholtz Centre for Environmental Research-UFZ, Magdeburg, Germany, dietrich.borchardt@ufz.de

HYDROMORPHOLOGICAL DEGRADATION, ORGANIC LOAD AND PESTICIDE CONTAMINATION: THE RESPONSE OF AQUATIC MACROINVERTEBRATE COMMUNITIES IN STREAMS

Hydromorphological degradation, organic load and pesticide contamination are simultaneously interacting stressors in many water bodies. To study the impact of these factors on macroinvertebrate communities in running waters, we used a data set of more than 250 sampling points at small streams in Hesse, Germany consisting parameters of macroinvertebrates (taxonomic and functional composition), hydromorphological features and organic load (saprobity). Additionally, the potential for diffuse pesticide input was analysed by modelling. We employed multivariate statistical analysis to explore impacts of individual and combined stressors to biological attributes. Stressors affected the benthic community in different ways. The relevance of hydromorphological degradation seemed to be more significant in water bodies of moderate water quality and high organic load cover diverse morphological conditions. Nevertheless, the dependencies between macroinvertebrates and stressors showed a high variability of relationships. We included the potential pesticide contamination in our analysis and could explain significantly higher portions of the overall variability. Thus we concluded that certain shifts in the macroinvertebrate community structure could be explained by pesticide exposure, but this effect maybe masked both by morphological degradation and organic load.

Vogt, **R**. **J**., University of Regina, Regina, Canada, richvogt@gmail.com
Droescher, I., University of Regina, Regina, Canada,
Patoine, A., University of Moncton, Moncton, Canada,
Rusak, J., Ontario Ministry of the Environment, Dorset, Canada,
Leavitt, P. R., University of Regina, Regina, Canada,

DIFFERENTIAL EFFECTS OF THE INFLUX OF ENERGY AND MASS ON THE LANDSCAPE SYNCHRONY OF LAKE ECOSYSTEMS

Considerable effort has been invested into exploring physical, chemical, and ecological drivers of aquatic community structure. Empirical analysis suggests that interannual variation in the influx of energy (irradiance, heat) is synchronous over large spatial scales, whereas mass influx (water, solutes, particles) reduces coherence because catchments act as local climate filters. This pattern also suggests that constituent components of lakes may exhibit different patterns of synchrony if regulated by Energy (E) or mass (m) pathways. We evaluated this hypothesis for diverse physical, chemical, and biological characteristics of six hard water lakes from 1994-2007. Consistent with expectations, physical variables regulated by E influx (temperature, oxygen) were highly coherent among lakes (r >0.75), whereas solute concentrations (N, P, DOC) were asynchronous (r <0.3). Unexpectedly, biological parameters exhibited a wide range of variability, from moderately coherent copepods (r ~0.5) to asynchronous cladocera (r <0.1) suggesting that species within a single trophic level may be differentially regulated by E and m. Similarly, analysis of the clearwater phase suggested that comparing the magnitude of synchrony (e.g., Daphnia vs. secchi) may help identify mechanisms regulating ecosystem structure.

von Schiller, **D**., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, danielvonschiller@igb-berlin.de
Ribot, M., Center for Advanced Studies of Blanes, Blanes, Spain, mribot@ceab.csic.es
Timoner, X., Catalan Institute of Water Research, Girona, Spain, xisca.timoner@udg.edu
Acuña, V., Catalan Institute of Water Research, Girona, Spain, vicenc.acuna@icra.cat
Martí, E., Center for Advanced Studies of Blanes, Blanes, Spain, eugenia@ceab.csic.es
Sabater, S., Catalan Institute of Water Research, Girona, Spain, sergi.sabater@udg.edu
Tockner, K., Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, tockner@igb-berlin.de

BIOGEOCHEMICAL SHIFTS DURING STREAM DRYING AND REWETTING

Temporary streams are a common feature in the Mediterranean region. The temporal and spatial extent of stream flow intermittency is predicted to increase due to climate change and water abstraction for irrigation and direct human uses. Consequently, there is an urgent need to understand how these hydrological changes will affect the ecology of stream ecosystems. In this study, we quantified the effects of gradual drying and rewetting on the dynamics of dissolved organic and inorganic nutrients in Fuirosos stream (Catalonia, NE Spain). We observed two abrupt but markedly distinct biogeochemical shifts. A major increase in spatial variability of nutrient concentrations occurred during the transition from continuous to fragmented flow. Pronounced increases in nutrient concentrations were observed immediately after flow recovery. The magnitude of these shifts differed among nutrients and was related to marked changes in redox conditions. Taken together, these results reflect biogeochemical thresholds that may strongly affect stream structure and function. This information is critical for the development of adaptive management strategies to mitigate the impacts of flow intermittency on stream ecosystems.

Vopel, **K**. **C**., AUT University, Auckland, New Zealand, kay.vopel@aut.ac.nz
Wilson, P. S., AUT University, Auckland, New Zealand, peter.wilson@aut.ac.nz

OXIDATION OF SURFACE SEDIMENT: EFFECTS OF DISTURBANCE DEPTH AND SEAWATER FLOW SPEED

Periodic disturbance of surface sediment is a natural feature of marine environments. Following exposure to oxygenated seawater, the disturbed sediment oxidises leading to the recovery of its chemistry. Despite its importance for the seafloor ecology, the dynamics of this recovery is poorly understood. We studied the effects of disturbance depth and seawater flow speed on the oxidation of cohesive sediment in a laboratory flume with microelectrodes. We removed surface sediment to 2 depths (5 and 50 mm) and observed changes in sediment oxygen distribution and consumption over 1 h under conditions of slow and fast flow (3.5 and 7.5 cm s–1). Measurements were repeated 1 d later. Our measurements confirmed the results of previous theoretical analyses. They indicate that the duration of the recovery of the surface sediment chemistry from the initial disturbance, and the chemical properties of the recovering sediment, are controlled by the kinetics of solute and solid oxidation. Oxidation of reduced solids in disturbed sediment can result in a characteristic chemical signature at the sediment surface that lasts in the order of at least days.

Waduwawara, **S**., Auburn University, Auburn, USA, szw0021@auburn.edu
Welch, C., Auburn University, Auburn, USA,
Moss, A. G., Auburn University, Auburn, USA, mossant@auburn.edu

SIGNIFICANCE OF WATER DISPLACEMENT BY SEDIMENT-APPOSED *MNEMIOPSIS* (CTENOPHORA: LOBATA).

We quantified multiple behavioral modes of laboratory-maintained *Mnemiopsis*. Near-benthic behaviors can be pooled into four classes: 1) Stationary, benthic pumping, 2) Repeated 'benthic bouncing'(previously called type 1 and type 2 behaviors), 3) T.I.E. fighter mode (stationary hovering, with body axis parallel to the sediment), and 4) Spiral swimming. All behaviors are highly stereotypic, with nearly identical repeated timing of behavior (e.g.: Mode 3 reliably lasts for 3 minutes). Recent analyses by others of *Mnemiopsis* seasonal density reveals an explosive bloom during its peak season, reaching as high as 500 adult animals m^{-3} in Narragansett Bay, (L&O 51:1819) and in Kiel Fjord (Biol. Invasions 11:873); if <1 cm: 1000 m^{-3} (L&O 51:1819). Laser particle interferometry of <1 cm Class 1 adults reveals water transport of ~0.45 mL / sec through the oral lobes. At peak seasonal densities, the <1 cm adult cohort processes up to 65% of coastal water per day. Ctenophores of the shallow coastal zones may make a significant contribution to sediment, nutrient and microbial resuspension. Support: NSF AL-EPSCoR EPS 0447675, AU-CMB, and NSF MCB-0348327 to AGM.

Wagner, **C**., Leibniz Institute for Baltic Sea Research Warnemünde, Rostock, Germany, carola.wagner@io-warnemuende.de
Adrian, R., Leibniz Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, adrian@igb-berlin.de
Alheit, J., Leibniz Institute for Baltic Sea Research Warnemünde, Rostock, Germany, juergen.alheit@io-warnemuende.de
Blenckner, T., Baltic Nest Institute, Stockholm Resilience, Stockholm University, Stockholm, Sweden, tblen@mbox.su.se
Hampton, S. E., National Center for Ecological Analysis & Synthesis, University of California, Santa Barbara, USA, hampton@nceas.ucsb.edu
Hoelker, F., Leibniz Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, hoelker@igb-berlin.de
Beare, D. J., Institute for Marine Resources & Ecosystem Studies, Ijmuiden, Netherlands, doug.beare@jrc.it
Schindler, D. E., School of Aquatic & Fishery Sciences, University of Washington, Seattle, USA, deschind@u.washington.edu

REGIME SHIFTS IN MARINE AND LAKE ECOSYSTEMS: TELECONNECTION PATTERNS

Climatically induced regime shifts in aquatic ecosystems can re-organize plankton communities and thus alter structural and functional system properties. These changes may be synchronized over large spatial scales and across different types of aquatic ecosystems. We studied the timing and type of long-term changes for several indicators of abiotic and biotic system components. The synchrony of regime shifts was analyzed with regard to system type (marine, freshwater), season (spring, summer) and geographic location. We choose two marine systems (North Sea, Baltic Sea) and three lakes (lakes Erken, Müggelsee, Lake Washington). We hypothesize coherent shifts of all physical system components in spring during the late 1980s in Europe – possibly synchronized by NAO dynamics - regardless of system type and location, but out of phase with the North American system. Further, biological responses were expected to be less coherent but still obvious shifts in ecosystems. In contrast, responses of all system components are expected to be more variable during summer.

Waiser, **M. J**., Environment Canada, Water Science and Technology Directorate, AEPRD, Saskatoon, Canada, marley.waiser@ec.gc.ca
Tumber, V., Environment Canada, Water Science and Technology Directorate, AEPRD, Saskatoon, Canada, vijay.tumber@ec.gc.ca

CONSEQUENCES OF EXCESS N AND P IN AN EFFLUENT-DOMINATED STREAM: WASCANA CREEK, SK, CAN

Regina, Saskatchewan, Canada treats its sewage at a modern sewage treatment plant (STP) on Wascana Creek. In winter, treated sewage effluent makes up almost 100% of stream flow. Surveys conducted from 2005 to 2007 indicated higher N and P concentrations at sites downstream of the STP compared to an upstream control site. Downstream, Wascana Creek is N hypersaturated (total dissolved nitrogen > 3 mg/L). Here, nitrate-nitrite concentrations far exceed World Health Organization limits for drinking water (10 mg/L) and sensitive taxa while unionized ammonia and nitrate-nitrite far exceed the Canadian Water Water Quality Guidelines for Protection of Aquatic Life and those for the US EPA High ammonia concentrations may be responsible for depressions in planktonic algal biomass and production observed downstream. Declines in primary to bacterial production ratios (PP:BP) always occurred below the STP, at times pushing ratios from net autotrophy to heterotrophy. Also observed was a disconnect between total phosphorus and Chlorophyll a (Chl a), as well as BP and Chl a. Wascana Creek serves as a model, illustrating risks presented to biota in effluent-dominated ecosystems.

Waite, **I. R**., U.S. Geological Survey, Portland, USA, iwaite@usgs.gov
Munn, M. D., U.S. Geological Survey, Tacoma, USA, mdmunn@usgs.gov
Black, R. W., U.S. Geological Survey, Tacoma, USA, rwblack@usgs.gov

CAUSAL PATH HIERARCHY: WATERSHED DISTURBANCE TO WATER QUALITY TO MACROINVERTEBRATES IN SMALL AGRICULTURAL INFLUENCED STREAMS ACROSS THREE LANDSCAPE SCALES.

Approximately thirty independent, wadeable stream sites distributed along a gradient of nutrient conditions from contrasting agriculturally dominated landscapes were selected in each of eight distinct study areas (n = 232 stream sites) within the U.S. Geological Survey's National Water-Quality Assessment Program (NAWQA). We developed an agricultural disturbance index from watershed-based variables that provided a common disturbance measurement for all sites as well as act as a predictor variable. Macroinvertebrate metrics were calculated individually for each study area and for areas combined into three geographic regions. In general, correlation along the causal path hierarchy (watershed disturbance to water quality to invertebrates) was low across the eight study areas except for one area in the West and improved when the data was combined in only one of the four larger scales. When information on specific agricultural practices, condition of riparian zone and regional characteristics were incorporated correlation improved and variation explained in developed models increased thus improving our understanding and insight into the causal pathways and their mechanisms.

Wallin, **M. B**., Swedish University of Agricultural Sciences, dept. Aquatic Sciences and Assessment, Uppsala, Sweden, marcus.wallin@vatten.slu.se
Buffam, I., University of Wisconsin, dept. Zoology and Center for Limnology, Madison, USA, buffam@wisc.edu
Öquist, M. G., Swedish University of Agricultural Sciences, dept. Forest Ecology and Management, Umeå, Sweden, mats.oquist@sek.slu.se
Billlett, M. F., Centre for Ecology and Hydrology, Edinburgh, United Kingdom, mbill@ceh.ac.uk
Bishop, K. H., Swedish University of Agricultural Sciences, dept. Aquatic Sciences and Assessment, Uppsala, Sweden, kevin.bishop@vatten.slu.se

SPATIOTEMPORAL VARIABILITY OF THE GAS TRANSFER COEFFICIENT (KCO2) AND ITS IMPORTANCE FOR THE EVASION OF CARBON DIOXIDE FROM A BOREAL STREAM NETWORK

Boreal headwaters represent potentially important conduits for the exchange of gaseous carbon between terrestrial ecosystem and the atmosphere. But due to lack of information is the literature often based on generalizations where one of the estimated key variables is the gas transfer coefficient (K). This paper presents the results of 114 independent measurements of KCO2 from 14 stream reaches in northern Sweden, to determine and predict spatiotemporal variability in KCO2. KCO2 correlated positively with slope of the stream reach, with higher gas transfer coefficients for steeper stream sections. Combining slope with a width/depth index of the stream explained 84 % of the spatial variability in KCO2. Temporal variability was more complex with mainly site specific variation but with significant correlations to discharge at 3 of 14 reaches. Our study concludes that variability in KCO2 is the main determinant of stream CO2 evasion. Using general published gas transfer coefficients in this study produced an error of up 230% in median instantaneous evasion rates compared to the actual measured values. Accurate landscape scale estimates of the evasion fluxes of CO2 therefore require a good understanding of the controls on gas exchange at the water surface.

Walsh, **E**. **J**., University of Texas at El Paso, El Paso , USA, ewalsh@utep.edu
Wallace, R. L., Ripon College, Ripon, USA, wallacer@ripon.edu
Schroeder, T., University of Texas at El Paso, El Paso, USA, tshroeder@utep.edu
Hamdan, L.,
Kelly, L., Ripon College, Ripon, USA, kellyl@ripon.edu

CHIHUAHUAN DESERT WATERS: HABITATS FAVORING CRYPTIC SPECIATION IN ZOOPLANKTON?

The Chihuahuan Desert has been designated as a globally important area of endemism, particularly in its aquatic habitats. In a 6-year study of zooplankton in >180 aquatic sites in this desert, both US and Mexico, we found relatively high levels of biodiversity in rotifers (S=250), copepods (S=32), and cladocerans (S=39), with many endemic and/or new species of former two groups. However, these may be underestimates of the true zooplankton biodiversity. Using partial cox1 and ITS sequences, we studied genetic variation in 4 rotifer species (Monogononta: Euchlanis dilatata, Lecane bulla, L. luna; Bdelloidea: Philodina megalotrocha) and a cladoceran (Chydorus brevilabris) to detect phylogeographic patterns. We found high levels of genetic diversity among populations within rotifer species. Genetic distances between populations ranged from 0 to 19% based on cox1 sequences and from 0 to 24% based on ITS sequences. At the upper range, these levels are equivalent to those reported between taxonomically distinct species. However, little variation was found among Chydorus populations. These results suggest that geographically isolated aquatic habitats of the Chihuahuan Desert may favor cryptic speciation at least in Rotifera.

Walters, **A**. **W**., National Marine Fisheries Service, Seattle, USA, annika.walters@noaa.gov
McClure, M. M., National Marine Fisheries Service, Seattle, USA, michelle.mcclure@noaa.gov

INTERACTIVE IMPACTS OF WATER DIVERSION AND CLIMATE CHANGE FOR JUVENILE SALMON SURVIVAL

Maintaining the functioning of stream ecosystems in the face of escalating human water demand and climate change is a major challenge for the 21st century. Water diversion and climate change are leading to shifts in the quantity and timing of streamflow, which can impact juvenile salmon survival. Historically, the Lemhi River watershed in Idaho was a major anadromous salmon producer, however overfishing and dam construction have led to large population declines. Currently, the Lemhi River experiences large-scale water diversion for irrigation and the impacts of this for threatened spring Chinook salmon are not fully understood. We explored the relationship of flow, temperature, salmon density, and size on juvenile salmon survival. We compared survival between diverted and undiverted scenarios for current and predicted future conditions under climate change. Water diversion substantially decreased survival due to lowered flow, while climate change scenarios led to small decreases in survival, primarily due to increased temperatures. Juvenile life-history variants differed in their susceptibility to environmental conditions, providing the opportunity for climate change and water diversion to lead to selection for life-history characteristics.

Walters, **D**. **M**., USGS, BRD, Fort Collins, CO, USA, waltersd@usgs.gov
Mills, M. A., USEPA, ORD, Cincinnati, OH, USA, mills.marc@epa.gov
Fritz, K. M., USEPA, ORD, Cincinnati, OH, USA, fritz.ken@epa.gov
Raikow, D. F., USEPA, ORD, Cincinnati, OH, USA, raikow.david@epa.gov

FROM ECOLOGICAL SUBSIDIES TO ECOLOGICAL INDICATORS: USING RIPARIAN SPIDERS TO MANAGE RISKS AT CONTAMINATED AQUATIC SITES

Emergent insects subsidize riparian predators but also transport contaminants to terrestrial food webs. We investigated aquatic insect consumption and PCB exposure in riparian spiders to determine if they are useful indicators for managing risks at contaminated aquatic sites. We sampled sediment, adult chironomids, terrestrial insects, spiders (Tetragnathidae, Araneidae, and *Mecynogea lemniscata*), and upland Araneidae along a sediment PCB gradient. Stable isotopes ($\delta^{13}C$, $\delta^{15}N$) and PCB data indicated that riparian spiders consumed contaminated aquatic insects, resulting in PCB levels >2 orders of magnitude higher than upland spiders consuming uncontaminated terrestrial insects. Riparian spider PCBs were positively correlated with sediment concentrations (r^2 = 0.44-0.87 among taxa). We calculated spider-based wildlife values (WVs), the minimum spider PCB concentrations causing a potentially harmful dose, to assess risks to arachnivorous birds. Spider PCBs exceeded WVs for most birds and were 14-fold higher than the WV for the most sensitive species (Chickadee nestlings, *Poecile* spp.). Spiders are abundant and ubiquitous in riparian zones and prey heavily on aquatic insects. These traits, along with the high degree of spatial correlation between spider and sediment concentrations, suggest that they are model indicator species for monitoring aquatic contamination and assessing risks to terrestrial ecosystems.

Walters, **T**. **L**., Skidaway Institute of Oceanography, Savannah, GA, USA, tina.walters@skio.usg.edu
Pavel, C. A., Savannah State University & Skidaway Inst Oceanography, Savannah, GA, USA, cpavel@student.savannahstate.edu
Frazier, L. M., Savannah State University & Skidaway Inst Oceanography, Savannah, GA, USA, lagina.frazier@skio.usg.edu
Peck, M. E., Skidaway Institute of Oceanography, Savannah, GA, USA, megan.peck@skio.usg.edu
Chiang, S., Skidaway Institute of Oceanography & Emory University, Savannah, GA, USA, schiang@learnlink.emory.edu
Leandre, M. Y., Hampton University, Hampton, VA, USA, mlean001@odu.edu
Gibson, D. M., Hampton University, Hampton, VA, USA, deidre.gibson@hamptonu.edu
Paffenhofer, G. A., Skidaway Institute of Oceanography, Savannah, GA, USA, gustav.paffenhofer@skio.usg.edu
Frischer, M. E., Skidaway Institute of Oceanography, Savannah, USA, marc.frischer@skio.usg

MOLECULAR GUT CONTENT PROFILING OF DOLIOLETTA GEGENBAURI IN SUBTROPICAL CONTINENTAL SHELF INTRUSION WATERS: WHAT ARE THEY EATING?

The ability to investigate trophic interactions for zooplankton species is vital for understanding processes that structure marine ecosystems. However, because of the difficulty of directly assessing gut content little is known about the in situ diets of most zooplankton species. This is particularly true for the gelatinous pelagic tunicate Dolioletta gegenbauri which forms large swarms in subtropical shelf environments. We have hypothesized that while large D. gegenbauri gonozoodids likely derive a significant fraction of their nutrition from large diatom species typical of intrusion waters, smaller animals do not. To address this hypothesis we presented intrusion water collected from the mid-shelf of the South Atlantic Bight to large D. gegenbauri gonozooids and assessed their gut content using a molecular PNA-PCR-based gut content assay. Surprisingly, although large diatom species including Guinardia spp. Rhizosolenia spp., Nitzschia spp., Pseudo-Nitzschia spp., and Skeletonema spp. dominated the phytoplankton biomass, they were not detected in the guts of the doliolids. Rather, smaller nanoplankton including E. huxleyi and softbodied alveolates were present. These studies represent the first assessment of the in situ diet of D. gegenbauri.

Wang, **S**., Duke University, Durham, USA, siyi.wang@duke.edu
Bernhardt, E. S., Duke University, Durham, USA, ebernhar@duke.edu
Wright, J. P., Duke University, Durham, USA, jw67@duke.edu
Wallenstein, M. D., Colorado State University, Fort Collins, USA, mawallen@nrel.colostate.edu
Sudduth, E. B., Duke University, Durham, USA, esudduth@duke.edu

IMPACTS OF WATERSHED URBANIZATION ON THE STRUCTURE AND FUNCTION OF DENITRIFYING BACTERIA COMMUNITIES IN STREAMS

The removal of harmful excess nitrogen by denitrifying bacteria (denitrifiers) is a critical ecosystem service. Watershed urbanization is associated with increased N loading together with increasing stormwater inputs and storm and sanitary sewer derived contaminants. We are interested in understanding how watershed urbanization affects the structure and function of stream denitrifiers. In this study, we compared denitrifier community composition and denitrification potential between eight urban and forested streams over three years. Denitrifier community composition was significantly different between urban and forested streams. Despite generally higher substrate availability and lower dissolved oxygen concentrations, denitrification potentials measured in urban stream sediments were generally equal to and occasionally lower than denitrification potentials measured for their forested counterparts – thus substrate supply only weakly predicted denitrification potential. By integrating denitrifier community composition data with substrate supply we were able to explain more than 60 percent of the variation in denitrification potential across streams.

Wang, **T**. **N**., University of Windsor GLIER, Windsor, Canada, tncwang@uwindsor.ca

Bailey, S. A., Fisheries and Oceans Canada, Burlington, Canada, sarah.bailey@dfo-mpo.gc.ca

Wiley, C., Fisheries and Oceans Canada/Transport Canada, Sarnia, Canada,

Jenkins, P. T., Philip T. Jenkins & Associates, Ltd, Fonthill, Canada,

Johengen, T., CILER/University of Michigan, Ann Arbor, USA,

Reid, D., NOAA/GLERL, Ann Arbor, USA,

MacIsaac, H., Great Lakes Institute for Environmental Research, University of Windsor, Windsor, Canada, hughm@uwindsor.ca

USE OF NACL BRINE AS A BALLAST WATER TREATMENT TECHNOLOGY FOR TRANSOCEANIC VESSELS ENTERING THE GREAT LAKES

Transoceanic ships coming to the Great Lakes must conduct ballast water exchange (BWE). Despite high compliance, some vessels arrive with incompletely exchanged ballast water with salinity <30 ppt. The addition of sodium chloride brine (NaCl ~230 ppt) may be an effective way to artificially augment ballast salinity. The objective of this study is to evaluate the biological efficacy of NaCl brine treatment of low-salinity ballast water under operational conditions at full-ship scale. Six shipboard trials were conducted in 2008 and 2009, three each in no-ballast-on-board (NOBOB) and ballast-on-board (BOB) tanks. BOB tanks were treated with 45ppt for multiple days of exposure and NOBOB tanks were treated with 115 ppt for a short duration (hours). 100% mortality was achieved during BOB and NOBOB trials given approximately 25 hours exposure of 37 to 50ppt final salinity and one hour expose at 115 ppt final salinity respectively. The NaCl brine mixed well during BOB trials but did not consistently mix with residual ballast. These results show that NaCl brine can be practicable and effective as a biocide for treating ballast tanks.

Ward, **A**. **S**., Department of Civil & Environmental Engineering, Penn State University, University Park, PA, USA, asw178@psu.edu

Gooseff, M. N., Department of Civil & Environmental Engineering, Penn State University, University Park, PA, USA, mgooseff@engr.psu.edu

Miller, M. P., Utah Water Science Center, U.S. Geological Survey, West Valley City, UT, USA, mamiller@usgs.gov

Boyer, E. W., School of Forest Resources, Penn State University, University Park, PA, USA, ewb100@psu.edu

Ferreri, C. P., School of Forest Resources, Penn State University, University Park, PA, USA, cpf3@psu.edu

HYPORHEIC RESPONSE TO STREAMBED CLOGGING: A FIELD AND NUMERICAL STUDY

Hyporheic exchange promotes a number of ecosystem processes, including processing of nutrients, buffering stream temperatures, and maintaining a unique subsurface habitat supporting a diverse group of organisms. The rate of hyporheic exchange and its extent are known to be functions of the physical characteristics of the near-stream aquifer, particularly hydraulic conductivity. However, the effects of another potentially important characteristic, streambed clogging, are poorly understood. We present results from replicate tracer studies that were conducted before and after an injected pulse of sediment and organic matter in a headwater stream under a steady state flow regime. Conservative tracer study results and the variation of chemical elements in the water column and in piezometers demonstrate temporal and spatial shifts in subsurface transport of water and solutes in response to the pulse. We hypothesize that changes in subsurface flowpaths are due to streambed clogging by fine sediments and organic material. We explored the relationship between streambed hydraulic conductivity and hyporheic flowpaths through numerical modeling. Results demonstrate hyporheic response to a range of spatial patterns and degree of clogging.

Ward, **D**. **M**., Dartmouth College, Hanover, NH, USA, darren.ward@dartmouth.edu

Nislow, K. H., USDA-USFS Northern Research Station, Amherst, MA, USA, knislow@fs.fed.us

Folt, C. L., Dartmouth College, Hanover, NH, USA, carol.folt@dartmouth.edu

CONTRASTING EFFECTS OF SUPPRESSED AQUATIC INVERTEBRATE BIOMASS ON ATLANTIC SALMON AND BROOK TROUT GROWTH AND MERCURY ACCUMULATION

Co-occurring brook trout (BT) and Atlantic salmon (AS) have similar foraging behavior and high diet overlap. Yet, terrestrial prey often account for a substantial proportion of BT diets, while AS tend to specialize on aquatic prey. Thus, relative to AS, BT may sustain high growth rates even at low aquatic prey biomass. Further, as mercury accumulates predominantly from aquatic prey, consumption of low-mercury terrestrial prey may reduce concentrations in BT relative to AS. We measured growth and mercury concentrations in young-of-the-year BT and AS at 20 sites that spanned a >50-fold range in aquatic prey biomass. Stable isotope analysis confirmed that BT used more terrestrial prey than AS. Growth, as mean mass in fall, ranged >4-fold across sites for both species. As predicted, AS grew slower at sites with low aquatic prey biomass but BT did not. While BT and AS mercury concentrations were similar at sites with high aquatic prey biomass, BT concentrations were 3-fold lower at sites with low aquatic prey biomass. Species-specific patterns of terrestrial subsidy use yield divergent responses to suppressed in-stream invertebrate production.

Ward, **G**. **M**., University of Alabama, Department of Biological Sciences, Tuscaloosa, AL, USA, mward@biology.as.ua.edu

Ward, A. K., University of Alabama, Department of Biological Sciences, Tuscaloosa, AL, USA, award@biology.as.ua.edu

Sponseller, R., University of Alabama, Department of Biological Sciences, Tuscaloosa, AL, USA, rsponseller@as.ua.edu

Cherry, J., University of Alabama, Department of Biological Sciences, Tuscaloosa, AL, USA, cherr002@as.ua.edu

Edmonds, J. W., University of Alabama, Department of Biological Sciences, Tuscaloosa, AL, USA, jwedmonds@as.ua.edu

ROLE OF WETLAND ECOSYSTEMS IN THE LANDSCAPE DYNAMICS OF THE EASTERN GULF COASTAL PLAIN: LONG-TERM STUDIES AT THE TALLADEGA WETLAND ECOSYSTEM

Eighteen years of research at the Talladega Wetland Ecosystem (TWE) has provided valuable insights into the ecological role of wetlands in the broader landscape. While many aquatic ecologists have studied active beaver ponds, our focus is on understanding the importance of temporal change in these systems. The TWE is one of many beaver-dominated, pond/wetland ecosystems in our region. We have observed the formation and loss of ponds, as well as drastic vegetative and hydrologic changes as the system transitions from a pond/rush stage to early stages of vegetative succession. These wetland ecosystems are embedded as nodes within stream networks, where they are sinks for imported POC and nitrate, but export DOC and ammonium downstream, even after ponds de-water. Following dam loss, rapid (2-5 yrs) herbaceous re-vegetation and colonization by nitrogen-fixing alder in the former wetland pond occur followed by more terrestrially adapted trees. Our fundamental premise is that the creation and demise of beaver ponds cause predictable hydrological, plant community, and soil changes which, in turn, drive external factors such as quantity and quality of nutrient/material export downstream.

Way, **C**. **M**., Barry A. Vittor & Associates, Inc., Mobile, USA, cway@bvaenviro.com

Thompson, C., Buckeye Florida, Perry, USA, chet_thompson@bkitech.com

SEASONAL CHANGES IN SEAGRASS ASSEMBLAGES IN THE FENHOLLOWAY AND ECONFINA RIVER ESTUARIES, APALACHEE BAY, FLORIDA.

The Big Bend area contains the largest seagrass beds in the eastern GOM with coverage estimates of over 750,000 acres. The most abundant taxa in the northern GOM include *Thalassia testudinum*, *Syringodium filiforme*, *Halodule wrightii* and *Halophila* spp. Seagrasses can occur in both continuous coverage and patchy beds and provide critical and valued habitat functions. Excessive rainfall over extended periods has been shown to damage seagrass communities; high amounts of rainfall can result in decreased light availability along Florida's Gulf coast and a reduction in seagrass abundances. Seagrasses have been monitored over the growing season at ten stations in the Fenholloway River and Econfina River estuaries during 2006 - 2009, as well as annual seagrass surveys in Apalachee Bay during 2005 - 2009. Data has shown that regional climatic factors, including seasonal rainfall and riverine discharge, affect the distribution and abundance of seagrasses in Apalachee Bay. There has been a gradual increase in the distribution and abundance of seagrasses from 2005 to 2009, coinciding with a decrease in both riverine discharge and water color and an increase in light availability.

Weatherwax, **S**. **A**., Indiana University School of Public and Environmental Affairs, Bloomington, IN, USA, seaweath@indiana.edu

Royer, T. V., Indiana University School of Public and Environmental Affairs, Bloomington, IN, USA, troyer@indiana.edu

Johnson, L. T., Indiana University School of Public and Environmental Affairs, Bloomington, IN, USA, latjohn@indiana.edu

Leff, L. G., Kent State University Dept of Biological Sciences, Kent, OH, USA, llefff@kent.edu

RIPARIAN ZONE DENITRIFICATION AND NITRATE REMOVAL IN A FIRST ORDER AGRICULTURAL STREAM

Riparian zones are important locations for denitrification and nitrate removal. In the Midwestern U.S., many headwater streams have degraded riparian zones, often with riparian benches existing in incised channels. However, the role of these habitats in N cycling is unknown. We quantified denitrification in the soils of riparian benches within Leary Weber Ditch, a first-order agricultural stream in central Indiana (USA). Sampling was done once a month and during seasonal weather events (e.g. pre- and post-flood). We predicted that these riparian zones would have higher denitrification rates during flooding events due to increased availability of nitrate. Soil nutrient concentrations were found to be 5.66 ± 2.52 µg N g-1 for nitrate and 8.26 ± 3.39 µg N g-1 for ammonium. Soil bulk density was 0.73 ± 0.13 g/cm3. Initial sampling found denitrification rates of 1624 ± 603 µg N m-2 h -1 for the riparian zone. Despite not being inundated, the rates are quite similar to those from vegetated wetlands. This suggests riparian benches along incised agricultural streams have significant potential for nitrogen removal and may serve as important biogeochemical landscape features.

Webb, **J**. **A**., The University of Melbourne & eWater Cooperative Research Centre, Melbourne, Australia, angus.webb@unimelb.edu.au

Padgham, M., The University of Melbourne & eWater Cooperative Research Centre, Melbourne, Australia, mark.padgham@email.com

THE INHERENT STABILITY OF DENDRITIC NETWORKS: HOW THE STRUCTURE OF RIVERINE LANDSCAPES PROTECTS ORGANISMS FROM UNPREDICTABLE EFFECTS OF DISTURBANCE

How does connectivity within landscapes affect population processes of resident organisms? And what are the effects of changes in connectivity? Landscape ecologists have used tools from graph theory to investigate how terrestrial landscapes affect populations, and more recent work has applied these techniques to rivers. However, rivers form a special type of landscape – a dendritic ecological network. These differ fundamentally from terrestrial landscapes, and these differences may have unique implications for population processes within rivers. We developed habitat access and population models for stream and terrestrial networks, and investigated the landscape-scale effects of multiple changes to connectivity. For terrestrial landscapes, we found that multiple disturbances can interact unpredictably to create network-scale effects far in excess of the sum of the expected individual effects. Such interactions can be potentially catastrophic for resident organisms. However, for dendritic networks, these interactions are smaller by approximately an order of magnitude. Thus, the unique structure of dendritic networks buffers resident organisms against the unpredictable interactive effects of disturbances to landscape connectivity. This 'inherent stability' is likely to have affected the evolution of Earth's riverine ecosystems.

Webb, **M**. **C**., University of New England, Armidale, Australia, munique.webb@canberra.edu.au

Reid, M. A., University of New England, Armidale, Australia, mreid24@une.edu.au

Thoms, M. C., University of New England, Armidale, Australia, martin.thoms@une.edu.au

FISH COMMUNITY STRUCTURE: THE INFLUENCE OF HYDROLOGY AT MULTIPLE TEMPORAL SCALES

Hydrological processes operate at a variety of spatial and temporal scales, all of which have the potential to generate ecological responses. We explored the influence of hydrology at different temporal scales on fish community structure in refugial waterholes of a dryland river. Hydrological variables measured at long-term scales (decadal to millennial) correlated with fish species assemblages of waterholes. We argue that this pattern exists because variables such as long-term predictability control the availability of habitats that suit life-history characteristics of individual species. These variables also determine the refugial landscape, which in turn regulates species resistance and resilience in response to extensive, landscape-scale dry periods and hence the local species pool. In contrast, hydrology operating at the flow-pulse scale (days to years) correlated with the size structure of assemblages. We argue that this relationship reflects population responses to flow pulses (as spawning cues) and the manner in which flow pulses regulate habitat accessibility and stability of habitats, and hence food availability affecting growth and development. Understanding the hierarchical influence of hydrology on fish community structure is vital for the sound management of these systems.

Weinstein, **Y**. **S**., Bar-Ilan University, Ramat-Gan, Israel, weinsty@mail.biu.ac.il

Shalem, Y., BAr-Ilan University, Ramat-Gan, Israel,

Yechieli, Y., Geological Survey of Israel, Jerusalem, Israel, yechieli@gsi.gov.il

Burnett, W. C., Florida State University, Tallahassee, USA, wburnett@fsu.edu

Swarzenski, P. W., US Geological Survey, Santa Cruz, USA,

Herut, B., Israel Oceanogrphic and Limnological Research, Haifa, Israel,

WHAT IS THE ROLE OF FRESH AND SALINE SGD IN CONVEYING NUTRIENTS TO THE SEA?

The composition of the groundwater discharging from the seafloor at Dor Bay, Israel, was studied in detail using seepage meters. It was found that the discharging fresh groundwater is the main conveyor of DIN and silica to the bay, with loads of 506 and 560 mole/yr, resepectively, per 1 m of shoreline. On the other hand, nutrient loads contributed by seawater recirculation in the subterenean estuary (sub-bay sediments) are relatively little, and consist mainly of ammonium (24 mole/yr per 1 m shoreline). However, this sub-bay zone has a larger role as a sink via the denitrification of some of the land-derived fresh groundwater (104 mole/yr). The phosphate flux to the bay is small (1.4 mole/yr per 1 m shoreline), whether supplied by the fresh groundwater or by recirculated seawater. These observations, together with similar cases of nutrient-poor recirculated seawater from other SGD locations, questions the extent of nutrient contribution to the coastal water by the subterranean estuary in some of the SGD sites.

Weitere, **M**., University of Cologne, Zoological Institute, Cologne, Germany, markus.weitere@uni-koeln.de

Kathol, M., University of Cologne, Zoological Institute, Cologne, Germany, marcel@kathol.eu

Fischer, H., Federal Institute of Hydrology, Koblenz, Germany, helmut.fischer@bafg.de

BEYOND BIVALVES: THE POTENTIAL ROLE OF BENTHIC MICRO-CONSUMERS IN THE PELAGIC-BENTHIC COUPLING IN RIVERS

Benthic filter feeders can play an important role in controlling riverine plankton and in importing planktonic production into benthic food webs. This function has largely been attributed to filter-feeding bivalves with emphasis on invasive species. However, several other benthic consumers on plankton exist, even though quantitative studies on their role are rare. In the present study we address the role of benthic micro-consumers (biofim-dwelling protozoans and small metazoans) in controlling plankton in rivers. During a 16-month study, we showed that natural biofilm communities from a large river are dominated by suspension feeding groups. Quantitative measurements showed high community clearance rates on both picoplankton (bacteria) and nanoplankton (algae and protozoans). These data suggest that biofilm-dwelling micro-consumers can play an important role as benthic grazers on potamoplankton besides bivalves. However, the community clearance behaviour of the micro-consumers differed considerably from that of bivalves, e.g. with respect to temperature response and food size preference. The different consumer groups and their specific feeding patterns need to be considered when estimating the total effect of benthic consumers on plankton.

Weller, **D**. **E**., Smithsonian Environmental Research Center, Edgewater, MD, USA, wellerd@si.edu

Baker, M. E., University of Maryland Baltimore County, Baltimore, MD, USA, mbaker@umbc.edu

Jordan, T. E., Smithsonian Environmental Research Center, Edgewater, MD, USA, jordanth@si.edu

NITRATE REMOVAL BY RIPARIAN BUFFERS AND IN-STREAM PROCESSES IN CHESAPEAKE BAY CATCHMENTS

We applied novel geographic and statistical analyses to compare the effects of riparian buffers and in-stream processes on average annual stream nitrate concentrations leaving 321 study catchments in the Chesapeake basin. We analyzed topographic and land cover data to quantify buffered and unbuffered

cropland, where "buffered" means that the downhill path from a cropland pixel to a stream passes through a riparian forest or wetland. For each cropland pixel, we also measured the length of stream channel traversed to the catchment outlet. We fit a nonlinear regression model to estimate the nitrate contributions of unbuffered and buffered cropland and the exponential rate of decline in concentration per km of stream traversed. Riparian buffers currently remove 18% of the nitrate lost from croplands in the study watersheds and reduce average nitrate levels by 0.4 mg N/l. The fitted rate of decay with stream length (0.082% per km) reduced nitrate concentration by an average of 0.01 mg N/l in the study catchments. At the annual time scale, riparian buffers seem to be more important sinks for nitrate than in-stream removal.

Welter, **J**. **R**., St. Catherine University, Saint Paul, MN, USA, jrwelter@stkate.edu
Bratt, A. R., St. Catherine University, Saint Paul, MN, USA,
Kaup, H. M., St. Catherine University, Saint Paul, MN, USA,
Turner, N. A., St. Catherine University, Saint Paul, MN, USA,

SPATIAL PATTERNS IN NITROGEN FIXATION AND NUTRIENT UPTAKE IN A RIVER NETWORK

Recent studies demonstrate that nitrogen fixation can play an important role in both lake and stream ecosystems, especially where nitrogen is limiting. This project explored spatial variation in N-fixation and the uptake of N and P by periphyton assemblages along a drainage area gradient in the South Fork Eel River (SFER) watershed in northern California. N-fixation and uptake of N and P by isolated periphyton assemblages was measured in five streams (0.58 – 148 km2). Fixation was measured in-situ using acetylene-reduction assays while uptake was measured following addition of N and P, both in re-circulating closed chambers. N-fixation rates increased significantly with drainage area in parallel with increases in N-fixer abundance and was also positively correlated with patterns in epilithon N:P and P uptake. Observed biogeochemical patterns suggest that shifts in microbial and algal community composition associated with stream network position may differentially affect availability of N and P, and potentially alter the limiting nutrient further downstream. Thus, N fixation may be an important driver of biogeochemical cycling in stream ecosystems and deserves more consideration in watershed studies.

Welti, **N**. **D**., BOKU / WasserCluster Lunz, Vienna, Austria, nina.welti@boku.ac.at
Bondar-Kunze , E., BOKU / WasserCluster Lunz, Vienna, Austria, elisabeth.bondar@boku.ac.at
Mair, M., BOKU / WasserCluster Lunz, Vienna, Austria, matthias.mair@boku.ac.at
Oswald, P., University of Vienna, Vienna, Austria,
Bonin, P., Université de la Méditerranée, Marseilles, France, patricia.bonin@univmed.fr
Wanek, W., University of Vienna, Vienna, Austria, wolfgang.wanek@univie.ac.at
Pinay, G., University of Birmingham, Birmingham, United Kingdom, G.Pinay@bham.ac.uk
Hein, T., BOKU / WasserCluster Lunz, Vienna, Austria, thomas.hein@boku.ac.at

MIMICKING FLOODPLAIN RECONNECTIONS AND DISCONNECTIONS USING ^{15}N MESOCOSM INCUBATIONS

The Danube River and its floodplains along with all other large rivers in the industrialized world have been changed to fit the needs of society for agriculture and hydro-power. Particularly, there is a significant decrease of hydrologic exchange of surface waters. The secondary channels and various water bodies within the floodplain are disconnected from the main river flow for long periods. In order to counteract these negative impacts on the floodplains, large scale restoration projects aim to increase hydrologic exchange with the floodplain. The presented study quantified the rates of denitrification using short term mesocosm incubations with 15N-NO3 tracing to follow the pathway of nitrate uptake within different floodplain sections. Triplicate sediment samples from two sites were incubated in the laboratory for five days in 25L mesocosms. The nitrate delivery regime and dissolved carbon content where changed to mimic disconnection and reconnection schemes. Denitrification, assimilation and DNRA rates were calculated based on isotopic analysis. Water sediment interactions changed which altered the rate of denitrification as well as the relationship between N2 and N2O emission.

Wenger, **S**. **J**., Trout Unlimited, Boise, ID, USA, swenger@tu.org
Isaak, D. J., US Forest Service Rocky Mountain Research Station, Boise, ID, USA, disaak@fs.fed.us
Luce, C. H., US Forest Service Rocky Mountain Research Station, Boise, ID, USA, cluce@fs.fed.us
Rieman, B. E., US Forest Service Rocky Mountain Research Station (emeritus), Seeley Lake, MT, USA, brieman@fs.fed.us

CLIMATE-INDUCED CHANGES TO FLOW REGIME MAY LEAD TO DECLINES IN AN INVASIVE FISH SPECIES

Most climate change research has focused on threats to native species, but non-native, invasive species may be impacted as well. We show that warmer temperatures and shifts from snowmelt runoff regimes to mixed runoff regimes in parts of the Northern Rocky Mountains, US, may reduce the occurrence of non-native brook trout (*Salvelinus fontinalis*) and indirectly benefit the native cutthroat trout (*Oncorhynchus clarkii*). Differences in reproductive strategy may account for the differential responses of the two species. We base these findings on models of species occurrence that use landscape and climatic variables as predictors and are built from a database of >4000 fish collection points. We estimate changes in stream hydrology with a macroscale hydrologic model driven by historical weather data (for model building) and by statistically downscaled climate models (for forecasts). This study is a precursor to a larger effort that will model trout species occurrence across much of the interior West and has important implications for prioritizing management of native and nonnative species.

Wenzel, **A**., Umeå University, Umeå, Sweden, anja.wenzel@emg.umu.se
Bergström, A. K., Umeå University, Umeå, Sweden, ann-kristin.bergstrom@emg.umu.se
Jansson, M., Umeå University, Umeå, Sweden, mats.jansson@emg.umu.se
Vrede, T., Sveriges Lantbruksuniversitet , Uppsala, Sweden, tobias.vrede@vatten.slu.se

EFFECTS OF DIFFERENT PHYTOPLANKTON:BACTERIOPLANKTON RATIOS IN THE FOOD ON SURVIVAL, GROWTH AND REPRODUCTION IN D. GALEATA

Pelagic food webs in lakes are based on autotrophic phytoplankton and heterotrophic bacterioplankton production and it has been recognized that the latter can be an important energy mobilizing pathway in unproductive lakes. However, this pathway may be less efficient due to food quality constraints. We conducted an experiment that tested the effects of different Rhodomonas lacustris:bacteria ratios in the food on survival, growth and reproduction of Daphnia galeata. Food concentration was kept constant. The mortality was 100% when solely feeding on bacteria but 0-15% in treatments with Rhodomonas. A higher proportion of phytoplankton in the diet resulted in increased specific growth rates as well as increasing numbers of individuals producing offspring. Egg production was positively related to the proportion of Rhodomonas in the diet and only occurred when the diet consisted of 50% or more Rhodomonas. The results imply that bacteria biomass is incorporated into Daphnia biomass less efficiently than phytoplankton biomass so that food webs based on bacterial energy mobilization may be less efficient than autotroph-based food webs.

Wesner, **J**. **S**., University of Oklahoma, Norman, USA, jeffwesner@hotmail.com

BIODIVERSITY-ECOSYSTEM FLUX: AQUATIC PREDATOR RICHNESS ALTERS THE DISTRIBUTION OF A TERRESTRIAL CONSUMER

I tested the hypothesis that predator richness in aquatic food webs alters terrestrial spider distribution indirectly by altering the flux of insects to terrestrial food webs using large, outdoor stream mesocosms. Fish species with complementary habitat domains and a shared prey guild were the predators (Etheostoma spectabile, Cyprinella lutrensis, and Gambusia affinis) in a substitutable design with all possible fish combinations. Total insect emergence biomass was reduced by nearly 40% from pools with high fish richness. This effect cascaded to terrestrial spiders (Tetragnathidae), which tracked insect emergence and were less abundant above mesocosms with high fish richness. For the overall prey assemblage (total emergence biomass and trophic structure), predation effects in polyculture were the average of fish performance in monoculture, suggesting redundancy. For common prey taxa and tetragnathid spiders, fish effects were generally synergistic in the high richness treatments, but redundant in the two species treatments. This study demonstrates that predator diversity effects are not limited to the habitat of the predator, but can propagate across habitat boundaries to adjacent systems.

Wheeler, **K**., Utah State University, Logan, USA, kitwheeler@gmail.com
Crowl, T. A., Utah State University, Logan, USA, facrowl@gmail.com
Miller, S. W., Utah State University, Logan, USA, scott.miller@usu.edu

THE ROLE OF ADFLUVIAL SPAWNERS IN LINKING STREAM AND LAKE ECOSYSTEMS: STOICHIOMETRIC, ALLOMETRIC, AND SCALE CONSIDERATIONS

The ability of migratory animals to influence nutrient cycling in recipient freshwater ecosystems is well established. Questions remain, however, about the nature of linkages between streams and lakes, and how linkages are modified by ecosystem attributes (e.g., size) and the diversity of species coupling the habitats. Toward that end, we are assessing the biological significance of nutrient translocation via migrations by adfluvial spawners (lake-dwelling fish that reproduce in tributaries). Studies are being conducted in the Utah Lake drainage basin, where differences in migratory fish communities and watershed characteristics between tributaries are expected to influence the relative importance of nutrient subsidies. We seek a broader understanding of the ecological role played by adfluvial spawners in coupling lake and stream ecosystems by: (1) examining how species specific stoichiometric and allometric constraints affect nutrient enrichment; (2) evaluating scaling relationships between densities of migratory fish and ecosystem size; (3) determining how effects related to fish migrations are modified by watershed characteristics; and (4) relating changes in stream food web structure to spawner-mediated enrichment.

Whiles, **M**. **R**., Southern Illinois University, Carbondale, USA, mwhiles@zoology.siu.edu
Verburg, P., National Institute of Water and Atmospheric Research, Hamilton, New Zealand, p.verburg@niwa.co.nz
Dodds, W. K., Kansas State University, Manhattan, USA, wkdodds@ksu.edu
Hall, R. O., University of Wyoming, Laramie, USA, BHall@uwyo.edu
Huryn, A. D., University of Alabama, Tuscaloosa, USA, huryn@bama.ua.edu
Rugenski, A., Southern Illinois University, Carbondale, USA, arugenski@yahoo.com
Peterson, S., Southern Illinois University, Carbondale, USA, pete13@siu.edu
Kilham, S. S., Drexel University, Philadelphia, USA, kilhams@drexel.edu
Lips, K. R., University of Maryland, College Park, USA, klips@umd.edu
Pringle, C. M., University of Georgia, Athens, USA, cpringle@uga.edu
Connelly, S., University of Georgia, Athens, USA, scottcon@uga.edu
Griffith, E., El Valle Amphibian Conservation Center, El Valle, Panama, virolasboy01@yahoo.com
Ross, H., El Valle Amphibian Conservation Center, El Valle, Panama, rossheid@yahoo.com

USE OF A ^{15}N TRACER TO QUANTIFY CHANGES IN NITROGEN CYCLING ASSOCIATED WITH A MASSIVE AMPHIBIAN DECLINE IN A TROPICAL HEADWATER STREAM

As part of the Tropical Amphibian Declines in Streams (TADS) project, we quantified N-cycling before and after a catastrophic amphibian decline in a Panamanian headwater stream using a $^{15}NH_4$ tracer addition. The stream initially harbored an abundant and diverse tadpole assemblage in 2006 (~10 species; 915 mg dry mass [DM] m^{-2}), which declined to 2% of pre-decline biomass by 2008. Standing stocks, turnover, and N-fluxes among basal resources and common consumers were quantified before and after the decline under similar dry season baseflow conditions of each year. Reach-scale N uptake rates did not differ between 2006 and 2008, and coarse particulate organic matter dominated N flux into basal resources during both years. Epilithon N standing stocks nearly doubled from 2006 to 2008, but N fluxes from epilithon to grazers decreased from 3.9 mg N d^{-1} in 2006 to 0.16 mg N d^{-1} with the loss of grazing tadpoles. Quality (as %N) and turnover rate of organic seston decreased by >50% from 2006 to 2008. Our findings indicate that amphibian declines result in fundamental shifts in stream ecosystem properties.

White, **B**. **A**., University of Minnesota, Minneapolis, USA, white805@umn.edu
Matsumoto, K., University of Minnesota, Minneapolis, USA, katsumi@umn.edu

CONTROLS ON LOWER TROPHIC LEVEL ECOSYSTEM TRENDS IN LAKE SUPERIOR: A NUMERICAL MODELING STUDY

Annual physical and biogeochemical dynamics in the North American Great Lakes are tightly coupled due to strong seasonal meteorological forcing. We use numerical modeling to study both physical and biological controls on lower trophic level ecosystem trends in Lake Superior. The Regional Ocean Modeling System (ROMS) a three-dimensional hydrodynamic model is used. A dynamic-thermodynamic ice model is coupled to the physical model. The coupled lower trophic level biological model is based on the nutrient-phytoplankton-zooplankton-detritus model described in Fasham et al. (1990) and modified to represent the strongly phosphorus limited state of Lake Superior. Examinations of both a persistent feature of the Lake Superior ecosystem, the deep chlorophyll maximum, and the role of ice cover in determining annual ecosystem dynamics are presented.

White, **M**. **S**., Laurentian University, Sudbury, Canada, mwhite@laurentian.ca
Sarrazin-Delay, C. L., Cooperative Freshwater Ecology Unit, Sudbury, Canada, csarrazindelay@laurentian.ca
Keller, W., Laurentian University, Sudbury, Canada, bkeller@laurentian.ca

THE ROLE OF AUTUMN WATER VELOCITY IN STRUCTURING BENTHIC MACROINVERTEBRATE COMMUNITYIES OF BOREAL STREAMS

Aquatic systems are defined by the quantity and quality of hydrologic inputs that they receive. While much research has focused on water quality related impacts on biotic communities, much less attention has been given to understanding how the quantity (frequency, magnitude and timing) of naturally occurring hydrologic inputs control aquatic communities. Using a seven year data set (2003-2009) of the Northern Ontario Benthic Invertebrate Biomonitoring Network (NOBIBN), we show how change in autumn water velocity structures benthic macroinvertebrate communities of eight pristine (i.e. minimally impacted) streams. Using principal component analysis to define community structure, we show that autumn water velocity correlates well with biotic groupings ($P < 0.05$, $r = 0.50 – 0.83$). In a headwater stream with cobble substrates, this corresponds to a shift from a low water velocity Chironomidae dominated community to a high water velocity community with higher proportions of Heptageniidae, Lepidostomatidae and Capniidae. However, a third order sandy substrate stream demonstrated a shift from a low water velocity Caenidae and Tubificidae dominated community to a high water velocity community with increased proportions of Chironomidae, Ephemerellidae and Empididae.

White, **S**. **M**., Columbia River Inter-Tribal Fish Commission, Portland, OR, USA, whis@critfc.org
Jurajda, P., Academy of Sciences of the Czech Republic, Brno, Czech Republic, jurajda@brno.cas.cz
Zahrádková, S., Masaryk University, Brno, Czech Republic, zahr@sci.muni.cz
Torgersen, C. E., U.S. Geological Survey, Seattle, WA, USA, ctorgersen@usgs.gov

HISTORICAL ROOTS OF THE FISH ZONATION CONCEPT AND ITS APPLICATION AS AN INDEX OF RIVER HEALTH IN CENTRAL EUROPEAN RIVERS

Although the concept of predictable change in fish communities along river profiles is frequently credited to Huet (1959), to the best of our knowledge the idea was first conceived by the Czech scientist Antonín Frič in 1871, who later produced a map of fish zonation of the Czech lands. Frič's idea has important implications for the present: First, quantifying deviations from expected fish community types can provide an index of river health sensitive to multiple stressors. Second, Frič's map is an historical record of fish distribution that can guide determination of reference conditions. We sampled young-of-year fish assemblages in over 230 sites across the Czech Republic and calculated a multivariate index describing deviation from expected fish zonation by river type. Our index was sensitive to land use occurring upstream in the watershed; especially the interrelated effects of reservoirs, urban areas, and agriculture. Next, we used Frič's map to evaluate determination of reference conditions, especially pertaining to diadromous fishes. We discuss implications for the Water Framework Directive, which requires water bodies to be at good or better ecological status by 2015.

Whited, **D**. **C**., The University of Montana, Flathead Lake Biological Station, Polson, USA, diane.whited@umontana.edu
Kimball, J. S., The University of Montana, Flathead Lake Biological Station, Polson, USA, john.kimball@umontana.edu
Bansak, T. S., The University of Montana, Flathead Lake Biological Station, Polson, USA, tom.bansak@umontana.edu
Lorang, M. S., The University of Montana, Flathead Lake Biological Station, Polson, USA, mark.lorang@umontana.edu
Ellis, B. K., The University of Montana, Flathead Lake Biological Station, Polson, USA, bonnie.ellis@umontana.edu
Stanford, J. A., The University of Montana, Flathead Lake Biological Station, Polson, USA, jack.stanford@umontana.edu

SCALING OF SALMON HABITAT TYPES OBTAINED BY SATELLITE REMOTE SENSING OF PACIFIC RIM RIVERS

Habitat classifications were derived at 30 m resolution using multispectral Landsat TM imagery and >60 m resolution digital terrain information encompassing 1500 salmon rivers of the North Pacific Rim. Similar classifications also were derived using fine scale (≤2.4 m resolution) imagery for 31 floodplain reaches of regionally representative rivers. Physical habitat metrics were derived at each resolution and examined for accuracy at different spatial scales. Main channel sinuosity, channel nodes, and proportional vegetation cover scaled significantly ($p < 0.01$). We specifically examined para- and orthofluvial spring channels and shallow shoreline area as delineated by fine scale imagery in relation to field surveys because these are critical salmon rearing habitats. Channel nodes were a strong indicator of shallow shoreline ($r^2 = 0.75$, $p < 0.01$) and parafluvial ($r^2 = 0.84$, $p < 0.01$) habitats, while maximum floodplain width was a useful indicator of orthofluvial habitat abundance ($r^2 = 0.53$, $p < 0.01$). Rivers of Kamchatka and western Alaska generally had the most critical habitat per river km and indeed, per unit area of this habitat, have had the highest densities of juvenile salmonids.

Whitney, **J**. **E**., Kansas State University, Manhattan, USA, jwhit@ksu.edu
Gido, K. B., Kansas State University, Manhattan, USA, kgido@ksu.edu

SPATIAL AND TEMPORAL VARIATION IN PRODUCTIVITY ACROSS TROPHIC LEVELS IN THE GILA RIVER BASIN OF NEW MEXICO: DOES ENERGY AVAILABILITY AND INVASION CORRELATE?

Arid-land streams are highly imperiled ecosystems worldwide. Two major reasons for this imperilment are altered abiotic conditions and introduced species. The Upper Gila River Basin of southwestern New Mexico provides a rare opportunity to investigate the dynamics of introduced species in the absence of a modified flow regime. To assess spatial and temporal variation in structure of the Gila River's fish communities, six longitudinally-positioned sites were sampled seasonally during 2008 and 2009. We also evaluated primary and secondary production across these sites to evaluate energy availability to fish communities. Nonnative biomass showed similar values across sites, seasons, and years, but the ratio of native to nonnative biomass decreased moving downstream. Primary and secondary production generally showed a downstream increase, failing to account for the greater native to nonnative ratio upstream. Although energy availability may influence interactions between native and nonnative fishes under certain environmental conditions, it does not appear to be the main driver of coexistence in the Upper Gila River.

Wicks, **C**. **M**., Louisiana State University, Baton Rouge, USA, cwicks@lsu.edu
Noltie, D. B., University of Missouri - Columbia, Columbia, USA, noltied@missouri.edu
Peterson, E. W., Illinois State University, Normal, USA, ewpeter@ilstu.edu
Dogwiler, T., Winona State University, Winona, USA, tdogwiler@winona.edu

DISTURBANCES IN THE HABITAT OF MACROCOTYLE GLANDULOSA (KENK)

Freshets can dislodge organisms from the streambed habitat and in some cases result in scour. Our aim was to characterize the relation between the scour and the magnitude of freshets through the sediment size distribution and the depth of water at numerous locations along a cave stream in the habitat of the imperiled of Macrocotyla glandulosa (Kenk), the pink planaria. Our hypothesis is that areas of stable streambed sediment would serve as habitat whereas areas of mobile streambed sediment would not serve as habitat. We used a numerical model of a cave stream and the size distribution of streambed sediment to designate locations of streambed stability or instability. Based on pink planaria census data, we have identified locations that the pink planaria occupy and those that are unoccupied. We found that five locations that lacked scour corresponded with locations of pink planaria occurrence; that two locations that experienced scour correspond with locations where the pink planaria were not found; and that one location experienced scour and planaria were found. There is a relation between the stability of streambed sediment and the use of that sediment as habitat.

Wiegand, **M**. **D**., University of Winnipeg, Winnipeg, Canada, m.wiegand@uwinnipeg.ca
Huebner, J. D., University of Winnipeg, Winnipeg, Canada, j.huebner@uwinnipeg.ca
Palitsky, D. J., University of Winnipeg, Winnipeg, Canada, danielpalitsky@gmail.com
Huebner, E., University of Manitoba, Winnipeg, Canada, ehuebnr@cc.umanitoba.ca
Loadman, N. L., University of Winnipeg, Winnipeg, Canada, n.loadman@uwinnipeg.ca
Young, D. L., University of Winnipeg, Winnipeg, Canada, d.young@uwinnipeg.ca

MATERNAL INFLUENCES ON *DAPHNIA MAGNA* OFFSPRING SIZE PERSIST AFTER EXPOSURE TO ULTRAVIOLET-B RADIATION AT TWO TEMPERATURES

Both ultraviolet B radiation (UV-B) and incubation temperature can reduce survival and reproductive output of *Daphnia* species. However, UV-B effects on offspring quality have received little attention, despite the anticipated increased penetration of UV-B due to climate change. We examined effects of exposing maternal *Daphnia magna* to UV-B on growth and neonatal (F1) size at 20 and 24 degrees C. Growth of controls was greater than that of UV-B exposed maternal *Daphnia* at both temperatures, and similar between temperatures. Neonatal F1 size increased with maternal age / size in both control and UV-B exposed *Daphnia* at both temperatures. F1 neonates from UV-B exposed parents were smaller than those from controls at both temperatures, and were smaller at 20 degrees than at 24. Our results indicate that UV-B exposure of maternal *Daphnia* reduces not only numbers of neonates, but also neonatal size, and thus fitness. It remains to be determined whether the smaller size of F1s from UV-B exposed parents is due to a direct prenatal effect of UV-B or is simply a function of reduced maternal size.

Wiegner, **T**. **N**., University of Hawaii at Hilo, Hilo, USA, wiegner@hawaii.edu
Mead, L. H., University of Hawaii at Hilo, Hilo, USA, lmead@hawaii.edu

STORM EFFECTS ON WATER QUALITY AND PRODUCTIVITY OF A TROPICAL HAWAIIAN ESTUARY

Storm runoff rapidly transports large quantities of watershed materials to estuaries dramatically affecting their water quality and productivity. Presently, little is known about storm effects on tropical estuaries. We studied Hilo Bay, Hawaii, examining how water quality changed immediately following a storm and evaluating the estuary's short-term response to storms. Hilo Bay was sampled during dry conditions and for five days following storms. Directions of water quality parameters' responses to storms were similar among stations; however, the magnitude of the response depended on whether the station was directly influenced by river flow, groundwater, or ocean exchange. Storms increased nitrate and PN concentrations, decreased those of ammonium, but did not affect DON concentrations. Storms also increased DOC and PC concentrations. Dissolved phosphorus was generally below detection and not affected by storms. Five days following storms, nutrient concentrations remained high, waters cleared, but phytoplankton blooms were not detected. Our results demonstrate that storms dramatically affected water quality and production in Hilo Bay and that understanding storm effects is paramount as more storms are predicted to hit this region with global warming.

Wigdahl, **C**. **R**., University of Maine, Orono, USA, courtney.wigdahl@gmail.com
Saros, J. E., University of Maine, Orono, USA, jasmine.saros@maine.edu

INDIRECT EFFECTS OF CLIMATE ON THE USE OF DIATOMS AS INDICATORS OF PALEOSALINITY IN PRAIRIE REGIONS (GREAT PLAINS, USA)

Lake sediment records contain a wide array of information on ecosystem response to climate change and provide a longer temporal perspective than instrumental data. Fossil diatoms are frequently used as indicators of

paleosalinity, a proxy for drought, in prairie saline lakes. However, diatom-based drought reconstructions from lake sediments in the Great Plains have yielded disparate results across sites. Here we investigate whether drought-related changes in lake level alter food web interactions and subsequently modify the fossil diatom record. Cladoceran zooplankton remains were analyzed in sediment cores from Moon Lake and Coldwater Lake (North Dakota, USA) in order to assess changes in trophic interactions, grazing pressure on algae, and the ratio of littoral:pelagic habitat. Key zooplankton taxa differ across lakes and time, with Bosmina sp., Alona sp., and Chydorus sphaericus present in Coldwater Lake, and larger bodied taxa present in Moon Lake. These data, in combination with additional biological and physical proxies, suggest differences in grazing pressure on diatoms between the two lakes, and will aid in improving the accuracy of drought indicators and paleosalinity reconstructions for the Great Plains.

Wilhelm, **F**. **M**., University of Idaho, Moscow, USA, fwilhelm@uidaho.edu

INCORPORATING SERVICE-LEARNING INTO AN INTRODUCTORY LIMNOLOGY COURSE

Service-learning provides a powerful and motivating approach to teaching and learning because it is active and challenges students with meaningful real-world problems. Lack of widespread adoption of the technique in specialized lab-based aquatic courses is probably due to apparent conflicts between limited time, the need to adequately communicate fundamental principles, and unfamiliarity with the pedagogical approach. I will present details of a service-learning model that has evolved over the last 5 years which incorporates a large service-learning segment in an introductory seniors' level limnology course. It challenges students with real-world problems; allows me to continue to teach the fundamentals; is not prohibitively time-consuming; and is highly valued and respected by students and community recipients.

Wilken, **S**., Netherlands Institute of Ecology, Nieuwersluis, Netherlands, s.wilken@nioo.knaw.nl

Wiezer, S., Netherlands Institute of Ecology, Nieuwersluis, Netherlands, s.wiezer@nioo.knaw.nl

Van Donk, E., Netherlands Institute of Ecology, Nieuwersluis, Netherlands, e.vandonk@nioo.knaw.nl

Huisman, J., University of Amsterdam, Amsterdam, Netherlands, j.huisman@uva.nl

EFFECT OF NITROGEN SOURCE AND ENRICHMENT LEVEL ON A PREDATOR PREY SYSTEM WITH A MIXOTROPHIC PREDATOR

We investigated a nitrogen limited food web consisting of a mixotrophic flagellate preying on the toxic cyanobacterium *Microcystis aeruginosa*. Because the mixotroph cannot use nitrate directly, the system resembles an ordinary predator prey system when nitrate is the only nitrogen source present. When ammonium is offered as nitrogen source the mixotroph is also competing for dissolved nitrogen with its prey and therefore acts as an intraguild predator. The population dynamics of this two-species system were compared in chemostat experiments using the two different nitrogen sources at three levels of enrichment. The mixotroph profited most from the presence of ammonium at low nitrogen concentrations using ammonium and its prey as substitutable nitrogen sources. However, it did not reduce its prey to lower densities for high levels of enrichments as expected from intraguild predation theory. With nitrate as nitrogen source predator prey oscillations occurred during transient dynamics at the intermediate but not the highest enrichment level. We compare our data to model predictions and suggest intraspecific interference within the mixotroph to explain the deviation from theoretical expectations at high levels of enrichment.

Wilkinson, **G**. **M**., St. Olaf College, Northfield, USA, wilkinso@stolaf.edu

Dunn, S. T., St. Olaf College, Northfield, USA, dunns@stolaf.edu

Hinrichs, A. P., St. Olaf College, Northfield, USA, hinricha@stolaf.edu

Marty, M. J., St. Olaf College, Northfield, USA, martymj@stolaf.edu

Schade, J. D., St. Olaf College, Northfield, USA, schade@stolaf.edu

Schmidt, S. N., St. Olaf College, Northfield, USA, schmidts@stolaf.edu

NITROGEN DYNAMICS ALONG A MOISTURE GRADIENT IN RESTORED NORTH TEMPERATE WETLANDS

Human activity has increased the amount of fixed nitrogen in the biosphere, significantly altering the function of aquatic ecosystems. We investigated nitrogen cycling in three prairie ponds that were once in agricultural production to assess possible impacts of patterns of precipitation. These wetlands seasonally expand and contract, creating a gradient in the extent of inundation of seasonally saturated soils. Soil samples were collected immediately after inundation, and over the following six weeks along a transect across the floodplain from permanently wet to permanently dry soil and analyzed for moisture and organic matter content, pH, extractable N concentrations, and mineralizable N. Nitrate showed no significant spatial pattern, but generally declined over the first 4 weeks, most likely due to weekly rainstorms, and recovered in week 5 after the rain stopped. In contrast, ammonium concentration and mineralization rate showed no temporal pattern, but were higher in saturated soils, and declined along the transect. Our results highlight the impact of precipitation on wetland N cycling, and suggest the possibility that future changes in precipitation patterns may substantially alter N dynamics in wetlands.

Willey, **K**. **T**., University of Maryland, Baltimore County, Baltimore, USA, tarawilley@umbc.edu

Swan, C. M., University of Maryland, Baltimore County, Baltimore, USA, cmswan@umbc.edu

Brown, B., Clemson University, Clemson, USA,

DENDRITIC NETWORK STRUCTURE CONSTRAINS METACOMMUNITY PROPERTIES IN RIVERINE ECOSYSTEMS

A metacommunity is a collection of local communities connected by dispersal. Thus, structure of local communities can be due to environmental constraints and species interactions, or regional, dispersal-driven effects. Though the metacommunity concept addresses space, the influence of metacommunity configuration (e.g., stream drainage networks) is less studied. We used a null model analysis and trait-based approach to learn whether local versus regional processes structure fish assemblages at different locations in Piedmont stream networks. We predicted that local effects should be more important in low order locations, while regional effects should prevail in higher order locations. Using a dataset of 185 fish communities comprising 50 species, we learned that local effects were important across all orders studied (1st – 4th), but strongest in 2nd order streams. Furthermore, trait analysis revealed that environmental filtering, not interspecific interactions, were responsible for this pattern. We conclude that environmental constraints structure fish communities across drainage networks, but that dispersal plays a smaller role in lower order streams than in more well-connected, higher order streams.

Williams, **B**. **S**., University of Kansas, Lawrence, USA, bradw0051@yahoo.com

Thorp , J. H., University of Kansas, Lawrence, USA, thorp@ku.edu

Flotemersch, J. E., US EPA (NERL) , Cincinnati, USA, Flotemersch.Joseph@epamail.epa.gov

D'Amico, E., Dynamac Corporation (US EPA), Cincinnati, USA, DAmico.Ellen@epamail.epa.gov

Kastens, J. H., University of Kansas, Lawrence, USA, jkastens@ku.edu

ASSESSING THE ECOLOGICAL SIGNIFICANCE OF LARGE HYDROGEOMORPHIC PATCHES WITHIN TWO LARGE RIVER WATERSHEDS

Riverine landscapes are composed of a discontinuous series of hierarchically nested patches that influence biotic communities and ecosystem function at multiple spatiotemporal scales. The emergent ecological properties of a patch at any given level within the hierarchy result from the diversity of patch types in the next lower level. Therefore, variations in ecosystem function and biotic communities at the catchment scale should reflect the diversity of lower scale patches termed functional process zones (FPZs). FPZs are large, hydrogeomorphically distinct patches that exist between catchment and river reach scales. The type and distribution of FPZs within river networks emerge from objective multivariate analyses that take into account the hydrogeomorphic forces that shape riverine landscapes, thereby making them the most appropriate spatial unit for catchment scale ecological assessments and river management plans. We used a GIS-based classification scheme to determine FPZs in the Kansas (159,000 km2) and the Kanawha (32,000 km2) rivers. The results of these analyses are currently being used as the spatial template for landscape scale studies of fish species diversity and distribution and watershed assessments by the U.S. EPA.

Williams, **C**. **J**., Trent University, Peterborough, Canada, claytonwilliams@trentu.ca

Xenopoulos, M. A., Trent University, Peterborough, Canada, mxenopoulos@trentu.ca

EFFECTS OF LAND USE AND SPATIAL SCALE ON DISSOLVED ORGANIC MATTER STRUCTURE AND BACTERIAL ACTIVITY IN STREAMS

Nutrient levels and dissolved organic matter (DOM) properties are affected differently by land use in a stream's catchment, which in turn can have distinct consequences on bacterial activity. However, it is unclear which spatial scale best captures the impact of land use on streams. We investigate the effect of land use on DOM characteristics (determined using ultraviolet-visible optical properties with PARAFAC), nutrient levels, and bacterial production and abundance at local stream scales within a watershed and regionally, across sub-watersheds. We test: do local changes in land use cause an immediate and predictable response in bacterial activity, DOM characteristics, and nutrient levels or does land use act more gradually, where land use effects on streams are observed better at a regional scale. Regional results show that bacterial activity and protein-like, microbial DOM signatures increased with agricultural land use. However, local changes in land use between stream sampling points did not always lead to the expected directional change in the stream response variables. These results suggest that local DOM cycling is more dynamic and less predictable than when examined at regional scales.

Williamson, **C**. **E**., Miami University, Oxford, USA, craig.williamson@muohio.edu

Fischer, J. M., Franklin & Marshall College, Lancaster, USA, janet.fischer@fandm.edu

Overholt, E. P., Miami University, Oxford, USA, overhoep@muohio.edu

Bollens, S. M., Washington State University, Vancouver, USA, sbollens@vancouver.wsu.edu

Breckenridge, J. K., Washington State University, Vancouver, USA, jbreckenridge@vancouver.wsu.edu

SHEDDING LIGHT ON ZOOPLANKTON DIEL VERTICAL MIGRATION: INTEGRATION OF ABIOTIC AND BIOTIC DRIVERS ACROSS TRANSPARENCY GRADIENTS

The relative contribution of biotic versus abiotic factors to the diel vertical migration (DVM) patterns of zooplankton varies greatly among lakes and oceans of differing transparency and productivity. Yet there has been no systematic consideration of how the relative importance of abiotic versus biotic forcing of DVM is likely to change across these environmental gradients. Here we synthesize new insights from recent studies on the effects of abiotic factors on DVM with the current predominantly biologically based hypothesis in an effort to develop a more comprehensive theory of DVM. We explicitly consider changes in the relative importance of biotic (food and predation) versus abiotic (temperature and UV radiation) forcing as drivers of DVM across transparency-productivity gradients ranging from more transparent 'blue-water' oligotrophic to 'green-water' eutrophic and 'brown-water' dystrophic systems. This "transparency-gradient hypothesis" provides a more versatile theoretical framework to explain variation in DVM relative to environmental changes of current concern ranging from nutrient-driven changes in productivity to climate driven-changes in temperature, DOC, and UV transparency in both inland and oceanic waters of the world.

Williamson, **N**. **A**., Pennsylvania State University, State College, USA, naw166@psu.edu

Tzilkowski, C., National Park Service, State College, USA, Caleb_Tzilkowski@nps.gov

Ferreri, C. P., Pennsylvania State University, State College, USA, cpf3@psu.edu

EFFECT OF REDUCING SAMPLING EFFORT ON STREAM ASSESSMENTS BASED ON BENTHIC MACROINVERTEBRATES

Sample collection and processing costs are a common limitation associated with benthic macroinvertebrate (BMI) monitoring. Reducing the number of samples or the size of each sample has been shown to reduce these costs. The objective of this study was to evaluate the effect of reducing the physical size of BMI samples in the field on water quality ratings based on these samples. Five semi-quantitative richest targeted habitat samples were collected from streams throughout the Delaware Water Gap National Recreation Area, Friendship Hill National Historical Site, Fort Necessity National Battlefield, and Johnstown Flood National Memorial. Half of each replicate was preserved separately and the remaining five halves were composited into one sample. Samples were sorted and identified in the lab to obtain a sample size of 300 ± 20% individuals. Samples were compared to the field composite individually and in all possible combinations of two to five samples using Jaccard's Similarity Index and commonly used metrics. As previous studies have shown, increasing the number of samples in our lab-generated composite decreased variability of metrics and increased similarity to the field composite.

Wilson, **K**. **P**., Death Valley National Park, National Park Service, Pahrump, USA, Kevin_Wilson@nps.gov

Williams, D. D., University of Toronto Scarborough, Scarborough, Canada, williamsdd@utsc.utoronto.ca

AN IN SITU TEMPERATURE MANIPULATION OF A SHALLOW GROUNDWATER ECOSYSTEM REVEALS MULTIPLE ABIOTIC AND BIOTIC RESPONSES

An ecosystem temperature manipulation was conducted in accordance with global warming projections for southern Ontario, Canada. Multiple response variables were examined below a first order stream to a depth of 1 m. Temperatures were increased following projections by general circulation models for this region. Specifically, treatment block temperatures in spring, summer, and autumn were elevated 3.9 ± 0.6 SD °C, whereas winter temperatures were elevated 5.0 ± 0.6 °C compared with a control block. A suite of other physicochemical parameters, as well as fungi, ciliates, and meiofauna were examined. Response variables were not consistent during the experiment. For example, total ciliates in the treatment block had a higher density than the control, but densities were both vertically and longitudinally variable. In comparison, there was no significant difference between blocks for total meiofauna, but taxon specific differences were detected. I will discuss the implications of these findings to the biogeochemistry and ecology of shallow groundwater. The benefits of using organisms with rapid life cycles as a proxy for higher, much longer-lived, eukaryotes in climate change studies will also be discussed.

Wilson, **P**. **S**., AUT University, Auckland, New Zealand, peter.wilson@aut.ac.nz

Vopel, K. C., AUT University, Auckland, New Zealand, kay.vopel@aut.ac.nz

TERRIGENOUS DEPOSITS IN COASTAL HABITATS: EFFECTS ON THE OXYGENATION OF MARINE SEDIMENT

Climate change models predict an increase in the frequency of extreme rainfall events and thus the supply of terrigenous sediments to coastal waters. This is of particular concern in regions where vegetation removal and coastal urbanization lead to large scale mobilisation of soil, and where steep topography supports rapid transport. The suspended sediment will eventually settle, smothering the seafloor and its organisms. The effects of such a deposition on coastal ecosystem functioning are poorly understood. We conducted two laboratory experiments to investigate how mm-thin surface deposits of terrestrial clay affect the distribution and consumption of oxygen in subtidal soft sediment. Two variables were considered: the thickness of the deposit and the number of resuspensions the clay had undergone before being deposited. Microelectrode measurements showed no effects from the latter variable. We found a negative linear correlation between layer thickness and both the sediment oxygen consumption and the oxygen penetration depth (OPD) in the marine sediment beneath the clay. Interestingly, the total OPD (including clay layer) exhibited a polynomial relationship with clay-layer thickness. We discuss the mechanism behind these relationships.

Wiltshire, **K**. **H**., Alfred Wegener Institute for Polar and Marine Research, , Helgoland, Germany, karen.wiltshire@awi.de

Boersma, M., Alfred Wegener Institute for Polar and Marine Research, , Helgoland, Germany, Maarten.Boersma@awi.de

Franke, H. D., Alfred Wegener Institute for Polar and Marine Research, Helgoland, Germany, Heinz-Dieter.Franke@awi.de

Scharfe, M., Gkss Reasearch Center, Geesthacht, Germany, scharfe@gkss.de

NORTH SEA, GERMAN BIGHT: A REVIEW OF 45 YEARS OF CHANGE.

The Helgoland Roads time series is one of the richest temporal marine data sets available. They include daily surface water sampling from 1962 until the present day, resulting in a pelagic data set comprising of phytoplankton, salinity, Secchi and nutrient analyses. Concurrently the time series are augmented by the biological parameters zooplankton, rocky shore macroalgae and macro-zoobenthos and bacteria data series which were sampled discontinuously until the 1990ties and which now have been restarted. Until recently it was relatively

difficult to interpret the long term data acquired at Helgoland. This was mainly due to a lack of meta-information and quality control of the data which has now been rectified. We present these data sets and give examples of the major changes in evidence for phytoplankton, through to macro-benthos at Helgoland. We discuss the changes in currents, salinity, temperature and nutrients. The changes in the hydrography, temperature and salinity and relate this to changes in species are presented. The evidence we have for neobiota and its placement in the system as well as species shifts are evaluated and related to climatic and hydrographic shifts in the North Sea.

Wimmer, **J. M.**, Wayne State College, Norfolk, USA, jewimm01@wsc.edu
Gerdes, C., Wayne State College, Wayne, USA,
Langdon, J., Wayne State College, Wayne, USA,
Hayford, B., Wayne State College, Wayne, USA, bhayford@gmail.com

RESPONSE OF MONGOLIAN STREAMS TO GRAZING AS MEASURED BY A RIPARIAN RANGE HEALTH PROTOCOL.

Overgrazing by domesticated herbivores can exacerbate the impact of climate change on Mongolian streams. Thus it is important to directly measure the impact of grazing on range health along streams. To this end, we developed a riparian range health protocol, which we tested on 34 streams in the Southern Altai region of Mongolia. We hypothesized that turbidity, which measures the amount of particles in water, would increase in streams which showed evidence of overgrazing. Multiple regression analysis was used to model the response of turbidity to predictor variables generated by the riparian range health protocol as well as landscape, reach- and microhabitat-scale variables. The model was significant at $p = 0.004$ and it accounted for 60% of variation in turbidity in the study sites. Percent of bare ground measured 30 meters from the stream channel was by far the strongest contributor to variation in turbidity followed by stream order, elevation, geographic position, percent bare ground nearer the stream, and percent forbs. We concluded that the riparian range health protocol was an effective tool in modeling stream response to grazing.

Winder, **M.**, University of California, Davis, USA, mwinder@ucdavis.edu
Jassby, A. D., University of California, Davis, USA, adjassby@ucdavis.edu

SHIFTS IN ZOOPLANKTON COMMUNITY STRUCTURE: IMPLICATIONS FOR FOOD-WEB PROCESSES IN THE SAN FRANCISCO ESTUARY

Zooplankton are an important trophic link and a key food source for many larval fish species in estuarine ecosystems. Here we show major shifts in zooplankton community structure in the San Francisco Estuary that are affecting the declining pelagic fish population. Shifts coincided with the beginning and end of the extended drought of 1987-1994, largely associated with direct and indirect effects of clam and zooplankton invasions. Several copepods and mysids species were introduced during low water years and displaced the local fauna. The zooplankton community shifted from a once calanoid and rotifer dominated community to a cyclopoid dominated community and mysid biomass dropped significantly. These shifts are accompanied by a decrease in mean zooplankton size and zooplankton food quality for fish. Changes in biomass, size and chemical composition of the zooplankton community are affecting pelagic food-web processes, including a drop in prey for foraging fish and an increase of carbon recycling in the microbial food web. This study shows that persistent climate shifts can drastically change communities, which can have major implications for the entire ecosystem.

Winders, **K. R.**, Kansas State University, Manhattan, USA, winders@ksu.edu
Dodds, W. K., Kansas State University, Manhattan, USA, wkdodds@ksu.edu
Banner, E. B., Kansas Department of Health and Environment, Topeka, USA, ebanner@kdheks.gov

STREAM SUSPENDED SOLIDS AS INFLUENCED BY STREAM DISCHARGE AND THE IMPACT OF TOTAL SUSPENDED SOLIDS ON AQUATIC BIOTA.

We analyzed long-term datasets collected by Kansas Department of Health and Environment and Missouri Department of Natural Resources from 1990-2009 for 3673 total suspended solids (TSS) samples taken from 43 sites. USGS-approved mean daily discharge data associated with each study stream were converted to percent exceedance values for each sampling location. Piecewise regression analyses were used to determine threshold values for the TSS loading rate by site and across sites. Daily discharge values that exceeding a breakpoint of 26 percent of the days accounted for 34 percent of the total TSS load. The regression below this breakpoint approximated the median TSS level; therefore, stream conditions were near the median TSS level 74 percent of days. The overall mean TSS level was ten times greater than the overall median value and better represented the total mass of suspended solids carried downstream. Relationships between site-independent median or mean TSS and aquatic macroinvertebrate communities were then analyzed to determine if median or mean TSS level better correlated to the macroinvertebrate community and to evaluate relationships between TSS levels and biotic integrity.

Winkworth, **C. L.**, University of Otago, Dunedin, New Zealand, cynthia.winkworth@otago.ac.nz
Townsend, C. R., University of Otago, Dunedin, New Zealand, colin.townsend@otago.ac.nz

THE EFFECTS OF AGRICULTURAL ANTIBIOTICS ON STREAM BIOFILMS FOLLOWING A SIMULATED CONTAMINATION EVENT

Microorganisms play key roles in stream ecosystem but comparatively little is known about their diversity and almost nothing about their resilience or susceptibility to chemical by-products of agricultural land use. Antibiotics used in the agricultural sector are of particular concern because they are designed to have biological effects and have been detected in waterways associated with agricultural land. Despite recent widespread agricultural intensification in New Zealand and the sector's high antibiotic use to promote animal growth, the effects of antibiotic by-products on stream microbial communities have yet to be characterised. We investigated the impacts of the agricultural antibiotic Monensin on microbial biofilm communities in a streamside replicated channel experiment. A 24-hour pulse experiment in pre-colonized channels contrasted the effects of a range of realistic Monensin concentrations with unmanipulated controls. Biofilm community composition was characterised immediately before and over 21 days after the pulse using Automated Ribosomal Intergenic Spacer Analysis. The consequences of the antibiotic for both diversity and abundance of microorganisms will be presented.

Winter, **J. G.**, Environmental Monitoring and Reporting Branch, Ministry of the Environment, Toronto, Canada, jennifer.winter@ontario.ca
Heneberry, J. H., Cooperative Freshwater Ecology Unit, Ministry of the Environment, Sudbury, Canada, jheneberry@laurentian.ca
Keller, W., Laurentian University, Sudbury, Canada, bkeller@laurentian.ca
Paterson, A. M., Dorset Environmental Science Ctr, Ministry of the Environment, Dorset, Canada, andrew.paterson@ontario.ca
Yan, N. D., Department of Biology, York University, Toronto, Canada, nyan@yorku.ca

PHYTOPLANKTON RECOVERY FROM ACID AND METAL CONTAMINATION: A COMPARISON OF NEUTRALIZED AND UN-MANIPULATED LAKES

We investigated changes in the phytoplankton of 4 lakes to assess recovery from acidification. The lakes are near Sudbury, Canada, an area extensively damaged by sulphur dioxide and metals. Emissions have been substantially reduced since the 1970s, resulting in improvements in the water quality of lakes in the area. One of the study lakes was untreated, one was limed but re-acidified within a few years, and two were limed resulting in sustained pH levels above 6. We compared changes in the phytoplankton communities in these lakes over 30 years to reference data collected within the same biogeographic region. There has been an increase in the diversity of phytoplankton taxa in the test lakes, which was correlated to increasing pH and decreasing metal concentrations. Correspondence analysis revealed changes in the taxonomic composition of the phytoplankton in the test lakes towards the reference lakes. However, the phytoplankton communities in the neutralized lakes were quite different to those from the reference lakes in certain years. Overall, there was evidence of recovery in the composition of phytoplankton communities of the acidified lakes.

Wittmann, **M. E.**, University of California, Davis, USA, mwittmann@ucdavis.edu
Chandra, S., University of Nevada, Reno, USA, sudeep@cabnr.unr.edu
Reuter, J. E., University of California, Davis, USA, jereuter@ucdavis.edu
Schladow, S. G., University of California, Davis, USA, gschladow@ucdavis.edu

POPULATION GROWTH AND RANGE EXPANSION OF AN INVASIVE BIVALVE *CORBICULA FLUMINEA* IN LAKE TAHOE: IMPLICATIONS FOR NEARSHORE ECOLOGY AND MANAGEMENT

The invasive Asian clam *Corbicula fluminea* is established the littoral zone of Lake Tahoe, CA-NV. High density populations (up to 6000/m^2) are observed

in the southeast region of the lake, where the clam has negative impacts on benthic diversity and is associated with filamentous algal blooms of *Zygnema sp.* and *Cladophora glomerata*. As part of a study of the ecology and lakewide distribution of *C. fluminea*, benthic samples were collected every 6-8 weeks from October 2008 through February 2010. These data along with in situ growth experiments were then used to estimate the abundance and growth of the *C. fluminea* population. K-means cluster analysis is used to track cohort growth rates. Widely distributed (2-70 m water depth) along Lake Tahoe's well-oxygenated littoral zone, *C. fluminea* maximum size and life expectancy is lesser in this subalpine, oligotrophic ecosystem, but growth rates and population densities are similar and can exceed those in warmer, more nutrient-rich ecosystems. *C. fluminea* range expansion continues within Lake Tahoe with long distance dispersal events. Experimental efforts to manage new populations using bottom barriers are currently underway.

Wojewodzic, **M**. **W**., University of Oslo, Oslo, Norway, marcin.wojewodzic@bio.uio.no

Kyle, M., Arizona State University, Tempe, USA, mkyle@asu.edu

Andersen, T., University of Oslo, Oslo, Norway, tom.andersen@bio.uio.no

Hessen, D. O., University of Oslo, Oslo, Norway, d.o.hessen@bio.uio.no

Elser, J. J., Arizona State University, Tempe, USA, j.elser@asu.edu

A HIGHLY SENSITIVE CHEMILUMINESCENCE METHOD FOR QUANTIFICATION OF ALKALINE PHOSPHATASE IN ZOOPLANKTON.

Phosphorus (P) is an essential element for all living organisms. Under P-limited conditions, organisms can access the P in organic compounds of foods or substrates by increasing their expression of alkaline phosphatases (AP). While several AP homologues produced by algae or bacteria are well documented, the regulation and activity of these enzymes in zooplankton remain poorly understood. Studies involving body content AP in zooplankton and other small invertebrates have also been hampered by the low sensitivity of available methods. Here we present a novel method to quantify AP in a single zooplankter by using an extremely sensitive chemiluminescent substrate. We than normalize the AP activity by using that individual's protein content. We evaluate this method by quantifying the AP activity in Daphnia magna during the first six days of growth and find that there are no changes with time if food remains constant. This method can be an important tool for investigating the regulation of AP activity in zooplankton and other small metazoans.

Wolff, **R**. **H**., U.S. Geological Survey, Pacific Islands Water Science Center , Honolulu, USA, rhwolff@usgs.gov

DEVELOPMENT OF A MACROINVERTEBRATE INDEX IN HAWAIIAN STREAMS: WHAT CAN NON-NATIVE INVASIVE SPECIES TELL US?

The U.S. Geological Survey, Pacific Islands Water Science Center is developing a benthic macroinvertebrate multi-metric index of stream quality in Hawaii. In 2006 and 2007 we collected macroinvertebrates from 40 sites on the island of Oahu. The macroinvertebrate assemblages showed that most of native macroinvertebrate species in Oahu streams, even in remote areas, have been supplanted by non-native invasive species. In total, only 6 native species were collected, averaging less than 1 per site and representing less than 0.6 percent of the total abundance. In 2009, macroinvertebrates were collected from 40 sites on the less urbanized island of Maui. In total, only 5 native species were collected, averaging less than 1.5 per site and representing less than 2 percent of the total abundance. The once prevalent native biota was all but absent from the samples, even from relatively pristine areas of Maui. Invasive species are often considered as indicators of ecological degradation or biocontamination. Because of a paucity of native species in Hawaiian streams, however, metrics are being developed using non-native species.

Wollheim, **W**. **M**., University of New Hampshire, Durham, USA, wil.wollheim@unh.edu

Peterson, B. J., Marine Biological Laboratory, Woods Hole, USA, peterson@mbl.edu

Vorosmarty, C. J., City College of New York, New York, USA, cvorosmarty@ccny.cuny.edu

DECLINE IN AQUATIC ECOSYSTEM SERVICE EFFICIENCY MAGNIFIES GLOBAL FLUX OF ANTHROPOGENIC NITROGEN TO COASTAL ZONES

Global demand for food provisioning ecosystem services (ES) requires large amounts of nitrogen (N) fertilizer, leading to greater N circulating in the environment and widespread negative impacts in the coastal zone. It is therefore critical to understand the effectiveness of nitrogen regulating ES that control transfer of nitrogen between land and ocean. We modified an existing global river network model that integrates streams, rivers, lakes, and reservoirs, to account for denitrification efficiency loss in order to understand how N regulating ecosystem services have changed between preindustrial and contemporary periods. Our model predicts that as a result of efficiency loss, exports to the global ocean have increased 5.3x, while global DIN inputs from land to river systems are estimated to have increased only 4.1x. Downstream lakes and constructed reservoirs are able to buffer the effects of efficiency loss, but only to a limited degree. Nevertheless, this buffering effect results in lakes and reservoirs providing a greater value of ecosystem service than streams and rivers in our analysis. Understanding how ecosystem services accumulate through river systems will be necessary for predicting impacts as the demand for multiple ecosystem services rises, particularly in a changing climate.

Won, S., Columbus State University, Columbus, USA, greywon@gmail.com

Keller, **T**. **A**., Columbus State University, Columbus, USA, keller_troy@colstate.edu

PHYSIOLOGICAL MECHANISMS OF COEXISTENCE: A NATIVE CRAYFISH TOLERATES HYPOXIA BETTER THAN ITS NON-INDIGENOUS COMPETITOR

The rapid spread of the invasive crayfish *Orconectes rusticus* into new habitats has resulted in the displacement of congeners from many aquatic ecosystems. Its aggressive behavior, superior predator avoidance, and rapid growth enable it to displace other crayfishes such as *O. virilis*. We hypothesized that *O. virilis*' distribution in deep portions of lakes and in stagnant streams could indicate that it has a physiological tolerance for low dissolved oxygen conditions. We tested the righting response of *O. rusticus* and *O. virilis* in 1, 3, 5, and 7 mg/L O_2 waters and found that *O. virilis* performed better than *O. rusticus*under hypoxic conditions. Additional comparisons of these species at initial O_2 concentrations of 1 and 7 mg/L showed that *O. virilis*has a lower oxygen consumption rate. Trap surveys confirmed *O. virilis*' ability to colonize hypoxic hypolimnetic waters, however too few *O. rusticus* were caught to draw any conclusions about that species. We conclude that *O. virilis*' physiological advantage in hypoxic environments could enable it to find competitor-free refugia and thus coexist with *O. rusticus* at the landscape level.

Wondzell, **S**. **M**., USDA Forest Service, Pacific Northwest Research Station, Olympia, USA, swondzell@fs.fed.us

Zarnetske, J. P., Oregon State University, Corvallis, USA, zarnetsj@geo.oregonstate.edu

Haggerty, R., Oregon State University, Corvallis, USA, haggertr@geo.orst.edu

Payn, R. A., Montana State University, Bozeman, USA, robpayn@gmail.com

Gooseff, M. N., Pennsylvania State University, State College, USA, mgooseff@engr.psu.edu

McGlynn, B. L., Montana State University, Bozeman, USA, bmcglynn@montana.edu

LIMITATIONS OF THE STREAM TRACER APPROACH FOR HYPORHEIC INVESTIGATIONS

Stream tracer studies and subsequent analyses with transient storage models have long been a mainstay of hyporheic investigations. These stream tracer studies are appealing. They are easier than methods that rely on direct observations from wells and appear to provide estimates of the size of the hyporheic zone. Stream tracer methods have many limitations however. Some are well known, for example, the "window of detection"; other limitations are less well known, for example, how the spatial ordering of gains and losses can influence estimates of lateral groundwater inputs. To illustrate these limitations we contrast tracer-based methods with well-network based methods. We show that, in most streams, tracer studies are only sensitive to very short residence time exchange flows and thus fail to characterize portions of the residence time distribution important to many biogeochemical processes. We suggest that all stream tracer studies should (1) conduct mass balances on recovered tracer mass and (2) use numerous wells to document the spatial extent of the hyporheic zone actually measured in any given tracer study. In summary: Transient storage does not equal hyporheic exchange.

Wong, **W**. **H**., University of Nevada, Las Vegas, USA, david.wong@unlv.edu
Holdren, G. C., U.S. Bureau of Reclamation, Denver, USA, choldren@do.usbr.gov
Gerstenberger, S. L., University of Nevada, Las Vegas, USA, shawn.gerstenberger@unlv.edu
Moore, B., National Park Service, Boulder City, USA, bryan_moore@nps.gov
Hickman, G., U.S. Bureau of Reclamation, Boulder City, USA, GHickman@usbr.gov
Wilson, D., City of Lake Havasu City, Lake Havasu City, USA, WilsonD@lhcaz.gov
Hatcher, M., Sweetwater Authority, Chula Vista, USA, mhatcher@sweetwater.org

IMPACTS OF INVASIVE QUAGGA MUSSELS (DREISSENA BUGENSIS) IN THE SOUTHWEST UNITED STATES

Quagga mussels (Dreissena bugensis) were found in Boulder Basin of Lake Mead in the Lower Colorado River Basin on January 6, 2007. Annual Chlorophyll a concentrations had decreased significantly in the post-quagga period (2007-2009) in the open water of Boulder Basin, but not in other basins. Significant monthly reduction of Chlorophyll a after quagga invasion was only found in one to three stations among the eighteen monitoring stations. No significant increase of water clarity has been detected between pre (2002-2006) and post-quagga periods in Lake Mead. In Lake Havasu, water was clearer in each month of 2009 than in most of the previous years. Zooplankton abundance in the Boulder Basin of Lake Mead has not significantly changed yet since quagga mussel invasion. The population of threadfin shad, a critical trophic in the fisheries of Lake Mead has not changed yet since 2007. Any potential ecological changes could be confounded by other factors in the past years such as drought and nutrient-loading reduction from wastewater treatment plants. Long-term ecological consequence needs to be systematically monitored in the Lower Colorado River Basin.

Woodward, **G**., Queen Mary University of London, London, United Kingdom, g.woodward@qmul.ac.uk
Pichler, D. E., Queen Mary University of London, London, United Kingdom, d.e.pichler@qmul.ac.uk
Friberg, N., N.E.R.I., Silkeborg, Denmark, nfr@dmu.dk
Olafsson, J., Institute of Freshwater Fisheries, Reykjavik, Iceland, jsol@veidimal.is
Gislason, G. M., University of Iceland, Reykjavik, Iceland, gmg@hi.is
Ledger, M. E., University of Birmingham, Birmingham, United Kingdom, M.E.LEDGER@bham.ac.uk
Brown, L. E., University of Leeds, Leeds, United Kingdom, L.Brown@leeds.ac.uk
Edwards, F., C.E.H., Wallingford, United Kingdom,
Thompson, M. S., Natural History Museum, London, United Kingdom, murray.s.thompson@googlemail.com
Demars, B., Macaulay Insitute, Aberdeen, United Kingdom, B.Demars@macaulay.ac.uk

CLIMATE CHANGE AND STREAM FOOD WEBS

The Earth is experiencing historically unprecedented rates of warming, with surface temperatures projected to increase by 3-5°C globally, and up to 7.5°C in high latitudes, within the next century. Knowledge of how these changes will affect biological systems is still largely restricted to the lower levels of organisation (e.g. species range shifts), rather than at the community, food web or ecosystem level, where responses cannot be predicted from studying single species in isolation. We present data from a range of systems to explore the likely consequences of climate change and global warming in the northern hemisphere. Our approach combines data from a "natural experiment" in Iceland and field manipulations in the U.K. Among the biological responses we have observed are: a simplification of food web structure and reduced biomass production during droughts; increases in food web height and chain length across a thermal gradient; alterations in the metabolic balance of whole ecosystems due to warming. These findings provide valuable new insights into how the more complex levels of biological organisation might respond to the next 100 years of global change.

Woodward, **K**. **B**., Griffith University, Brisbane, Australia, b.woodward@griffith.edu.au
Fellows, C. S., Griffith University, Brisbane, Australia,
Sheldon, F., Griffith University, Brisbane, Australia,
Hughes, J. M., Griffith University, Brisbane, Australia,

THE EFFECTS OF FLOOD FREQUENCY UPON SOIL PROPERTIES AND SOIL MICROBIAL COMMUNITY STRUCTURE.

The connection between a river and its floodplain, via floodplain inundation, is essential for the health of both; as it enables the exchange of matter and energy. The regulation of river systems results in smaller and less frequent flooding events, thus reducing the connectivity between a river and its floodplain. Inundation has many important consequences for both the physical and chemical aspects of soils, and the microbial communities that live within them. Soils from four different heights above base flow conditions and thus with differing inundation frequencies from five different locations, were collected from the Gwydir River (Northern, New South Wales, Australia). Within each flood level soils were analysed for the release and bio-availability of carbon and the release of nitrate, ammounium and phosphate using cold water extractions. The isotopic signature of carbon and nitrogen found within each soils and its particle size distribution was also investigated as well as the amount of leaf litter upon each flood level. Finally, the microbial communities found at each flood level were investigated using molecular methods.

Wooten, **M**. **S**., SD1, Fort Wright, KY, USA, mwooten@sd1.org
Hawley, R. J., Colorado State University/Sustainable Streams, LLC, Louisville, KY, USA, bob.hawley@sustainablestreams.com

INTERACTIONS AND EFFECTS OF WATERSHED LANDCOVER AND HYDROMODIFICATION ON THE MACROINVERTEBRATE COMMUNITY OF NOTHERN KENTUCKY STREAMS

SD1 has recently initiated a large, multi-component (biological, chemical, physical, etc) data collection effort in support of an adaptive watershed approach to managing water quality. In order for this management strategy to be effective, it is vital to understand the influence that various land covers play on each of the components, especially in highly developing watersheds, such as many of those located in Northern Kentucky. The objective of this project is to present the preliminary findings on the relationship of the macroinvertebrate communities and the surrounding land covers within these streams, and begin to examine the relationship of stream hydromodification and the macroinvertebrate community. Macroinvertebrate samples were collected using protocols developed by the Kentucky Division of Water. Community data were analyzed using various multivariate techniques and the Kentucky Macroinvertebrate Index. Hydromodification surveys were performed at most sampling locations (i.e. 24 of 55), and primary land cover was determined by visual interpretation of GIS coverage. Preliminary results indicate negative relationships within macroinvertebrate communities associated with degree of development, imperviousness and hydrologic alteration, and positive relationships associated with forested land covers.

Woulé Ebongué, **V**., Vrije Universiteit Brussel - ANCH, Brussels, Belgium, vwouleeb@vub.ac.be
Brion, N., Vrije Universiteit Brussel - ANCH, Brussels, Belgium, nnbrion@vub.ac.be
Hove, N., Vrije Universiteit Brussel - ANCH, Brussels, Belgium, Nathalie.Hove@vub.ac.be
Barrón , C., Universidad de Cádiz, Cádiz, Spain, cristina.barron@uca.es
Dehairs, F., Vrije Universiteit Brussel - ANCH, Brussels, Belgium, fdehairs@vub.ac.be
Bal, K., Universiteit Antwerpen, Wilrijk, Belgium, kris.bal@ua.ac.be
Schoelynck, J., Universiteit Antwerpen, Wilrijk, Belgium, jonas.schoelynck@ua.ac.be
de Deckere, E., Universiteit Antwerpen, Wilrijk, Belgium, eric.dedeckere@ua.ac.be
Bouma, T., Netherlands Institute of Ecology, Centre for Estuarine and Marine Ecology, Yerseke, Netherlands, t.bouma@nioo.knaw.nl
Meire, P., Universiteit Antwerpen, Wilrijk, Belgium, patrick.meire@ua.ac.be

MACROPHYTES AND NUTRIENT DYNAMICS IN THE UPPER REACHES OF LOWLAND RIVERS: INFLUENCE OF HYDRAULICS ON THE UPTAKE OF NH4+

Experiments were done to determine the spatial variability of NH4+ uptake rates by macrophytes within a patch, and its link with the modified currents distribution. Two macrophyte species: Potamogeton natans and Ranunculus fluitans were incubated for 6h with 15N-NH4+ under various patch configurations (3) and at two current velocities (0.1 and 0.3 m/s) in an artificial flume. C, N contents and 15N abundance were measured on selected specimens (by Elemental Analyser-Isotope Ratio Mass Spectrometer) to calculate the NH4+ uptake rate U. Flow measurements were carried out with an Acoustic Doppler Velocimeter. First results showed that the spatial variability in U was highest in P. natans patches at 0.1m/s. The NH4+ uptake rates were generally higher in R. fluitans patches. Patch configuration does not seem to influence U. The effects

of (i) species, (ii) flow velocity and (iii) patch configuration on U will provide an improved insight in the detailed processes of nutrient uptake in macrophytes. Both the increased understanding and the associated modeling will be essential for incorporating the role of the macrophytes in the scope of integrated water management.

Writer, **J. H.**, University of Colorado / USGS, Boulder, USA, writer@colorado.edu
Ryan, J. N., University of Colorado, Boulder, USA, joseph.ryan@colorado.edu
Bradley, P. M., USGS, Columbia, USA,
Barber, L. B., USGS, Boulder, USA,

THE ROLE OF THE EPILITHON IN CONTROLLING THE FATE AND TRANSPORT OF ENDOCRINE-ACTIVE COMPOUNDS IN STREAMS

Low concentrations of compounds that have the potential to disrupt the endocrine system of aquatic organisms have been identified in surface waters worldwide. These compounds, known as endocrine-active compounds (EACs), include steroidal hormones, detergent formulations, plasticizers, and pharmaceuticals. Bed sediments below streams are ubiquitously coated by biofilms, generally referred to as the epilithon in freshwater ecosystems. Biogeochemical cycling in the epilithon is an important component of stream ecosystem function as nutrients and organic matter are absorbed and utilized by the biotic consortia. Therefore, evaluating the potential of this matrix to attenuate EACs is an important part of understanding their fate in surface waters. Our research shows that EACs accumulate in the epilithon of streams. Sorption to both the epilithon and to the sediments occurred on a temporal scale much faster (< 1 h) than the potential of the epilithon to mineralize the target compounds (50% mineralization > 70 d) and this has ecological implications. Additionally, although the epilithon attenuated EACs in streams, environmental sampling indicated that these compounds are still transported kilometers downstream.

Wurtsbaugh, **W. A.**, Utah State University, Logan, USA, wayne.wurtsbaugh@usu.edu

STROMATOLITE BIOSTROME COMMUNITIES IN THE GREAT SALT LAKE: THEIR IMPORTANCE FOR SELENIUM AND MERCURY BIOACCUMULATION IN THE FOOD WEB

In the Great Salt Lake (Utah) stromatolite biostromes grow profusely at depths < 3 m and cover >20% of littoral zone. The periphyton community growing on (and building) the biostromes is 99% colonial cyanobacteria (*Aphanothece* sp.) with mean chlorophyll levels of 800 mg m^{-2}--seven times that of the phytoplankton. The stromatolites are the principal habitat for brine fly (*Ephydra gracilis*) larvae and pupae that are fed upon by many of the birds utilizing the lake. Mean larval densities were 13,000 m^{-2}. Mean selenium concentrations in the periphyton, fly larvae, and goldeneye duck predators (Vest et al. 2008) were 1.7, 1.2 and 6.0 µg Se g^{-1} dry weight. Respective total mercury concentrations were 0.17, 0.17, and 60 µg Hg g^{-1}. Since Se and Hg are antagonistic, the mercury is likely fully detoxified in the flies, but not in the ducks. The relatively unstudied stromatolite community apparently is extremely important in the lake's food web dynamics. However, the complexities of Se-Hg interactions indicate that additional work is needed to understand the importance of these contaminants for ducks and shorebirds utilizing the lake.

Wyatt, **K. H.**, Michigan State University, East Lansing, USA, wyattkev@msu.edu
Turetsky, M. R., University of Guelph, Guelph, Canada, mrt@uoguelph.ca
Rober, A. R., Michigan State University, East Lansing, USA, roberall@msu.edu
Kane, E. S., Michigan Technological University, Houghton, USA, citezenkane@gmail.com
Giroldo, D., Fundação Universidade Federal do Rio Grande, Rio Grande, Brazil, dmbgirol@furg.br
Stevenson, R. J., Michigan State University, East Lansing, USA, rjstev@msu.edu

ALGAL RESPONSES TO WATER TABLE MANIPULATION IN AN ALASKAN PEATLAND: IMPLICATIONS FOR CARBON CYCLING IN THE BOREAL FOREST

We monitored algal responses to an ecosystem-level water table manipulation, including both drought and flooding treatments, in an Alaskan fen to evaluate how changes in hydrology might effect algal-derived energy and carbon (C) cycling in boreal peatlands. We measured consistently higher growing season algal productivity (mg C m^{-2} h^{-1}) in the drought treatment (5.55 ± 1.25 – 37.99 ± 13.89) than in both the control (0.31 ± 0.19 – 5.16 ± 3.53) or flooded treatment (0.21 ± 0.11 – 6.41 ± 2.27). Water-column dissolved organic C (DOC) concentrations increased with algal productivity (R^2 = 0.85, p<0.001). We calculated that algae released 0.18 ± 0.06 mg DOC L^{-1} h^{-1} into the water column for each mg C fixed during photosynthesis. At this rate, we predict that algae contribute more than 6.84 mg DOC L^{-1} h^{-1} during peak productivity under drought conditions. Our work also is investigating the chemical nature and biodegradability of total versus algal-derived DOC. These findings indicate that algae serve as an important component of the boreal peatland C pool and may become more important to peatland C cycling under future drought conditions.

Wymore, **A.**, Northern Arizona University, Flagstaff, USA, asw54@nau.edu
Compson, Z. G., Northern Arizona University, Flagstaff, USA, zacchaeus.compson@nau.edu
Gettel, G. M., University of New Hampshire, Durham, USA, gretchen.gettel@unh.edu
Marks, J. C., Northern Arizona University, Flagstaff, USA, jane.marks@nau.edu

COTTONWOOD GENETIC VARIATION INFLUENCES DISSOLVED ORGANIC CARBON CONCENTRATION AND COMPOSITION: LINKING GENETICS TO AQUATIC BIOGEOCHEMISTRY

Ecosystem science has long ignored intraspecific differences arguing that the effects would be too diffuse to affect ecosystem-level processes. However, data from the Populus hybridizing system (Cottonwood) are challenging this paradigm. Using genetically characterized cottonwood genotypes, we demonstrate that lotic carbon-cycling can indeed be affected by genetic differences in a common riparian species. Dried leaves were leached for 24-hours and subsequently filtered for particulates. DOC concentration was assessed using a TIC-TOC analyzer and composition was visualized and quantified with the novel technique of fluorescent spectroscopy. Dissolved organic carbon (DOC) concentration and composition varied significantly between cottonwood cross-types as well as between genetically distinct individuals of the same species. These data reveal that genetic-level variation between members of the same species can influence carbon pools which may influence ecosystem-level processes. These results have important applications for riparian and stream restoration projects.

Wynn, **T. D.**, The University of Alabama, Tuscaloosa, USA, tdwynn@crimson.ua.edu
Benke, A. C., The University of Alabama, Tuscaloosa, USA, abenke@as.ua.edu

ESTIMATION OF PLEUROCERID SNAIL DISTRIBUTION, BIOMASS, AND PRODUCTION AMONG THREE PRIMARY HABITATS OF A CAHABA RIVER SHOALS

Pleurocerid snails are conspicuous members of the Cahaba River shoals macroinvertebrate community, and are dominant in terms of invertebrate biomass. Distribution, biomass, and production of five common pleurocerid species (*Elimia clara*, *E. ampla*, *E. showalteri*, *E. cahawbensis*, and *Pleurocera vestita*) was estimated in three primary habitats [bare bedrock (BR), *Podostemum ceratophyllum* (POD), and *Justicia americana* (JUS)], using the instantaneous growth technique along with empirical growth models derived from a previous field study. Monthly quantitative sampling of each habitat was conducted for one year in order to examine possible differences in snail density, biomass, and production between habitats. Average density (N) and biomass (B) of *E. showalteri* across five months follow a general trend between habitats (BR < POD < JUS)(N_{BR} = 99.53 ind./m^2, B_{BR} = 2995 mgAFDM/m^2; N_{POD} = 196.37 ind./m^2, B_{POD} = 5930 mgAFDM/m^2; N_{JUS} = 223.27 ind./m^2, B_{JUS} = 7609 mgAFDM/m^2), though a one-way ANOVA reveals these relationships to be insignificant. Further analysis of the remaining sampling dates and species may elucidate the possible relationships (or lack thereof) between these pleurocerid species and associated habitats.

Xin, **P.**, The University of Queensland, Brisbane, Australia, p.xin@uq.edu.au
Yuan, L. R., The University of Sun Yat-Sen, Guangzhou, China, l.yuan@uq.edu.au
Li, L., The University of Queensland, Brisbane, Australia, l.li@uq.edu.au

TIDALLY DRIVEN MULTI-SCALE GROUNDWATER FLOWS IN SALT MARSHES

Located at the land-ocean interface, salt marshes are complex hydrological systems characterised by strong, dynamic interactions between coastal surface and ground water, driven by tides. During the rising tide, surface water infiltrates the marsh soils as the marsh platform gets inundated. When the tide recedes, the exchanged water together with the nutrient sourced from the marsh soils seeps out to the surface water and subsequently produces an input to the coastal sea

(nutrient outwelling). The main purpose of this study was to examine such tidally driven flow and transport processes at vari-ous scales. The simulation results of multi-scale flows and the associated particle trace and water exchange in the salt marsh will be discussed here in details. We will also discuss the implications of the modelling results for the determination of submarine groundwater discharge and associated chemical input to coastal seas at coastlines that include wetland systems such as salt marshes.

Yates, **A**. **G**., Environment Canada, Burlington, Canada, adam.yates@ec.gc.ca
Culp, J. M., Environment Canada, Canadian Rivers Institute, University of New Brunswick, Fredericton, Canada, joseph.culp@ec.gc.ca

STRENGTHS AND WEAKNESSES OF DATA SOURCES FOR GENERATING DETAILED DESCRIPTIONS OF AQUATIC ECOSYSTEM EXPOSURE TO HUMAN ACTIVITY

Over the last decade numerous studies have identified correlative relationships between aquatic biota and human activities occurring at the landscape scale. In addition to definitively demonstrating the pervasive effects of these activities on aquatic biota, these findings have encouraged researchers to suggest that predictive relationships between human activities and aquatic biota could be used to enhance diagnostic power of biological assessments, predict future changes in species distributions and inform land use planning. However, in order to maintain the observed growth in predictive power and achieve these important goals, descriptions of human activities will almost certainly need to become more detailed than the simple land-cover classifications currently used. The purpose of this paper is to highlight four sources of human activity data (Census Data, Orthoimages, Windshield Surveys and Existing GIS layers) that can be used to increase the level of detail with which the human environment is described. Strengths and weaknesses of each data source are discussed and methods for adapting these data to the research and management of aquatic systems are described by drawing on experiences from agricultural landscapes of southern Manitoba and Southwestern Ontario, Canada.

Yeardley, R. B., Shaw Environmental Inc., Milford, USA, roger.yeardley@shawgrp.com
Nietch, **C**. **T**., U.S. EPA, ORD, NRMRL, Water Supply Water Resources , Cincinnati, USA, nietch.christopher@epa.gov
Brown, D. S., U.S. EPA, ORD, NRMRL, Water Supply Water Resources, Cincinnati, USA, brown.donald@epa.gov
Taulbee, W. K., Great Lakes Environmental Center, Columbus, USA, ktaulbee@glec.com

AN INTRODUCED SUBSTRATE SAMPLING METHOD FOR SYNOPTIC ASSESSMENT OF STREAM SITES AND MESOCOSMS

An introduced substrate sampling method is being used by USEPA's National Risk Management Lab to assess material fluxes and biotic conditions in streams draining Ohio's East Fork Watershed. These gravel-filled trays are used for normalizing sampling conditions across stream sites and mesocosms. Tray-specific parameters including invertebrate and periphyton structure, intergravel nutrients, C, N, P, CPOM, FPOM, and size-specific sediment accumulation, can be studied among sites, through time, or in relation to watershed properties for real streams or experimental treatments imposed on mesocosms. Comparison of synoptic results quantifies realism for the experiments and qualifies cause/effects in the field. The method was evaluated for cross-project application by simultaneously assessing invertebrate structure using the more standard Hess Sampler during 12 monthly outings. The two methods were not entirely equivalent, but the gravel-tray gave comparable results for many invertebrate metrics and one index (FBI). Invertebrates in the gravel tray appeared unaffected by deployment time and season sampled. The method continues to serve as a standard means of stream monitoring and determining the application and scalability of mesocosm data.

Ylla , **I**., University of Girona, Girona, Spain, irene.ylla@udg.edu
Romaní , A. M., University of Girona, Girona, Spain, anna.romani@udg.edu
Sabater, S., University of Girona, Girona, Spain, sergi.sabater@udg.edu

DEGRADATION CAPACITY OF DISSOLVED ORGANIC CARBON BY BIOFILMS UNDER DIFFERENT WATER TEMPERATURES

DOC inputs to Mediterranean stream catchments change from high quality DOC in periods of high primary production to recalcitrant DOC accumulated during summer drought. Climate change may drive shifts in DOC quality and concentration. A laboratory experiment mimicking the potential changes was performed considering two extreme DOC qualities (labile and recalcitrant) and two water temperatures (14 and 18ºC). We aimed to determine how the predicted temperature increase in Mediterranean streams may affect DOC biofilm degradation capacity, as well as the effects of these two factors (temperature and DOC) on the biofilm structure and function. Changes on the biofilm structure (algal and bacterial biomass) and function (extracellular enzymes, metabolism) and DOC quality (absorbance scans, fluorescence index) were analyzed. High enzyme activities (peptidase and β-glucosidase) and respiration rates were obtained under upper temperature treatments. Live bacterial cells peaked when labile DOC was available, and higher algal biomass occurred in recalcitrant treatments. Fluorescence index and DOC scans indicate differences in DOC degradation capacities between the treatments. Overall, DOC quality and temperature shaped the biofilm structure and function modulating its own DOC degradation capacity.

Yoshimura, **C**., Tokyo Institute of Technology, Tokyo, Japan, yoshimura.c.aa@m.titech.ac.jp
Iwata, Y., Gifu University, , Japan,
Hashimoto, Y., Mie University, , Japan,
Hiradate, S., National Institute for Agro-Environmental Sciences, , Japan,

RESERVOIR EFFECTS ON PARTICULATE ORGANIC MATTER AND ASSOCIATED METAL TRANSPORTS IN RIVERS

In aquatic ecosystems, organic substances play an important role in metal transport. The present study aimed to understand the reservoir effects on metal transport mediated by particulate organic matter (POM) in rivers. In December 2008, we collected water samples at 18 sites along the Ibi and Nagara rivers in Central Japan. The Ibi River has four large dams along its main stem whereas the Nagara River does not have any large dams. Along the Ibi River, POM showed substantial modifications in their chemical structure after passing through the dams. Carbon stable isotope analysis and solid-state ^{13}C NMR spectroscopy revealed that reservoirs increased the proportion of terrestrially derived POM, which is characterized by a high aromatic content. A sequential extraction analysis showed that the fraction of metals (Fe, Al, Mn, and Zn) associated with POM was greater in the Ibi River (with dams) than in Nagara River (without dams). The results imply that metal leaching in reservoirs is closely related to POM decomposition processes, and thus the reservoir effect on metal transport depends on POM dynamics.

Young, **B**. **A**., Griffith University, Brisbane, Australia, b.young@griffith.edu.au
Sheldon, F., Griffith University, Brisbane, Australia, f.sheldon@griffith.edu.au
Schmidt, D., Griffith University, Brisbane, Australia, d.schmidt@griffith.edu.au

HOW FAR CAN YOU FLY? MEASURING DISPERSAL OF MAYFLIES IN HEADWATER STREAMS USING GENETIC MARKERS

Although the effects of logging on macroinvertebrate communities have been well studied, little research has considered the impacts of selective harvesting on adult stream insects. The removal of vegetation by harvesting can create more open forest, thus fragmenting and degrading habitat used by adult macroinvertebrates to complete life cycles and disperse between streams. Microclimate conditions, particularly air temperature and humidity, can be more severe in these open forest areas, and may exceed tolerance limits of adult macroinvertebrates. Dispersal by winged adult stages may enable stream-dwelling insects to circumvent terrestrial barriers between adjacent freshwater habitats. The lack of movement of adults between habitats caused by harvesting may have important consequences for population dynamics and inter-population gene-flow. I will present initial results from the population genetics analysis of the mayfly Leptophlebiidae located in catchments of dry sclerophyll forest in northern New South Wales, Australia.

Yousef, **F**., Michigan Technological University, Houghton, MI, USA, fyousef@mtu.edu
Kerfoot, W. C., Michigan Technological University, Houghton, MI, USA, wkerfoot@mtu.edu
Green, S. A., Michigan Technological University, Houghton, MI, USA, sgreen@mtu.edu

REMOTE SENSING CAPTURES WINTER BLOOM COLLAPSE

The so called "doughnut ring" in the southern basin of Lake Michigan is a late winter algal bloom. These blooms provide resources for overwintering

zooplankton populations. Remote sensing imagery in combination with sea-truth water quality and optical parameters was used to characterize this phenomenon. From 2001 to 2008, we observed a dramatic shift in water parameters. Water transparency increased from 74-85% in 2001 to 94-96% in 2008, and Chl-a concentrations declined from 1.1-2.6 µg/L in 2001 to 0.4-1.5 µg/L by 2008. Invasive quagga mussels (*Dressenia rostiformis bugensis*)were one of the main drivers exploiting the late winter bloom. Changes were quantified using Sea-viewing wide field-of-view (SeaWiFS) images, collected between 1998 and 2009, and CTD shipboard measurements. Veliger larvae exploited the late winter phytoplankton bloom, whereas attached adults filtered the overlying water column. The observed reduction of Chl-a was greatest around the edges of the "doughnut", where more water was filtered. Severe reduction of late winter phytoplankton poses a serious threat to open water food webs.

Yuan, **L**. **L**., U.S. Environmental Protection Agency, Washington DC, USA, yuan.lester@epa.gov

Pollard, A. I., U.S. Environmental Protection Agency, Washington DC, USA, pollard.amina@epa.gov

USING PROPENSITY SCORES TO ESTIMATE THE EFFECTS OF TEMPERATURE ON THE DISTRIBUTION OF STREAM INVERTEBRATES

We use propensity score analysis to control for covarying factors and to estimate relationships between the capture probability of benthic invertebrates and stream temperature. Propensity scores identify groups of samples in which the distributions of different factors that covary with temperature are similar. Thus, within each group, estimated effects of temperature on invertebrate capture probabilities can be more confidently attributed to causal relationships. We scale relationships estimated from different strata so that they can be graphically assessed for consistency across strata. Because of variations in how congeneric species respond to temperature and other factors, responses to temperature estimated for particular genera from simple regression models may not be accurate. The propensity score analysis described here provides a means of identifying these taxa. We use the results of the propensity score analysis to screen genera used to infer temperature at a single site with 13 years of paired temperature and macroinvertebrate data. Excluding genera that did not respond consistently or significantly to temperature improved the degree to which temperature inferred from the biological data accounted for variability in the observed temperature.

Yule, **C**. **M**., Monash University, Kuala Lumpur, Malaysia, Catherine.yule@sci.monash.edu.my

Raymond, M. L., Monash University, Kuala Lumpur, Malaysia, mlray1@student.monash.edu

Jinggut, T., Monash University, Kuala Lumpur, Malaysia, tajang_@hotmail.com

HUMAN DISTURBANCE OF ECOSYSTEM FUNCTION IN MALAYSIAN STREAMS: THE INFLUENCE OF LOGGING, SHIFTING AGRICULTURE AND URBANIZATION ON LEAF LITTER BREAKDOWN

Shredder diversity and/or biomass were high and shredders exhibited a significant role in leaf breakdown in pristine forested Malaysian streams. Typical shredders included cockroaches, elmids, eulichadids, stoneflies, lepidostomatids, calamoceratids, and tipulids with crabs and (regionally abundant) large snails (*Brotia* spp.) in Peninsular Malaysia but isopods in Borneo. Urbanization of a Kuala Lumpur stream had a dramatic effect on ecosystem function. At urban sites the stream flowed in a concrete channel with little riparian vegetation and became increasingly polluted with runoff from roads, houses and a golf course causing elevated nutrients, higher temperatures, decreased oxygen and altered microbial communities. Only 1km downstream from a pristine forest site, shredders had been eliminated (along with predators and scrapers) and leaf breakdown was mediated entirely by microbes. In Borneo, traditional slash and burn farming practices had minimal impact on stream ecosystem function in comparison with modern mechanized deforestation which adversely affected shredder communities and leaf breakdown. The farmed streams differed slightly from pristine streams in terms of shredder taxa present, but were similar in terms of shredder abundance, species richness and leaf decomposition rates.

Zalack, **J**. **T**., Michigan State Universtiy, East Lansing, USA, zalackja@msu.edu

Wolin, J. A., Cleveland State University, Cleaveland, USA, j.wolin@csuohio.edu

Stevenson, R. J., Michigan State Universtiy, East Lansing, USA, rjstev@msu.edu

DEVELOPMENT, TESTING, AND IMPLEMENTING A METHOD FOR THE ASSESSMENT OF DIATOM BIODIVERSITY FOR THE NATIONAL LAKES ASSESSMENT.

One goal of the USEPA's National Lakes Assessment was to assess human effects on biodiversity. Multimetric indices of biological condition have been widely used in streams and wetlands to characterize the deviation in biodiversity from the management goal, i.e. "minimally disturbed by human activities," but such indices are rarely used in lakes. Therefore, a multimetric index of biological condition was developed for lakes using the taxonomic composition of diatoms in surface sediments. Approximately 100 candidate metrics were tested and those that most precisely distinguished between reference and impaired lakes were selected for inclusion in the lake diatom condition index (LDCI). Ten metrics were selected for the LDCI, for example percent of taxa characteristic of reference condition, number of taxa, % chain forming, percent of low P indicators and percent Cyclotella and Stephanodiscus. Benchmarks for good, fair, and poor condition of diatom biological condition were related to deviations from expected minimally disturbed condition to account for natural variation in lake type. The LDCI showed 47% of US lakes in good condition, 27% in fair condition, and 23% in poor condition.

Zamor, **R**. **M**., University of Oklahoma Biological Station, Kingston, Ok, USA, fraggle145@gmail.com

Glenn, K. L., University of Oklahoma Biological Station, Kingston, Ok, USA, klooper@ou.edu

Easton, J. D., University of Oklahoma Biological Station, Kingston, Ok, USA, Jeaston@ou.edu

Easton, A. C., University of Oklahoma Biological Station, Kingston, Ok, USA, anne@ou.edu

Hambright, K. D., University of Oklahoma Biological Station, Kingston, Ok, USA, dhambright@ou.edu

SEASONAL AND SPATIAL PATTERNS IN PRYMNESIUM PARVUM IN SUBTROPICAL WATERSHEDS AS REVEALED BY QPCR AND PREDICTED BY ENVIRONMENTAL VARIABILITY

In summer 2007, we began monitoring invasive toxigenic Prymnesium parvum in Lake Texoma (an impoundment of the Red River, OK-TX) using quantitative real-time PCR and standard microscopy. Both methods revealed similar seasonal and spatial dynamics in the lake ($r2=0.84$, $P<0.001$). Based on single winter samples of P. parvum and various environmental parameters (e.g., nutrients and conductivity) from 70 sites within the Red River watershed a stepwise discriminant function analysis based on conductivity, chlorophyll, and total nitrogen correctly classified 87.1% of the sites where P. parvum was detected. We then applied this model to the adjacent Canadian River watershed (26 sites) during spring of 2009 in effort to identify sites that may be environmentally conducive to P. parvum invasion. The model correctly classified the single known P. parvum site and identified multiple possible sites that should be monitored for future blooms.

Zandonà, **E**., Drexel University, Philadelphia, USA, ez34@drexel.edu

Auer, S. K., University of California-Riverside, Riverside, USA, sonya.auer@gmail.com

Kilham, S. S., Drexel University, Philadelphia, USA, kilhams@drexel.edu

Howard, J. L., Drexel University, Philadelphia, USA, jason.le.howard@gmail.com

Pringle, C. M., University of Georgia, Athens, USA, cpringle@uga.edu

Reznick, D. N., University of California-Riverside, Riverside, USA, gupy@ucr.edu

THE ROLE OF DIET AND RESOURCE AVAILABILITY IN THE LIFE HISTORY EVOLUTION OF TRINIDADIAN GUPPIES (*POECILIA RETICULATA*)

Guppy populations from high- (HP) and low-predation (LP) streams exhibit marked differences in their life-history traits. These differences have been attributed to direct and indirect effects of predation, which influence mortality rate, but also the structure and density of guppy populations and thereby the per capita resource availability. Specifically, resource levels could affect prey selectivity, which could lead to changes in life-history traits. We examine differences in guppy diet among stream types and how they relate to gut length and benthic invertebrate biomass. Fish and invertebrate samples were collected from two HP and two LP reaches of two distinct study rivers in Trinidad. MANOVA showed that HP guppies ate significantly more invertebrates than LP guppies, which instead fed more on algae and detritus. In one river, LP guppies had significantly longer guts ($p<0.01$) than HP guppies. No strong correlation was found between invertebrate biomass in the environment and invertebrates in guppy guts ($r^2=0.087$), suggesting that diet differences are caused by evolved differences in diet preferences. As predators shape life histories, they also shaped the evolution of other guppy attributes.

Zarnetske, **J**. **P**., Oregon State University, Corvallis, USA, zarnetsj@geo.oregonstate.edu

Haggerty, R. D., Oregon State University, Corvallis, USA, haggertr@geo.oregonstate.edu

Wondzell, S. M., Pacific Northwest Research Station, Olympia Forestry Sciences Lab, Olympia, USA, swondzell@fs.fed.us

Baker, M. A., Utah State University, Logan, USA, mbaker@biology.usu.edu

DYNAMICS OF NITRATE PRODUCTION AND REMOVAL AS A FUNCTION OF RESIDENCE TIME IN THE HYPORHEIC ZONE: A 15N TRACER STUDY

We examined residence time controls on hyporheic (HZ) nitrification and denitrification in an upland agricultural stream with a whole-stream steady-state 15NO3- and conservative tracer (Cl-) addition experiment. We measured relevant solute, 15N isotope, and hydraulic transport conditions of the reach and along HZ flowpaths of an instrumented gravel bar. HZ exchange was observed across the entire gravel bar with flowpath lengths up to 4.2m and corresponding median residence times greater than 28.5h. The HZ transitioned from a net nitrification environment at its head (residence times, <6.9h) to a net denitrification environment at its tail (residence times, 6.9-28.5h). 15NO3- tracing confirmed that a fraction of the NO3- removal was via denitrification as 15N2 was produced across the entire gravel bar HZ. Production of 15N2 across all observed flowpaths and residence times indicated that denitrification microsites are present even where net nitrification occurred. These findings demonstrate that: 1. the HZ is an active nitrogen sink in this system, and 2. the distinction between net nitrification and denitrification in the HZ is a function of residence time and exhibits threshold behavior.

Zhang, **T**., Michigan State University, East Lansing, USA, tz@msu.edu

QUANTIFYING THE DISTANCE-DECAY PATTERN OF NUTRIENT LOADING AT THE WATERSHED SCALE: INTEGRATING SPATIALLY-EXPLICIT MODELING WITH EMPIRICAL MODELING

Past studies examining nutrient export to surface waters have typically used either detailed spatially-explicit modeling or empirical regression modeling to simulate nutrient distance-decay patterns. However, few studies have integrated the two approaches in a single study. My goal in this study was to better quantify the role of distance on non-point source nutrient loads in rivers by developing regression models using simulation results of a spatially-explicit model applied to the watersheds in the Upper Chattahoochee River Basin, Georgia. I found that the nutrient contribution from a unit area decays exponentially as the flow distance to the river networks increases. But the decay rate for forest and agricultural land is higher than that for urban land. I also found that nutrient contribution from areas that were greater than 300 meters to the river networks was negligible. The model validation showed that the three non-linear regression models can estimate the nutrient loads well. This study illustrates the advantages of using comprehensive spatially-explicit models to design and configure simpler regression models for improving our understanding of nutrient export from land to water.

Zhang, **Y**., Texas State University, San Marcos, USA, yz11@txstate.edu

Cooper, S. D., University of California, Santa Barbara, USA, scooper@lifesci.ucsb.edu

Englund, G., Umeå University, Umeå , Sweden, Goran.Englund@emg.umu.se

STATE-DEPENDENT EMERGENT PREDATION EFFECTS: TRADE-OFFS IN RISK REDUCTION AND RISK ENHANCEMENT

The effects of multiple predators on prey are influenced by the predators' energetic state and by positive and negative effects of different predators on each other's consumption rates. We examined predation by two larval dragonflies, including a sit-and-wait predator (*Cordulegaster*) and a more actively searching predator (*Paltothemis*), on a larval mayfly (*Tricorythodes*) to test the hypothesis that emergent effects of multiple predators vary with their energetic condition. Starved predators when together consumed more mayfly prey than predicted by a multiplicative risk model; however, the two predators together under non-starvation conditions ate less prey than predicted by the model. By combining de-hooked predator species with unmodified predator species, we separated the consumptive and behavioral effects of predators on their predation rates. When predators were not starved, the risk of predation for prey was lowered by interference between the two predator species; however, starved predators in combination facilitated prey consumption. These results provided mechanisms to explain observed patterns in risk reduction and risk enhancement. This study revealed that changes at energetic states of multiple predators led to different effects on prey populations.

Zheng, **L**., Tetra Tech, Inc, Owings Mills, USA, lei.zheng@tetratech.com

Suter II, G. W., EPA, CINCINNATI, USA, suter.glenn@epa.gov

Yuan, L. L., EPA, Washington, D.C., USA, Yuan.Lester@epamail.epa.gov

Cormier, S., EPA, CINCINNATI, USA, Cormier.Susan@epamail.epa.gov

DEVELOPING BENCHMARKS FOR POLLUTANTS USING FIELD-DERIVED SPECIES SENSITIVITY DISTRIBUTIONS

The standard method for developing water quality criteria in the United States uses the 5th percentile of affected species based on laboratory toxicity tests of at least eight genera. However, observations from field studies include the full range of conditions, effects, species, and interactions that occur in the environment. Therefore distributions of responses of genera were derived using field monitoring data. The endpoint for each genus was the stressor concentration that we defined as effectively extirpating the genus from streams. Hence, the benchmark is the concentration that protects 95% of species from extirpation. However because these relationships are estimated from observational data, the degree to which the estimated relationships between stressor and biological responses reflect causal relationships must be assessed. Any variables that are correlated with the stressor or the biotic response may confound the relationship of biota to conductivity. Nevertheless, this eco-epidemiological method provides a useful complement to controlled laboratory experiments.

Ziegler, **C**. **R**., US EPA, Washington DC, USA, ziegler.rick@epa.gov

Webb, J. A., eWater CRC & Department of Resource Management and Geography, The University of Melbourne, Melbourne, Australia, angus.webb@unimelb.edu.au

TOWARD AN INTERNATIONAL ECOLOGICAL EVIDENCE DATABASE

Effective environmental management and decision making require synthesis of evidence from scientific studies. Independent research in U.S., Australia, and Europe has produced synthesis methods and three similar evidence databases to fill this need. The databases (1) jointly contain information extracted from roughly 1,000 scientific studies, (2) focus primarily on stream ecology causal associations and related data, but could be extended to other disciplines, (3) are populated by reading studies and hand-entering information, which is time consuming, and (4) could be interconnected and further populated by others. In October 2009, the U.S. EPA convened an international meeting to brainstorm database connectivity, information standardization, self-sustainability through on-line peer-production, and business models for stewarding this global effort. The proposed effort could readily provide scientific information for various analyses, such as causal assessment, thereby bridging the gap between decision making and science. Other significant issues related to this effort include: origins of the three existing programs, characteristics and benefits of the proposed interconnected database, recent activity, and next steps.

Ziegler, **S**. **E**., Memorial University of Newfoundland, St. John's, Canada, sziegler@mun.ca

Bonnell, E. J., Memorial University of Newfoundland, St. John's, Canada, jbonnell@mun.ca

Lane, C. S., Memorial University of Newfoundland, St. John's, Canada, chad.lane@mun.ca

BOREAL STREAM DISSOLVED ORGANIC MATTER COMPOSITION AMONG CONTRASTING SUBCATCHMENTS IN A LARGE NEWFOUNDLAND WATERSHED

We present chemical composition results for dissolved organic matter (DOM) collected from headwater stream sites within five subcatchments representing those dominated by wetland, deciduous or coniferous forest cover in the Humber River watershed. DOM was analyzed using CPMAS 13C-NMR spectroscopy, elemental, stable isotopic, spectrophotometric and fluorometric measures. To link terrestrial sources with DOM, chemical characterization was also preformed on litter, soil horizons, and their leachates. Proportionally less aliphatic and more carbohydrate C was detected in the most peatland influenced stream, whereas all other streams exhibited similar proportions of functional group C as determined via 13C-NMR. Proportional decreases in carbohydrate and aromatic C and increases in aliphatic C were observed between upstream and downstream sites in all streams congruent with decreases in carbohydrate concentration, UV absorbance, and DOM bioavailability. Results suggest DOM composition varies less among streams and more within streams due to variation in in-stream processes and source including proximity to small ponds and wetlands. Further, downstream trends suggest loss of labile DOM and greater retention or input of soil C in downstream reaches in this watershed.

Zou, X., Biodiversity Institute of Ontario, University of Guelph, Guelph, Ontario N1G 2W1, Canada, xinzhou@uoguelph.ca

Chuluunbat, S., Mongolian Aquatic Insect Survey, Biology Laboratory, Institute of Meteorology and Hydrology, Ulaanbaatar, Mongolia, suvdaa314@yahoo.com

Morse, **J. C**., Clemson University, Clemson, SC 29634-0315, USA, jmorse@clemson.edu

DNA BARCODING OF THE CADDISFLIES (INSECTA: TRICHOPTERA) OF MONGOLIA

The caddisfly fauna of Mongolia has been intensively investigated through a series of biotic surveys from 2003-2008. Representative specimens of this now-well-documented fauna obtained from these collecting expeditions were analyzed for the DNA barcode region of the mitochondrial cytochrome c oxidase 1 gene (COI). A total of 467 COI sequences were collected from 95 caddisfly species, including 13 families and 41 genera. This barcode reference library covers 57% of the 168 known species from Mongolia, making this the top country with regard to the percentage of barcoded caddisfly species. In all but 4 caddisfly species, DNA barcode results were highly concordant with morphological species delineation, where COI sequences obtained from conspecific individuals formed reciprocal clusters on the Neighbor-Joining tree. Overall, DNA barcodes were able to distinguish 96% of the Mongolian caddisfly species examined in this study. This DNA barcode reference library lays a sound foundation for future species revisions and larval associations for Mongolian caddisflies, which is critical to the development of freshwater biomonitoring programs for the country.

Zurel, **D**., Tel Aviv University, Tel Aviv, Israel, drorzure@post.tau.ac.il

Benayahu, Y., Tel Aviv University, Tel Aviv, Israel, yehudab@tauex.tau.ac.il

Gophna, U., Tel Aviv University, Tel Aviv, Israel, UriGo@tauex.tau.ac.il

INVESTIGATING THE MICROBIOLOGY OF A SUCCESSFUL INVASIVE MARINE OYSTER: GULF OF EILAT VS. THE EASTERN MEDITERRANEAN SEA

The Indo-Pacific oyster *Chama pacifica*, first recorded from the Mediterranean coast in 1993, is one of many species which have invaded the region since the opening of the Suez Canal (1869). This oyster, regarded as a successful invader, has established a substantial population, both in terms of density and size of individuals compared to its Indo-Pacific counterpart. However, aspects regarding the oyster's microbiota, such as its role in the invasion and possible effects on the invaded ecosystem have not been explored. This present study compared the microbial communities of individual *C. pacifica* oysters from Eilat (Red Sea, source of invasion) and Sdot-Yam (Mediterranean Sea, invasion site), using 16s ribosomal DNA clone libraries and Automated Ribosomal Intergenic Spacer Analysis (ARISA). ARISA results revealed significant differences in community structure and seasonal dynamics between the microbial communities harbored by oysters in both regions. Clone libraries revealed possible symbiotic bacteria found in all oysters examined, regardless of origin. Further research is being undertaken in order characterize this symbiosis and its role in the success of this invasion.

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Upcoming ASLO Meetings

2011 Aquatic Sciences Meeting
13 – 18 February 2011
San Juan, Puerto Rico

2012 Ocean Sciences Meeting (with TOS & AGU)
19 – 24 February 2012
Salt Lake City, Utah

2012 Summer Meeting
6 – 13 July 2012
Lake Biwa, Otsu, Japan

2013 Aquatic Sciences Meeting
17 – 22 February 2013
New Orleans, Louisiana

Upcoming NABS Meetings

2011 Annual Meeting
22 – 26 May 2011
Providence, Rhode Island

2012 Annual Meeting
21 – 25 May 2012
Louisville, Kentucky

For more information on the 2010 Joint Meeting with ASLO & NABS,
address all correspondence and questions regarding registration,
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2010 ASLO/NABS Summer Meeting
5400 Bosque Boulevard, Suite 680
Waco, Texas 76710-4446
santafe2010@sgmeet.com E-mail
http://www.aslo.org/santafe2010 Web
800-929-ASLO (Within the U.S., Canada, and the Caribbean), 254-399-9635 (All other countries) Phone
254-776-3767 Fax