ABSTRACTS

# NEW VIEWS NEW TOOLS

# IAGLR

## 58th Annual Conference on Great Lakes Research

## Burlington, Vermont

## MAY 25-29, 2015

at the University of Vermont

International Association for Great Lakes Research

# ABSTRACTS

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# ABSTRACTS

*An alphabetical listing of abstracts presented at the 58th Annual Conference on Great Lakes Research, organized by first author. Presenters are underlined.*

## A

ABEBE, F.[1], RIOS MENDOZA, L.M.[1], and DUHAIME, M.B.[2], [1]University of Wisconsin Superior, Belknap and Catlin, Superior, WI, 54880; [2]University of Michigan, Kraus Natural Sciences, N. University, Ann Arbor, MI, 48109. **Persistent Organic Pollutants on Microplastic Debris from Great Lakes.**

Microplastic pollution is becoming a fast growing problem in our environment. Our society is highly dependent on plastic products; from large industrial goods to the smallest plastic bags one gets from the stores, can all be potential hazards to the environment if they are not disposed properly. These products are not being recycled properly and they are polluting different water bodies and also other natural environments. Microplastic pollution can be highly catastrophic to the aquatic organisms because of the known potential to adsorb persistent organic pollutants, POPs, which can affect the human race. The problem is not being emphasized as it should be compared to its disastrous impact. The objective of this research is to provide an assessment of the pollution caused by microplastic debris in the Great Lakes waters by adsorption of toxic compounds. The preliminary results presented are from 44 samples from surface water (33 samples) and sediments (11 samples) collected from May to August, 2014. The plastic debris collected was classified by color, size, and chemical composition of the synthetic polymer. *Keywords: Microplastics, POPs, PCBs, Freshwater, PAHs.*

ALAKAYAK, W.M.[1], SOKOL, E.C.[2], and URBAN, N.R.[2], [1]Keweenaw Bay Ojibwa Community College, 111 Beartown Rd., Baraga, MI, 49908; [2]Michigan Technological University, 1400 Townsend Dr., Houghton, MI, 49931. **Lake Characteristics that Affect Biomagnification of Mercury in Michigan's Upper Peninsula.**

Food webs in the Lake Superior watershed are impacted by the atmospheric deposition of mercury. Torch Lake, an inland lake connected to Lake Superior suffers from high concentrations of mercury leading to fish consumption advisories that affect members of the Keweenaw Bay Indian Community who use it as a traditional spear fishing site. This poster examines factors that influence the bioaccumulation of mercury in lake food webs; we focus here on fish community as a surrogate for food web structure. Using existing data for multiple lakes in the western Upper Peninsula, we developed an empirical relationship between lake characteristics and lake fish communities. We measured biological components of Torch Lake and compared these to the empirical model to test its ability to predict fish communities in lakes for which the model was not calibrated. This is one step towards building a model that can help predict mercury concentrations in other settings. As numerous lakes across the region have similar problems with mercury contamination, our findings will help local residents determine how much fish can be consumed safely. *Keywords: Mercury, Bioaccumulation, Food chains.*

ALARCON, M.A. and MAIGRET, J., Taubman College of Architecture & Urban Planning, University of Michigan, Ann Arbor, MI. **Visualizing the Dynamic Shorelines of the Great Lakes.**

The shoreline landscapes of the Great Lakes are dynamic natural systems and an important part of the culture, economy, and ecology of the coastal communities in the region. Yet our desire to inhabit the shore also yields conflict between the built environment and the physical realities of coastal dynamics. The conservation, enjoyment and development of the shoreline over time have triggered a series of planning efforts aimed to sustainably manage these resources. This talk integrates research informed by urban planning, coastal engineering, landscape architecture and law through the use of visualization techniques. The project employs computational analysis, spatial modeling and graphic visualization techniques to enhance our understanding of the complex dynamics of Great Lakes shorelines. Through the selection of specific coastal sites, the work explores different techniques of visualization to gain knowledge of a physical and ecological system that fluctuates over space and time, and question current regulatory mechanisms defining water levels and development. These digital technologies sponsor collaborative conversations between urban planners, coastal engineers, state policy makers, architects, land owners, and local public officials to find a common language for making informed shoreland management decisions. *Keywords: Coastal engineering, Urban watersheds.*

ALBERT, D.A.[1] and SCHOLTENS, B.[2], [1]Oregon State University, 4017 Agriculture and Life Sciences, Corvallis, OR, 97331-7304; [2]College of Charlston, 66 George St., Charleston, SC, 29424. **Thirty Five Years of Great Lakes Marsh Vegetation Sampling: Cecil Bay, Michigan.**

Vegetation was systematically sampled along a 200 m long transect in Cecil Bay in northern Lake Michigan annually from 1971 through 2005, recording the number of stems of each plant species, as well as water depth. Additional, more detailed sediment data was collected adjacent to the transect in 1980 and along a nearby transect during the post 2000 low water conditions, allowing establishment of further correlations of vegetation to sediment characteristics. Plant diversity along the transect ranged from 10 in a high-water year to 113 in a low-water years. Analysis provides insights into stability of the primary vegetation zones (wet meadow and emergent), lagged seed bank response to water level fluctuations, and the dynamics of invasive plants to characteristic Great Lakes water level fluctuation. Above- and below-ground biomass characterization of the bulrush species,*Schoenoplectus pungens* and *S. acutus*, provides further insights into the dynamics of the dominant emergent species of the marsh. *Keywords: Coastal wetlands, Distribution patterns, Water level fluctuations.*

ALEXANDROU, N., HUNG, H., BRICE, K., SU, K., PARK, R., NORONHA, R., SHIN, C., ROSEN, J., BRODIE, S., LANIGAN, N., PAJDA, A., JEBB, K., RICKERT, D., and RANA, A., Air Quality Processes Research Section, Environment Canada, 4905 Dufferin Street, Toronto, ON, M3H 5T4. **Air Concentrations of Alternative Flame Retardants and PBDEs in the Canadian Great Lakes Basin.**

The occurrence of polybrominated diphenyl ethers (PBDEs) and other flame retardants (FRs) in air is of concern due to the suspected toxicity of these compounds. Once deposited from the air to the Great Lakes, they may accumulate through the foodchain, impacting the health of wildlife and humans. Ambient air samples were collected from two sites in the Canadian Great Lakes Basin (GLB). Sampling methods involved the collection of particulate phase and vapour phase semi-volatile organic pollutants from approximately 400 m3 of air. The air concentration data for FRs were determined in air samples collected from 2009-2013 at both sites. Hexabromobenzene (HBB), allyl 2,4,6-tribromophenyl ether (ATE), anti- and syn- dechlorane plus (anti-DP and syn-DP) dominated the profile at both sites with levels lower than PBDEs. Similar to the PBDEs, measurements of FRs indicate a strong seasonality with higher concentrations in the summer months. For example, in the 2011 sampling year, anti-DP and syn-DP reached maximum values of 32.7 pg/m3 and 50.7

pg/m3 respectively on June 8. Furthermore, gas-particle partitioning was observed with the lower molecular weight FRs mostly in the vapour phase and the heavier FRs mainly in the particle phase. Air concentration data for some PBDEs collected at Point Petre, Ontario show decreasing trends. *Keywords: PBDEs, Alternative flame retardants.*

ALFORD, L.K.[1], READ, J.G.[2], COTEL, A.[1], VACCARO, L.E.[2], BENNION, D.[3], and FISCHER, J.L.[3], [1]University of Michigan, Ann Arbor, MI, 48109; [2]University of Michigan Water Center, 214 S. State St., Ste. 200, Ann Arbor, MI, 48109; [3]USGS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105. **Evaluation of Artificial Spawning Reef Design Using Computational Fluid Dynamics (CFD).**

Over the past 15 years, a multi-agency team of scientists has been working to study and restore fish spawning habitat in the St. Clair-Detroit River System using an adaptive management (AM) approach. Through years of ecological research and 3 experimental spawning reef projects, the team has learned to site and construct habitat that attracts the desired fish species and successful spawning has been documented. However, some sections of completed reef projects are becoming covered in sediment, diminishing their long-term value as fish habitat. Hence, the team has begun using a variety of hydrodynamic modeling techniques to study completed projects, evaluate future reef locations, and test different reef designs for feasibility and performance prior to installation. Hydrodynamic models are especially important for developing restoration plans for new and often challenging locations, such as several under consideration in the Detroit River. Computer simulation can provide quick, virtual testing of many different reef designs, and the most promising designs can then be tested using a physical model leading to improved performance of the reefs. This presentation will describe the method used to create 3D models of proposed sites and the use of Computational Fluid Dynamics (CFD) to evaluate potential reef designs. *Keywords: Remediation, CFD, Detroit River, Hydrodynamics.*

ALLEN, I.W. and DELAVAN, S.K., SUNY University at Buffalo, Buffalo, NY, 14260. **Hydrodynamic Modeling of the Upper Niagara River to Assess Aquatic Connectivity.**

Physical modifications to the upper Niagara River attributed to dredging and land reclamation have reduced aquatic habitat and presumably lead to decreased aquatic connectivity between the Niagara River and Lake Erie. The emerald shiner (*Notropis atherinoides*), a pelagic minnow with key ecological and economic value, is one species thought to be adversely affected. In this study, two-dimensional hydrodynamic modeling was used to assess aquatic connectivity in relation to requirements for emerald shiner passage. Simulations of depth-averaged velocity were conducted for scenarios pertaining to various water levels in the river. Results indicated that amongst the scenarios, changes in the velocity profiles were minimal. To evaluate aquatic connectivity, two-dimensional velocity profiles were compared to the reported swimming capability of the emerald shiner. Large velocity magnitudes in the center of the river, particularly immediately downstream of the Lake Erie outlet, point to little opportunity for shiner movement. Near shore areas offer narrow pathways for upstream shiner movement, but passage in these areas may also be affected by excessive turbulence levels stemming from the complex hydrodynamic characteristics of the river. Results suggest remediation work may be necessary to help facilitate shiner passage. *Keywords: Niagara River, Hydrodynamic model, Fish populations.*

ALLIS, J.T.[1], CALAPPI, T.J.[1], TAURIAINEN, E.C.[1], SU, T.Y.[1], and THOMPSON, A.F.[2], [1]U.S. Army Corps of Engineers, 477 Michigan Ave., Detroit, MI, 48226; [2]Environment Canada, 867 Lakeshore Road, Burlington, ON, L7S 1A1. **Great Lakes Connecting Channels and Diversions, and their impact on the Great Lakes Water Budget.**

The St. Mary's, St. Clair, Detroit, and Niagara Rivers form the connecting channels that link each of the Great Lakes together. Monitoring the flow through these channels as well as the International Section of the St. Lawrence River and understanding how the channels change over time is important to understanding the overall water budget for each of the Laurentian Great Lakes. There are also several diversions of water into and out of the Great Lakes which are important to understand in context with the other components of the water budget. The U.S. Army Corps of Engineers (USACE) has been responsible for measuring and calculating flow through the connecting channels and monitoring for changing conditions for almost 150 years. Environment Canada, the Canadian Department of Fisheries and Oceans, the United States Geological Survey, and the National Oceanic and Atmospheric Administration also contribute to the collection of data and establishment of methods critical for monitoring flow through the connecting channels. This presentation will discuss methods for calculating flow through the connecting channels, methods for monitoring for changes in the channels themselves, an overview of diversions and how this all fits together to explain the water budget for each of the Great Lakes. *Keywords: Data acquisition, Flow, Monitoring, Connecting channels, Detroit River, Diversions.*

ALMEIDA, L.Z., GUFFEY, S.C., SEPÚLVEDA, M.S., and HÖÖK, T.O., Forestry and Natural Resources, Purdue University, 195 Marsteller St, West Lafayette, IN, 47907. **The**

**effects of hypoxia on yellow perch (Perca flavescens) foraging behavior and physiology.**

Hypolimnetic hypoxia caused by anthropogenic nutrient loading has the potential to disrupt food webs by decreasing access to benthic prey. However, in some systems such as Lake Erie, yellow perch (*Perca flavescens*) may have developed an adaptive behavior in response, in which they dive into the hypoxic zone to forage on benthic prey. To examine if yellow perch will inherently forage in hypoxic zones and to evaluate the mechanism and physiological effects of such behavior, we conducted three laboratory experiments on two strains of yellow perch. The first investigated if yellow perch were willing to leave a normoxic environment to feed in hypoxic waters. The second assessed the effects of acute hypoxia exposure on yellow perch hemoglobin concentration and expression of genes that mediate the physiological response to hypoxia (e.g., *hif-1a*). The third investigated the effects of chronic hypoxia exposure on yellow perch consumption, growth, hemoglobin concentrations, and gene expression. Preliminary results indicate that hemoglobin concentrations do not respond significantly to hypoxia under either short or long-term exposure. We will interpret these findings through simultaneous consideration of all three experiments and both behavioral and physiological responses. *Keywords: Yellow perch, Hypoxia, Fish behavior, Physiology.*

ALOYSIUS, N.R.[1], MARTIN, J.F.[3], LUDSIN, S.A.[4], and STUMPF, R.P.[2], [1]Dept. of Food, Agricultural Engineering and Aquatic Ecology Laboratory, 590 Woody Hayes Drive, Columbus, OH, 43210; [2]NOAA National Centers for Coastal Ocean Science, Silver Spring, MD, 20910; [3]Dept. Food, Agricultural and Biological Engineering, 590 Woody Hayes Drive, Columbus, OH, 43210; [4]Department of Evolution, Ecology, and Organismal Biology, 1314 Kinnear Road, Columbus, OH, 43212. **Impact of Climate Change on Harmful Algal Blooms in the Western Lake Erie.**

The extent and frequency of Harmful Algal Blooms (HABs) in Lake Erie have increased in the past two decades. Non-point source nutrients from agricultural watersheds and changing climate conditions have been identified as causes exacerbating HABs. Past studies have shown that wet springs followed by dry summers create favorable conditions for harmful algae growth. Climate conditions such as increased spring rainfall and summer droughts have been projected to increase in the future and hypothesized to increase the severity of future HABs. However, quantitative studies that link actual climate models to river discharge and HABs are lacking. Here, we conduct new simulations linking projections from a suite of Global Climate Models, a hydrology model and a predictive model of HABs to examine the anticipated changes in runoff, nutrient loading and the frequency of HABs in Lake Erie. Results include increased frequency of HABs and their areal extent under several climate change scenarios. We further identify climatic scenarios that favor HABs in the future and compare the frequency of these patterns to historical trends. These results highlight the need to accelerate the adoption of management practices to mitigate further degradation of ecosystem services due to climate changes predicted for the coming century. *Keywords: Climate change, Harmful algal blooms, Hydrologic cycle.*

AMINI, K. and KRAATZ, H.B., Department of Physical and Environmental Science, University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A4. **Towards the Development of a Hand-held Tool for the Detection of Pathogen Contamination of Surface W.**

Surface waters have a wide range of applications, from drinking water to recreational and commercial use. And thus, water contamination by pathogenic agents poses significant public health risks. As a result of human fecal pollution, human enteric pathogens, such as Salmonella spp., and Shigella spp. and also enteric viruses like adenoviruses can be found in surface waters. Wastewater from domestic or farm animals also may further contribute to the pathogen contamination of surface waters with E. coli O157:H7, Cryptosporidium spp., etc. The detection of these pathogens in a rapid and precise way is of crucial importance to environmental monitoring. Traditional pathogen detection methods such as cell culturing and polymerase chain reaction require complicated instrumentations and are not suitable for in situ analysis. Therefore development of highly sensitive, fast, low-cost, and easy-to-miniaturize methods for pathogen detection is a needed. Our group has been working on the development of novel electrochemical impedance-based sensors for pathogen detection. This contribution focuses on the use of Toll-Like Receptor (TLR) immunoproteins as the bio-recognition element. The interaction between pathogen-associated molecules and TLRs give rise to a quantifiable signal. The results of our research are discussed in this contribution. *Keywords: Environmental waters, Water quality monitoring, Pathogen contamination.*

AMOS, M.M.[1], PALMER, C.J.[1], STAPANIAN, M.A.[2], LEWIS, T.E.[3], WALTERS, L.[1], BLUME, L.J.[4], and RODRIGUEZ, K.[4], [1]CSC, Alexandria, VA; [2]U.S. Geological Survey, Sandusky, OH; [3]U.S. Army Corps of Engineers, Vicksburg, MS; [4]U.S. EPA Great Lakes National Program Office, Chicago, IL. **Measuring Success for Ecological Restoration Projects.**

An interagency committee on quality assurance/quality control (QA/QC) was formed as part of the Great Lakes Restoration Initiative. The committee provides training in QA/QC procedures for ecorestoration professionals, particularly for projects in the Great Lakes basin. In addition, the committee has developed a guidance document that is a "how-to" manual for (1) selecting and preparing measurement quality objectives and standard operating procedures; (2) training and certifying field crews; (3) evaluating the precision, accuracy, and overall variability of data collected within and among field crews; and (4) data review in ecorestoration projects. The committee has compiled the best practices across several federal agencies to provide a simple, stepwise approach for the development of restoration project goals and objectives, sampling objectives, and quality acceptance criteria for data collection activities. This information then feeds directly into the adaptive management framework. This presentation demonstrates this process and provides real-life examples to illustrate the procedures and principles suggested in the guidance document. *Keywords: Habitats, Ecosystems.*

ANDERSON, E.J.[1], BECHLE, A.J.[2], WU, C.H.[2], MANN, G.E.[3], SCHWAB, D.J.[4], and LOMBARDY, K.[5], [1]NOAA/GLERL, 4840 S. State Rd, Ann Arbor, MI, 48108; [2]University of Wisconsin, 1415 Engineering Drive, Madison, WI, 53706; [3]NOAA/NWS/WFO-Detroit, 9200 White Lake Road, White Lake, MI, 48386; [4]University of Michigan, 625 E. Liberty St., Ann Arbor, MI, 48104; [5]NOAA/NWS/WFO-Cleveland, Federal Facilities Building, Cleveland, OH, 44135. **Detection and Reconstruction of a Meteotsunami on Lake Erie.**

On May 27, 2012, atmospheric conditions gave rise to two mesoscale convective systems from the northwest that traveled across Lake Erie. During this event, the imposing weather conditions generated a series of waves in the meteotsunami band that reflected off of the southern and then northern shorelines, sweeping three swimmers a half mile into the lake, and produced edge waves that traveled along the coast and led to a capsized boat and swamped marina. To investigate these conditions, the meteorology is reconstructed using observations of wind speed and air pressure as well as a high-resolution WRF model. Surface forcing conditions are supplied to a hydrodynamic model of Lake Erie, built on the FVCOM-based Lake Erie Coastal Forecasting System. Results show the importance of wind stress and air pressure in Great Lakes meteotsunami events and illustrate the effects of enclosed basins on wave reflection and retention of wave energy, and in particular the danger associated with the temporal differences between the passing of the convective storm and the arrival of the meteotsunami waves. Although several historical cases have been reclassified as meteotsunamis, this work presents the only recent case of meteotsunami detection and impact to the coastal community. *Keywords: Hydrodynamics, Meteotsunamis, Hydrodynamic model, Lake Erie.*

ANDREWS, R.A., DUFOUR, M.R., MAYER, C.M., and QIAN, S.S., University of Toledo and Department of Environmental Sciences and Lake Erie Center, Toledo, OH, 43606. **Do Lake Erie walleye conform to an ideal free distribution?**

The Ideal Free Distribution (IFD) predicts that organisms in a given habitat will distribute themselves in proportion to prey resources. However, competition from other predators may lessen conformation to IFD. We employed a nighttime hydroacoustic survey in Lake Erie's Sandusky sub-basin to quantify walleye (*Sander vitreus*)-forage fish overlap and influence from smaller predators (*e.g. Morone spp.*) that may act as competitors. Transects were subset into 1 km sections termed elementary distance sampling units (EDSUs). Linear regression of EDSU-specific walleye-forage fish density ratios reveals a slope of 0.81, not significantly different from an IFD slope of 1. To explain differences in EDSU-specific walleye-forage fish density ratios from expected IFD ratios we compared the residual variation against small predator (-33.5 to -36 dB) densities. A significant positive relationship demonstrated that walleye are more abundant relative to prey when other predatory fish are present. This relationship indicates there may be a benefit to foraging in a mixed species group. Quantifying predator-prey overlap can improve demand-supply models with more accurate abundance and biomass estimates and improve understanding of habitat use and seasonal migrations. *Keywords: Hydroacoustics, Fisheries, Distribution patterns.*

ANGRADI, T.R.[1], BOLGRIEN, D.W.[1], and LAUNSPACH, J.[2], [1]United States Environmental Protection Agency, 6201 Congdon Blvd, Duluth, MN, 55804; [2]SRA International (contractor to USEPA), 6201 Congdon Blvd, Duluth, MN, 55804. **Mapping ecosystem services in the St. Louis River Estuary.**

Estuaries of the Great Lakes provide a concentrated supply of ecosystem goods and services from which humans benefit. As long-term centers of human activity, most estuaries of the Great Lakes have a legacy of chemical contamination, degraded habitats, and non-point-source pollution, which reduce the benefits current and future human communities receive from estuary ecosystems. In this paper, we bring a GIS-based ecosystem service mapping approach into the context of local estuary management. We describe an empirical method for examining how local-scale human actions can affect spatial variation in the supply of 26 different ecosystem services from the St. Louis River Estuary of Lake Superior. This service-mapping approach is based on simple, spatially explicit GIS models and other

data sources that allow us to map the spatial distribution of ecosystem goods and services (or their proxies) across the estuary at spatial scales amenable to examining trade offs and fostering deliberation among managers and stakeholders. *Keywords: Estuaries, Ecosystem services, St. Louis River AOC, Decision making.*

ARANDA-RODRIGUEZ, R.[1], JIN, Z.[1], CHERRY, A.[2], YASVINSKI, G.[2], and GIDDINGS, M.[2], [1]EHSRB, Health Canada, 50 Colombine Driveway, Ottawa, ON; [2]WAQB, Health Canada, 69 Laurier Ave, Ottawa, ON. **Canadian Guidelines for Cyanobacterial Toxins in Drinking and Recreational Waters.**

The presence of cyanobacteria and their toxins is of concern in Canada for both drinking and recreational waters. Although Health Canada (HC) has established drinking and recreational water guidelines for microcystins (MC), HC is currently working collaboratively with the US-EPA to evaluate current knowledge regarding health effects, analytical methodologies, and treatment technologies for freshwater toxins in order to update the current drinking water guideline. This presentation will focus on the analytical challenges in the detection of MC for monitoring and regulatory purposes. Although several methods have been published, there is currently no consensus on which method should be used to test for MC. Another challenge is that a limited number of laboratories have accredited methods for MC analysis. As part of the EPA-HC effort, the analytical feasibility of various methods is under review. The Toledo episode highlighted some of the issues around sample preparation (lysis vs. non-lysis) and sample collection strategies (raw vs. treated) that can affect analytical results. This presentation will describe HC's work on the applicability of commercially-available field test kits for the on-site determination (presence-absence) of MC within a water supply and discuss the comparison of some analytical methods. *Keywords: Microcystis, Monitoring, Human health.*

ARIFIN, R.R.[1], DE ALWIS PITTS, D.A.[2], JAMES, S.C.[3], HAMLET, A.F.[1], SHARMA, A.[1], and FERNANDO, H.J.S.[1], [1]University of Notre Dame, 156 Fitzpatrick Hall of Engineering, Notre Dame, IN, 46656; [2]Center for Research Computing, 111 Information Technology Center, Notre Dame, IN, 46556; [3]Baylor University, One Bear Place #97354, Waco, TX, 76798. **Numerical Modeling of Thermal Bar and Stratification Pattern in Lake Ontario using the EFDC Model.**

Thermal bar is an important phenomenon in large, temperate lakes like Lake Ontario. Spring thermal bar formation reduces horizontal mixing, which in turn, inhibits the exchange of nutrients. Evolution of the spring thermal bar through Lake Ontario is simulated using the 3D hydrodynamic model Environmental Fluid Dynamics Code (EFDC). The model is forced with the hourly meteorological data from weather stations around the lake, flow data for Niagara and St. Lawrence rivers, and lake bathymetry. The simulation is performed from April to July, 2011; on a 2-km grid. The numerical model has been calibrated by specifying: appropriate initial temperature and solar radiation attenuation coefficients. The existing evaporation algorithm in EFDC is updated to modified mass transfer approach to ensure correct simulation of evaporation rate and latent heatflux. Reasonable values for mixing coefficients are specified based on sensitivity analyses. The model simulates overall surface temperature profiles well (RMSEs between 1-2°C). The vertical temperature profiles during the lake mixed phase are captured well (RMSEs < 0.5°C), indicating that the model sufficiently replicates the thermal bar evolution process. An update of vertical mixing coefficients is under investigation to improve the summer thermal stratification pattern. *Keywords: Hydrodynamics, Thermal BAR, Lake Ontario, GIS.*

ARMENIO, P.M., ROGERS, M.W., and BUNNELL, D.B., U.S. Geological Survey Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105. **The HABs and HAB-nots: Zooplankton communities within Lakes Erie and Huron.**

According to the nearshore shunt hypothesis, allochthonous nutrients are trapped and recycled in the nearshore region via dreissenid mussels, leading to less productivity offshore. The spatial distribution of nutrients can greatly affect zooplankton communities. We explored whether the west-to-east gradient in Lake Erie is similar to the nearshore-to-offshore gradient in Lake Huron. We sampled zooplankton monthly at six sites across Lake Erie from April-October 2014. Likewise, we sampled zooplankton monthly from April-October 2012 along two nearshore-offshore transects in northern Lake Huron. We hypothesize that the more productive waters (western basin of Lake Erie and nearshore depth of Lake Huron) would attain higher zooplankton densities and be dominated by cladocerans in Erie and cyclopoid copepods in Huron, while the less productive waters (east in Lake Erie and offshore in Lake Huron) would have lower densities and be dominated by calanoid copepods. We also looked for patterns in zooplankton communities across seasons at each location. The density and community of zooplankton can have implications for growth and survival of planktivorous fish species. *Keywords: Lake Huron, Offshore, Lake Erie, Nearshore, Zooplankton.*

ARTS, M.T. and HIXSON, S.M., Ryerson University, 350 Victoria Street, Toronto, On, M5B 2K3. **Simple and Complex Lipid-Based Indices of Ecosystem Health.**

Lipids are an integral to the dynamic function of cells and tissues of all organisms. They provide fuel, structural support, and serve as precursors for metabolically-important biochemicals. They are thus considered essential for the underlying maintenance of health and vitality in aquatic organisms. The great variety and roles of lipid molecules also opens up many exciting possibilities to use them as biochemical tracers; to assess the health/status of ecosystems and to track the flow of energy, nutrients, and contaminants in time and space. We will review simple and complex, older and newer, lipid-based indices/metrics of organismal/ecosystem health in the context of Great Lakes food webs. We will also compare and contrast the benefits and drawbacks of the various indices/metrics and describe some of the ways they have been used inside and outside the Great Lakes. *Keywords: Bioindicators, Lipids, Food chains, Fatty acids, Ecosystem health, Tracers.*

AUSTIC, G.B., Michigan State University, 612 Wilson rd, East Lansing, MI, 48823. **Open Source Hardware for environmental monitoring.**

Sensor-enabled communities of practice, like Publiclab.org, PhotosynQ.org, Smart Citizen, and many others, represent the next generation of global, collaborative citizen science efforts. These platforms are not just an extension of past citizen science communities, but engage the citizen as an equal to the scientist, bringing non-hierarchical structures for asking research questions, analyzing the data, or creating new equipment. This talk with describe a few of these platforms, with case examples on how they are answering the important environmental questions in their fields. We'll close with some thoughts on where sensor-enabled communities can go next in the fields of citizen science and environmental monitoring. *Keywords: Citizen science, Data acquisition, Commons.*

AUSTIN, J.A. and FIORENTINO, L.A., University of Minnesota, Duluth, Large Lakes Observatory, Duluth, MN, 55812. **Temporal and Spatial distribution of sediment resuspension in coastal Lake Superior.**

Autonomous underwater gliders were deployed along a cross-lake transect in the western arm of Lake Superior during 2011, 2012, and 2014, completing a total of 89 cross-lake transects. The gliders collected a variety of physical and biogeochemical parameters, including backscatter, which can be used as a proxy for suspended sediment concentration. A common feature of the cross-sections was a 10-30m thick layer of resuspended sediment in waters less than 100m deep. However, not all sections displayed this resuspension layer. A comparison with meteorological data from a nearby buoy shows a strong correlation between bottom backscatter concentration and thermal stratification, but weak correlation between backscatter and surface waves, suggesting that bottom sediment resuspension is due primarily to near-inertial waves propagating on the thermocline, as opposed to surface gravity waves. *Keywords: Lake Superior, Circulation, Sediment resuspension.*

AVLIJAS, S.[1], MANDRAK, N.E.[2], and RICCIARDI, A.[1], [1]McGill University, Montreal; [2]University of Toronto Scarborough, Toronto. **Evaluating the Impacts and Spread of Tench, a Globally Invasive Cyprinid.**

The Tench *Tinca tinca*, a Eurasian cyprinid, has been expanding its range from the Richelieu River upstream to Lake Champlain, and downstream to the St. Lawrence River, at an increasing rate since its initial detection in 1991. The recent high rates of dispersal of Tench, and its expansion towards the Great Lakes system, raise concerns about the potential ecological consequences of this invasion. Despite the global scale of the Tench introductions, its impacts on invaded systems are poorly understood. One complicating factor is its long lag time to establishment and spread in the early stages of invasion. In general, the risk assessment of invaders is complicated by the context-dependent nature of impact. To better understand the role of Tench in invaded systems, we are collecting data through field studies across highly disparate invaded watersheds spanning multiple continents, including North America and Africa. Impacts will be assessed through an analysis of the trophic relationships and diet overlap of fishes in invaded communities using stable isotope analysis. To develop more rapid risk assessments, we are testing the utility of shape-space analysis as a novel method of forecasting impacts. *Keywords: Invasive species, Tench, Risk assessment.*

# B

BACKUS, J.B.[1], CRIMMINS, B.S.[1], HOLSEN, T.M.[1], and XIA, X.[2], [1]Department of Civil and Environmental Engineering, Clarkson University, 8 Clarkson Ave, Potsdam, NY, 13699; [2]Center for Air Resources Engineering and Science, Clarkson University, 8 Clarkson Ave, Potsdam, NY, 13699. **Organophosphorus Flame Retardants in Fish: UPLC-QToF Method Development and Application.**

Organophosphorus Flame Retardants (OPFRs) are widely used in commercial products and observed in the Great Lakes Atmosphere, yet there is limited data on the presence of OPFRs in Great Lakes fish. The development of a robust, quick, and sensitive analysis method would help to address this data gap. A method that couples ultra-high pressure liquid chromatography with a quadrupole time-of-flight mass spectrometer (UPLC-QToF) was developed and optimized. Samples of whole fish homogenates from the Great Lakes Fish Monitoring and Surveillance Program were extracted under a variety of conditions and used to assess method performance. Application of the methodology to additional fish samples could advance the understanding of OPFRs in the Great Lakes by exploring temporal trends in fish over time. *Keywords: Organophophorus Flame Retardants, UPLC-QToF Method, Fish Tissue.*

BAI, X.[1] and WANG, J.[2], [1]CILER, University of Michigan, 4840 S. State Rd., Ann Arbor, MI, 48108; [2]NOAA/GLERL, 4840 S. State Rd., Ann Arbor, MI, 48108. **Great Lakes ice surface heat budget analysis: 1979-2012.**

Daily surface heat fluxes over ice and water from 1979 to 2012 were calculated using daily ice cover, lake surface temperature, and atmosphere variables (2-m surface air temperature, 2-m specific humidity, 10-m wind speed, total cloud cover, and incoming solar radiation). A formula of ice growth was derived, by which ice coverage can be quantitatively estimated given the net surface heat flux. Surface heat flux analysis shows that sensible heat flux contributed most to the net surface heat flux anomaly. Surface air temperature is the dominant factor governing the interannual variability of Great Lakes ice cover. *Keywords: Ice, Air-water interfaces, Climatic data.*

BAKER, D.B., JOHNSON, L.T., CONFESOR, R.B., and KRIEGER, K., Heidelberg University, 350 E, Market Street, Tiffin, OH, 44883. **Changing Location, Timing and Composition of Phosphorus Inputs to Lake Erie: Challenges for Modelers.**

Load-response modeling, using total phosphorus (TP) loads as the independent forcing variable has a 45-year history in the Lake Erie Basin. However, the nature of TP loads has changed dramatically over this time. In the late 1960s, point sources (PS) dominated TP loading. TP coming from PS is mainly composed of dissolved phosphorus (DP), is discharged at approximately equal daily rates throughout the year, and, for Lake Erie, primarily delivered by the Detroit River. As PS controls took effect in the 1970s, agricultural nonpoint sources (NPS) began to dominate TP inputs. These inputs are largely composed of particulate phosphorus (PP), discharged primarily during winter and spring runoff events, and delivered mostly by northwestern Ohio rivers. In the 1980s, management efforts shifted focus to erosion control to reduce PP, which is 25-30% bioavailable. While PP concentrations have decreased, increases in river discharge have largely negated load reductions. The DP component of NPS loading, which is 100% bioavailable, dropped significantly between the mid-1970s through the early 1990s and then increased substantially before leveling by the mid-2000s. To generate reliable management guidelines, these changes in the bioavailability, timing and location of TP inputs need to be taken into account in load-response modeling. *Keywords: Lake Erie, Bioavailable phosphorus, Tributaries, Monitoring, Phosphorus.*

BALAS, E.K., SWINTON, M.W., and SCHALLER, M.F., Rensselaer Polytechnic Institute, 110 8th St., Troy, NY, 12180. **Tree Ring Records Reveal a Shift in Precipitation Regime in the Lake George Basin.**

Over the last three decades, precipitation received by the southern Adirondack region is increasingly from fewer, but more intense individual events. The NOAA weather station in Glens Falls, NY records this trend in the precipitation falling over the Lake George catchment, which is consistent with GCM simulations for climates under elevated atmospheric pCO2. We expect that vegetation local to the lake will reflect this shift. We analyzed cores taken from a stand of water-stressed Hemlock trees and compared key metrics to instrumental climate data. We identified a strong correlation between annual precipitation and rate of tree growth, and increased late-wood density and decreased yearly rate of growth reflecting the increasing intensity of rainfall events. While early-wood is a good indicator of precipitation in response to changing climate, we found no relationship between these variables and ring widths. Using transfer functions between early-wood density and precipitation from our 55-year period of overlap, we reconstructed precipitation variability for the last 160 years and found the trends over the last three decades to be unique. This indicates that a switch to more intense storm events may be as detrimental to tree growth as a decrease in precipitation, and may in fact be indistinguishable from the tree ring record. *Keywords: Environmental effects, Dendrochronology, Climate change, Lake George, Climatology.*

BALDRIDGE, A.K.[1] and NALEPA, T.F.[2], [1]NOAA GLERL, 4840 S State Rd., Ann Arbor, MI, 48108; [2]Water Center/Univ. Mich., Ann Arbor, MI, 48104. **The status of Dreissenid mussels in the Great Lakes and suggested future research directions.**

The introductions of invasive zebra and quagga mussels (*Dreissena polymorpha* and *D. rostriformis bugensis*, respectively) have had profound impacts throughout the Great Lakes basin and other areas across North America. This talk will synthesize the major effects of Dreissenid mussels on multiple trophic levels within Great Lakes food webs. We will also present updated abundance data for Lakes Michigan, Ontario, and Huron based on whole lake surveys completed in the last 5 years and provide a historic perspective of long term trends. Zebra and quagga mussels have many similar characteristics, but still exhibit different habitat requirements, growth rates, and population dynamics. Thus, information for one species cannot necessarily be applied to the other. We will present key differences between the species and remaining knowledge gaps for each. Recent advances in potential control techniques are generating new research questions. We will emphasize priority research areas as identified by the Invasive Mussel Collaborative that will help to optimize management actions. *Keywords: Management, Environmental effects, Dreissena.*

BALDWIN, A.K.[1], CORSI, S.R.[1], MASON, S.A.[2], and LENAKER, P.L.[1], [1]USGS Wisconsin Water Science Center, 8505 Research Way, Middleton, WI, 53562; [2]State University of New York at Fredonia, Fredonia, NY, 14063. **Microplastics in Great Lakes Tributaries.**

Microplastics-plastic particles less than 5mm in diameter-are a growing contaminant of concern in freshwater systems. Sources are known to include abrasive beads in personal care products, fibers shed from synthetic clothing during washing, breakdown of larger plastic litter, and pre-production pellets and powders, among others. In 2014 the USGS and SUNY Fredonia characterized the types and relative contributions of floating microplastics in 29 Great Lakes tributaries in 6 states under different hydrologic conditions and land uses. Tributaries were sampled four times each, during both high-flow and low-flow conditions. Samples were collected from the upper 20-30cm of the stream using a 0.33mm mesh neuston net. Results from seven tributary samples have been reported to date, with a maximum concentration of 1.93 particles/$m^3$ (equivalent to 502,000 particles/$km^2$). The median concentration was 0.22 particles/$m^3$ (38,600 particles/$km^2$), over seven times greater than the median concentration previously reported for samples from the Great Lakes (Superior, Huron, and Erie). Over 90 percent of sampled plastic particles were between 0.35 and 1.0mm in diameter. Fibers/lines were the dominant type, followed by foam, fragments, films, and pellets/beads. *Keywords: Microplastics, Great Lakes Restoration Initiative (GLRI), Tributaries.*

BALLENT, A.M.[1], CORCORAN, P.L.[1], and HELM, P.A.[2], [1]Department of Earth Sciences, University of Western Ontario, 1151 Richmond St. N, London, ON, N6A 5B7; [2]Environmental Monitoring and Reporting Branch, Ontario Ministry of the Environment andClimate Change, Toronto, ON, M9P 3V6. **Microplastic Accumulation in Beach and Lake Bottom Sediments of Lake Ontario, North America.**

As the most populated and industrial region surrounding Lake Ontario, the city of Toronto is a large contributor of plastic pollution to the lake. Plastic debris accumulates in beach sediments and near-shore lake bottom sediments along the north-western shore of Lake Ontario. Five sandy beaches were surveyed for plastic debris between Hamilton Harbour and immediately north of Toronto Harbour. The average density of plastic fragments, pellets, foam and intact items <1 mm in size ranged from 12-86 g plastic/$m^3$ sediment, and varied with sediment grain size and shoreline orientation. Late summer strandline accumulation rates measured over a period of 8 days ranged from 2-45 plastic fragments/$m^2$ (0.5-8 g/$m^2$) with the highest rates at Marie Curtis Park. Three near-shore sediment cores 6 to 15 cm thick were sampled from Humber Bay using a Glew corer. On average, 100 g (dry weight) of the muddy to silty sediment contained 7-11 potential low-density (<1.00 g/$cm^3$) plastic fragments and fibres >25 microns in size. Combined with a recent investigation of pellet distribution along the Humber River and Humber Bay shoreline, the results indicate that the Humber River is a potential transport pathway for plastics into Lake Ontario. *Keywords: Lake Ontario, Microplastics, Sediments.*

BANACH, D.[1], BROOKS, C.N.[1], and FEDORA, M.[2], [1]Michigan Technological University, Michigan Tech Research Institute, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [2]Ottawa National Forest, E6248 US Highway 2, Ironwood, MI, 49938. **Using Multi-temporal Imagery to Improve Mapping of Forested Roads in Michigan's Upper Peninsula.**

While roads provide transportation for people and goods, there are a greater number of negative ecological impacts that stem from road network. A significant impact of concern for more rural roads is an increase in the number of road-stream crossings which can cause fish passage issues, impact in-stream habitat, and affect stream sedimentation. While multiple studies have examined and quantified the effects roads have on landscape structures, many may have been based on incomplete data sets. An updated and improved road data set is necessary to draw inferences that quantify the total impact that a road network has on a landscape. The purpose of this project was to develop an updated and improved regional roads data layer through interpretation of existing imagery, with the resulting GIS layer being applied in ecological analysis and planning. Preliminary investigations of forested watersheds in Michigan's Upper Peninsula by the project team had shown that as few as 1/7 of the roads in these watersheds are captured by existing GIS layers. The resulting updated road dataset was used to calculate the total mileage added and was further analyzed to indicate any location where a road and stream intersect and compared to the results using existing roads layer. *Keywords: Environmental effects, Roads, Lake Superior.*

BANDA, J.A.[1], CHOY, S.J.[4], GEFELL, D.[5], JORGENSON, Z.G.[6], LEE, K.E.[2], MOORE, J.N.[7], SCHOENFUSS, H.L.[3], and THOMAS, L.[3], [1]U.S. Fish and Wildlife Service, 4625 Morse Rd., Ste. 104, Columbus, OH, 43230; [2]U.S. Geological Survey, 2280 Woodale Dr., Mounds View, MN, 55112; [3]St. Cloud State University, 720 4th Ave. South, St. Cloud, MN, 56301; [4]USFWS Green Bay Field Office, Green Bay, WI; [5]USFWS New York Field Office, Cortland, NY; [6]USFWS Twin Cities Field office, Bloomington, MN; [7]USFWS East Lansing Field Office, East Lansing, MI. **Contaminants of Emerging Concern and Their Effects to Fish and Wildlife in the Great Lakes Basin.**

Water and sediment samples from sites across 17 Great Lakes tributaries were analyzed for over 150 contaminants of emerging concern (CECs); encompassing pharmaceuticals, hormones, pesticides, plasticizers and flame retardants. Fish also were collected, and at multiple sites in select rivers caged fish were deployed for 14 days to determine CEC exposure and alterations to reproductive health. Fish tissues were histologically analyzed to determine the health of gonads, liver, and reproductive status. ELISAs were used to quantify plasma vitellogenin concentrations. Concentrations of CECs in sediment and water were detected in large, complex mixtures at all locations and vary among location, media sampled, and land use. Increased feminization (vitellogenin) and decreases in percent mature sperm were measured in both caged and resident fish in multiple rivers and correlate to increases in CEC concentrations. A predator avoidance behavioral assay also was conducted that exposed fish larva for 21 days to site water collected at each caged fish location. Decreases in body length, reaction time, and predator escape response were measured in larval fish. These results are consistent with laboratory studies reported in literature and preliminary findings suggest that CECs in the Great Lakes may adversely affect wildlife resources. *Keywords: Assessments, Endocrine disruption, Environmental contaminants.*

BARBIERO, R.P.[1], LESHT, B.M.[2], WARREN, G.J.[3], and BLUME, L.J.[3], [1]CSC, 1359 W Elmdale Ave #2, Chicago, IL, 60660; [2]CSC, Chicago, IL; [3]U.S. EPA Great Lakes National Program Office, 77 West Jackson. Boulevard, Chicago, IL, 60604. **A Brief Overview of the EPA's Water Quality Survey of the Great Lakes.**

The Great Lakes National Program Office (GLNPO) of the U.S. EPA has been conducting regular water quality monitoring surveys of the Great Lakes since 1983. The surveys were initiated in support of the Great Lakes Water Quality Agreement (GLWQA), and were primarily intended to track changes in offshore nutrients in order to assess compliance with GLWQA goals. This program currently represents the most extensive regular monitoring being undertaken on the Great Lakes. A key element of the program has

been the use of the same sampling platform and analytical laboratories across multiple lakes, thus allowing inter-lake comparisons. While spatial and temporal coverage is limited by resource constraints, and consistency through time has sometimes been compromised by evolving goals and discontinuities in analysts, the GLNPO data series remains one of the most important in the Great Lakes. In this talk we will briefly discuss the history of the program, provide examples of some important insights gleaned from it, and point out some lessons learned that might be of use to other monitoring programs. *Keywords: Monitoring, Water quality, Eutrophication.*

BARTSCH, W.M.[1] and YURISTA, P.M.[2], [1]US Environmental Protection Agency - Mid-Continent Ecology Division, ORISE Participant, 6201 Congdon Blvd., Duluth, MN, 55804; [2]US Environmental Protection Agency - Mid-Continent Ecology Division, 6201 Congdon Blvd., Duluth, MN, 55804. **Using the Shiny Package in R to Interactively Display Great Lakes Water Quality Data.**

R is becoming a popular programming language for statistical analysis and graphic generation. R is open source and has more than 6000 user-created packages that can perform specialized tasks. The Shiny package, by R Studio, has the flexibility to build varied web applications that can incorporate data, analysis, graphics, spatial information, and more. Shiny was used to develop a web application for data from the 2010 National Coastal Condition Assessment (NCCA). The NCCA is a probability-based survey used to assess the condition of both marine and Great Lakes coastal areas of the United States. The survey is coordinated by the US Environmental Protection Agency Office of Water and is conducted every five years. The NCCA web application allows users to view Great Lakes water quality data in a variety of formats, including: color coded maps, histograms, plots, and tables. Additionally, users can specify data based on water quality parameter, scale, and sampling design criteria. Shiny is an effective tool to facilitate the sharing of NCCA data with resource managers, researchers, and the public. *Keywords: Water quality, Data visualization, Coastal ecosystems.*

BASSETT, N.L., American Steamship Company, 500 Essjay Road, Williamsville, NY, 14221. **The Challenge of Ballast Water Treatment on Great Lakes Ships and Pursuit of a Home-Grown Solution.**

The existing fleet of US-flag commercial ships that ply the waters of the Great Lakes pose a most unique challenge with respect to ballast water treatment. The designs of these vessels has evolved into an extremely efficient transportation mode typified by very full hull forms and relatively modest speeds as compared to ocean-going vessels of similar lengths; hull construction and coatings methods suitable for only fresh water operation; relatively large ballast volumes with extremely high-speed and high capacity ballast pumping systems; and comparatively short duration trips. These factors, combined with a relatively small number of vessels compared to ocean-service ship numbers, has severely limited the commercial opportunity attractiveness for the makers of ballast water treatment systems. This challenge has led to minimal US Federal and State regulation of the ships that operate solely within the Great Lakes as no commercially available treatment systems can be reasonably and feasibly applied to these unique vessels. This presentation outlines and discusses the unique features and operating environment that define typical Great Lakes ships, and presents the work of a collaborative team seeking a "home-grown" solution to the treatment of ballast water on these vessels. *Keywords: Ballast, Invasive species, Transportation.*

BATTAGLIA, M.J., ENDRES, S.L., and BOURGEAU-CHAVEZ, L.L., Michigan Tech Research Institute, 3600 Green Ct., Ste 100, Ann Arbor, MI, 48105. **An Evaluation of Satellite Synthetic Aperture Radar for Vernal Pool Detection.**

Vernal pools are small, temporary bodies of water that form in shallow depressions within forested areas. Vernal pools are important to the biodiversity and health of the Great Lakes region's forests as they provide habitat for a number of wildlife species, including threatened amphibians and invertebrates, and contribute other ecosystem services including nutrient cycling, water storage and infiltration, and groundwater recharge. Vernal pools can be difficult to identify because of their seasonality and small size and have received little protection under federal and state wetland regulations. As a result, many of these small, temporary wetlands have been lost or degraded. The detection and mapping of vernal pools is hindered by forest canopy cover, limiting the utility of optical imagery. Synthetic aperture radar (SAR) sensors have low frequencies which are capable of penetrating forest canopy to detect the presence of standing water on the ground. L-band and C-band SAR data were evaluated in three study areas in Michigan to determine their effectiveness to identify vernal pools. When combined with digital elevation models, seasonally appropriate SAR data were found to be a cost-efficient and accurate means of vernal pool detection. *Keywords: Remote sensing, Vernal pools, Wetlands.*

BATTAGLIA, M.J., FRENCH, N.H., and ENDSLEY, K.A., Michigan Tech Research Institute, 3600 Green Ct, Ste. 100, Ann Arbor, MI, 48105. **MichiganView Brings Remote Sensing and Invasive Species Monitoring to the Classroom.**

MichiganView is a statewide consortium of academic member institutions. Its mission is to promote the use and further the science of remote sensing technologies in Michigan schools, governments, and industry. One of MichiganView's primary goals is to introduce K-12 students to remote sensing through exciting and curriculum appropriate hands-on activities. This poster presents the results of a project conducted with fifth-grade students from Wixom, Michigan. By working with teachers, MichiganView was able to develop age-appropriate lessons on remote sensing and wetland ecology. Students were taught basics of remote sensing, such as how imagery is acquired and how to identify different wetland types from air photos. Following in-class sessions, students were led on a field trip to a local wetland where they acted as "citizen scientists." The fifth-graders were able to collect information of plant life and record GPS coordinates for the location of invasive *Phragmites*. Upon returning to the classroom students were able to upload the data they collected to a web-based map tied to a *Phragmites* database maintained by scientists at the Michigan Tech Research Institute. *Keywords: Education, Remote sensing, Phragmites australis.*

BECHLE, A.J. and WU, C.H., University of Wisconsin Madison, 1415 Engineering Drive, Room 1269, Madison, WI, 53706. **Meteorological Tsunami Occurrence and Trends: Great Lakes and Beyond.**

Meteotsunamis (or meteorological tsunamis) are propagating water waves generated by a moving atmospheric disturbance. Meteotsunamis exhibit many similarities to seismic tsunamis, as both have wave periods from 2 minutes to 2 hours and can undergo resonant amplification that transforms relatively small waves in open water into destructive forces at the coast. These destructive waves have resulted in property damage, injuries, and drownings throughout the world. In this talk, we will examine the spatial and temporal patterns of destructive meteotsunamis worldwide from the past century. The Great Lakes will be of particular focus, as the frequency of meteotsunamis in Great Lakes will be examined from water level records over the past two decades. Statistical models are fit to these data to predict the probability of meteotsunamis throughout the Great Lakes. In addition, meteorological records, along with radar and satellite imagery, will be utilized to characterize the meteorological conditions that accompany these meteotsunami events. The results of this study will help assess the risk associated with these destructive waves and understand the causative meteorology. *Keywords: Waves, Coastal processes.*

BECKER, R.H.[1], CLINE, M.T.[1], BRIDGEMAN, T.B.[1], LEKKI, J.[2], ANDERSON, R.[2], TOKARS, R.[2], and LIUO, L.[2], [1]University of Toledo; Department of Environmental

Sciences, 2801 Bancroft St; MS 604, Toledo, OH, 43606; [2]NASA Glenn Research Center, 21000 Brookpark Road, Cleveland, OH, 44135. **Interpretation of Airborne Hyperspectral Data for HAB identification.**

The Western Basin of Lake Erie comprises one of the shallowest expanses of all the Great Lakes and, in the modern era, is frequently subject to dense algae blooms in the late summer. In order to understand the annual algal population cycles it is valuable to detect the location and time of population surges and their spatial propagation through the lake. To develop new airborne hyperspectral imagery based algorithms, we took optical measurements and acquired water samples throughout the Western Basin on eight separate days through August and September of 2014, coincident with NASA GRC airborne hyperspectral imager (HSI) flights. Integrated lakewater samples were collected for Total Suspended Solids, Volatile Suspended Solids, Chl-a and algae type, in addition to depth profiles from a YSI sonde. ASD Fieldspec 3 Hi-Res measurements of reflectance were taken using a 10 degree FOV optic, utilizing a 10x10 Spectralon Board as white reference. At lake spectrometer measurements were inverted to obtain IOPS. These calculated total absorption and backscatter measures were used to estimate algae optical properties. ASD spectra were utilized to atmospherically correct airborne radiance values, and reflectance images were generated. The algorithm developed for on lake spectra was utilized to extend classification to the entire image. *Keywords: Harmful algal blooms, Remote sensing.*

BEHBAHANI, M., GIBBONS, K.J., XUE, D., BRIDGEMAN, T.B., and SEO, Y., University of Toledo, 2801 West Bancroft Street, Toledo, OH, 43606. **Application of Microelectrodes to Measure Soluble Reactive Phosphorous in Lake Erie Sediments.**

Understanding phosphorus release from lake sediments is important for efforts to control eutrophication in the Great Lakes. In this study, cobalt-based microelectrodes with small tip size (<100 μm) were fabricated, calibrated and tested to assess their performances in measuring soluble reactive phosphorous (SRP) in sediments. First, the performance of phosphate microelectrodes was examined for different characteristics such as detection limit, response time, selectivity, reproducibility, and ion interference. Then, phosphate microelectrodes were applied to sediment samples collected from different locations in Lake Erie and SRP releasing was measured under both oxic and anoxic conditions with 1 mm measurement increment. Detection limits of phosphate microelectrodes were 10-7 M concentration of phosphate ion with stable signal responses. However, signal interferences (especially with oxygen) needed to be considered and addressed. For in-situ SRP profiling in Lake Erie sediment samples, the microelectrodes were able to measure phosphate concentration changes with high resolution and sensitivity. Overall, results showed that the phosphate microelectrode can be an effective tool for the measurement of phosphate in both bulk water and sediment samples. *Keywords: Phosphorus, Lake Erie, Sediments.*

BELETSKY, D.[1], BELETSKY, R.[1], HAWLEY, N.[2], and WANG, J.[2], [1]CILER, University of Michigan, Ann Arbor; [2]NOAA Great Lakes Environmental Research Laboratory, Ann Arbor. **Interannual Variability of Winter Circulation and Ice in Lake Erie.**

Winter circulation in the Laurentian Great Lakes is less known than summer circulation and impacts of ice on lake circulation are poorly understood. Lake Erie is at least partially covered with ice from December until April, and its normal peak ice cover is about 90%. To study thermal structure, circulation, and ice thickness, 7 current profilers, 4 ice profilers and 37 temperature sensors were deployed in Lake Erie in October 2010 - May 2011, and again in September 2011 - May 2012. Wind speed observations were obtained from National Weather Service and Environment Canada meteorological stations. Significant interannual variability in the extent of ice cover was observed during the two field years, and that allowed us to study the impact of ice on thermal structure and circulation in Lake Erie. *Keywords: Hydrodynamics, Lake Erie, Ice.*

BENNION, D.[1], ESSELMAN, P.[1], SUEDEL, B.C.[2], SCHAEFFER, J.[1], BIJAUER, P.[2], FRIONA, T.[2], RUBY, R.[2], GRUNDELL, R.[3], and FREDDETTE, T.[2], [1]USGS Great Lakes Science Center, Ann Arbor, MI; [2]U.S. Army Corps of Engineers, 3909 Halls Ferry Rd., Vicksburg, MS, 39180; [3]USGS Lake Michigan Ecological Station, Porter, IN. **Coastal Navigational Infrastructure as a Source of Evironmental Services.**

Coastal navigational infrastructure is a common feature of urban shorelines. Many of these features are maintained and managed by the U.S. Army Corps of Engineers, providing opportunities for targeted management and potential modification during routine maintenance activities. In addition to providing navigational benefits, they can provide secondary benefits to human users like anglers or beach goers, and with some modifications, coastal infrastructure may also be enhanced to provide ecological services such as temporary refugia for migrating birds, or as habitats for game fishes. In other cases, individual structures may not serve the navigational purposes for which they were once intended, making them candidates for repurposing or removal. We present a Great Lakes basin-wide analysis of federally owned breakwaters for their potential to provide benefits for public access, angling, bird habitat, and fish habitat based on their construction, human visitation/usage rates, and position in the landscape relative to ports and migratory bird habitats. We examined each structure relative to their highest potential non-navigational values as well as their structural and functional condition as engineered structures. The results of our analysis allow for prioritization, planning and design of potential infrastructure modification. *Keywords: Breakwaters, Coastal ecosystems, GIS.*

BERGIN, C.S., CHIN, M.J., DONOVAN, N.T., DYKHUIS, K.M., VIAL, B.S., and ALFORD, L.K., University of Michigan, 2600 Draper Rd., Ann Arbor, MI, 48109. **Self-Cleaning Microplastic Filter for Wastewater Treatment Plant.**

Microplastics--plastic particles less than 5 millimeters in diameter--are particularly damaging to marine environments. Due to their small size and density (similar to that of water), microplastics, commonly from synthetic textile fibers and cosmetic products containing microbeads, can potentially pass through wastewater treatment plants. Once in an aquatic environment, microplastics attract persistent bioaccumulative toxic compounds (PBTs) and persistent organic pollutants (POPs) which cause harm to the ecosystem. While some systems have been designed that can treat for microplastics, such as membrane bioreactors (MBRs), they are currently very costly and not widely used. Our goal was to design a new method for effectively removing microplastics greater than 80 μm from wastewater and develop a prototype that is self-cleaning via backflushing. After researching the design of wastewater treatment plants, we toured the plant in Ypsilanti, MI, and evaluated the installation location and feasibility of a microplastics filter. We then conducted flow rate testing with filter screens of different porosity, angle, and spacing. The results of these tests were used to design a filter system that can be retrofitted to modern wastewater treatment plants. *Keywords: Microplastics, Filtration, Environmental contaminants, Wastewater treatment plants, Water quality.*

BERNSTEIN, D.N.[1], AUSTIN, J.A.[1], XUE, P.[2], SPENCE, C.[3], and BLANKEN, P.D.[4], [1]Large Lakes Observatory University of Minnesota Duluth, 2205 E. 5th St., Duluth, MN, 55812; [2]Dept. of Civil and Environmental Engineering & Great Lakes Research Center Michigan Technological Un, 1400 Townsend Drive, Houghton, MI, 49931; [3]Environment Canada, Saskatoon, SK; [4]University of Colorado-Boulder, Boulder, CO. **Estimation of the Spatial Distribution of Evaporative Flux on Lake Superior.**

The greatest source of uncertainty in the mass balance of large lakes is the evaporative term, due largely to the paucity of reliable measurements. In this study we use output from a high-horizontal resolution, Finite-Volume, primitive equation Community Ocean Model (FVCOM) to study the spatial and temporal structure of the latent heat flux.

Empirical Orthogonal Functions (EOFs) were computed using a year's worth of output from the model. The bulk of the variability can be explained with the first mode, which is largely uniform in space and has the expected seasonal structure. However, the second and third modes are spatially coherent, representing a meridional and zonal anomaly, respectively.In addition, simulated fluxes were compared to the time series of eddy covariance evaporation measured from Stannard Rock located near the central part of Lake Superior. This analysis could be used to more objectively determine ideal locations for additional eddy covariance measurements. *Keywords: Air-water interfaces, Lake Superior, Evaporation.*

BETCHER, D.[1], TRESKA, T.[2], WANG, G.[1], MCAULAY, J.[3], and HRODEY, P.[3], [1]Great Lakes Commission, 2805 South Industrial Hwy. Suite #100, Ann Arbor, MI, 48104; [2]U.S. Fish & Wildlife Service, 2661 Scott Tower Road, Green Bay, WI, 54229; [3]Great Lakes Fishery Commission, 2100 Commonwealth Blvd, Suite 100, Ann Arbor, MI, 48105. **Sea lamprey control barriers and treatments: New mapping and data visualization tools.**

The Great Lakes Commission, in collaboration with the Great Lakes Fishery Commission, has developed a new web mapping application, which offers the ability to trace upstream or downstream along unified U.S. and Canadian stream data, terminating at both existing and user-input barriers. This allows the user to visualize the impact of potential Sea Lamprey barrier addition or removal. Historical Sea Lamprey control data are provided in addition to basic stream attribute data. The application is built as a platform for decisionmaking regarding sea lamprey control investments, natural resource management and barrier removal for native species connectivity. A prototype of the tool was introduced in October 2014. The project demonstrates the power of binational stream data harmonization, and the seamless integration of data visualization and network analysis through open source and commercial software. Additional enhancements are planned in 2015, including metrics that are considered in treatment planning, trapping locations and results, and more historical attributes. *Keywords: Invasive species, Sea lamprey, Spatial analysis, Native species connectivity, Fish management, Sea lamprey control investments.*

BIESINGER, Z.[1], GORSKY, D.[1], and JACOBS, G.R.[2], [1]US Fish and Wildlife Service, 1101 Casey Road, Basom, NY, 14013; [2]US Fish and Wildlife Service, 227 Washington Ave, Lamar, PA, 16848. **Lake Sturgeon Spawning Habitat Use in the Lower Niagara River from Radio Telemetry.**

Historically, Lake Sturgeon was a dominant species in large rivers and nearshore areas throughout the Great Lakes. Among other factors, degradation of and loss of access to spawning habitat are thought to have contributed to population declines and extirpation in many spawning rivers by the early 20th century. In spite of long protections, sturgeon populations remain less than 1% of historical levels. The lower Niagara River is home to one of the remaining populations of Lake Sturgeon in Lake Ontario, where they are officially listed as "threatened" in New York State and the Province of Ontario. Preferred spawning habitat is over clean, coarse rubble in fast flowing water. To assess spawning habitat use in the lower Niagara River, we record movement of 105 individuals using fixed-station and manual radio tracking from 2010-2013. We classify locations as being in the river gorge, below the gorge, and at the river mouth in Lake Ontario. We quantify habitat type below the gorge and at the mouth using sidescan and multibeam sonars. Preliminary analysis suggests mature male and female sturgeon use the entire lower river, probably spawning upstream in the gorge. Though immature females use the river, immature males are not observed.
*Keywords: Niagara River, Lake Sturgeon, Radio Telemetry.*

BISWAS, S.[1], MCGRATH, J.M.[2], and SAPKOTA, A.[3], [1]Heidelberg University-NCWQR, 310 E Market Street, Tiffin, OH, 44883; [2]University of Kentucky, N122-P Ag Science North, Lexington, KY, 40546; [3]University of Maryland, SPH Building, Room 2234F, College Park, MD, 20742. **Dynamics of an emerging antimicrobial contaminant in soil-water systems.**

Monensin, biochemically known as an ionophore, has been commonly used as an antimicrobial and growth-promoter in confined animal feed operations for cattle, swine and poultry. Ionophores are emerging contaminants that are not routinely monitored or treated in effluents and can enter into the environment freely. Monensin causes antibiotic resistance in microbes and is toxic to biota at concentrations > 1 $mgL^{-1}$. Monensin has been detected in the Great Lakes Basin in the water treatment plant influents and effluents of Chicago, Ontario and Detroit-Windsor regions with concentrations ranging from 0.01$ngL^{-1}$ to 810 $ngL^{-1}$. We performed a mechanistic study to understand the mobility of monensin in soil-water systems using novel methodologies, consisting of, in part, a batch equilibrium study to reveal the partitioning behavior of monensin. Soils used in the study were similar to soils of Great Lakes Region. We developed a LC-MS/MS method that was used to quantify monensin in the soil and water matrices. Sorption-desorption isotherms were generated with partition-coefficients ranging from 6.41 $Lkg^{-1}$ to 343.83 $Lkg^{-1}$. These results suggest that, monensin can be used as a biomarker to indicate the importance of manure as a source of agricultural pollution in Great Lakes watershed. *Keywords: Soil and water quality, Mass spectrometry, Monensin, Organic compounds, Transportation, Isotherm.*

BLANKEN, P.D.[1], SPENCE, C.[2], LENTERS, J.D.[3], GRONEWOLD, A.D.[4], and PETCHPRAYOON, P.[5], [1]University of Colorado, Boulder, CO, 80309-0260; [2]Environment Canada, Saskatoon, SK, S7H 1A1; [3]LimnoTech, Ann Arbor, MI, 48108; [4]NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI, 48108; [5]Geo-Informatics and Space Technology Development Agency, Bangkok. **An Observational Study of the Influence of Ice on Heat and Water Loss from the Upper Great Lakes.**

Ice cover on the Great Lakes is highly variable in both space and time, and poorly understood feedbacks between the lakes and atmosphere hinder our ability to predict fluctuations in water levels due to wintertime ice conditions. The economic costs of ice can be large, with an estimated shipping loss alone of $705 million in 2013-14. When ice is present, its cover is usually discontinuous with areas of exposed water in direct contact with the atmosphere. Using time-lapse photography and remote sensing, we detailed the development of ice formation on northern Lake Michigan, and related this to simultaneous direct measurements of the turbulent fluxes of sensible and latent heat using the eddy covariance approach. Footprint analysis of the area contributing to the turbulent fluxes together with the fraction of ice cover in the sampling area allowed us to examine the dynamic changes in sensible heat and evaporative water loss that occur as ice developed. Significant decreases in the sensible and latent heat fluxes occurred when an ice cover of 30% was achieved. Annually, compared to adjacent ice-free northern Lake Huron, ice resulted in a 43% reduction in the evaporative water loss, and a 57% reduction in the sensible heat loss. *Keywords: Atmosphere-lake interaction, Climate change, Hydrologic cycle.*

BLAZER, V.S., WALSH, H.L., HAHN, C.M., and BRAHAM, R.P., U.S. Geological Survey, 11649 Leetown Road, Kearneysville, WV, 25430. **Identifying Risk Factors for Skin and Liver Tumors of Brown Bullhead and White Sucker.**

"Fish tumors and other deformities" is a Beneficial Use Impairment (BUI) at many Great Lakes Areas of Concern. Most of the remedial action plans addressing this BUI list PAHs and PCBs as the most likely cause. However, despite clean-up efforts to reduce expose to these contaminants, skin and liver tumors of brown bullhead and white sucker are still observed at prevalence above acceptable levels. This suggests that perhaps we need to move beyond PAHs and PCBs to understand potential risk factors associated with the skin and liver carcinogenesis in these fishes. Biological agents such as viruses and parasites initiating proliferation, inflammation and oxidative damage, emerging contaminants such as estrogens that may act as promoters and the complex interactions of these with legacy chemicals need to be understood. Chemical analyses of individual tissues as well as developing molecular techniques, along with histopathology, are proving insights into the development of these tumors. *Keywords: Fish, Toxic substances, Bioindicators.*

BLUME, L.J.[1], CORCORAN, M.M.[2], KLONICKI, P.T.[3], AMOS, M.M.[3], PRANCKEVICIUS, P.[1], SCHOFIELD, J.A.[3], and WARREN, G.J.[1], [1]US EPA Great Lakes National Program Office, Chicago, IL; [2]Oak Ridge Institute for Science and Education, Chicago, IL; [3]CSC, Alexandria, VA. **New Direction for GLNPO's Quality and Long-Term Monitoring Programs.**

New requirements & policies are being enacted across the EPA impacting the quality management system that supports GLNPO's Water Quality Surveys & the GLRI. These changes have ripple effects since groups receiving EPA funds also often need to comply with the requirements. Some of these new policies dictate what & how samples & supporting documentation should be stored & archived. The documentation of samples, analysis, & data review ultimately aids data users in understanding how the data were generated, the quality and rigor, & any limitations of use. The reality is that some historical data sets contain summary data, lacking individual sample data or associated QC; thereby, reducing the utility of the data. However, responding to new requirements is easier said than done, especially for long-term monitoring programs. This presentation discusses changes to GLNPO's Quality Program, how changes may impact EPA collaborators, & measures GLNPO is taking to make its supporting documentation more readily available via an on-line repository system. These efforts will improve accessibility to our historical monitoring record & allow an integration of the historical information with new information being generated through the GLRI. *Keywords: Monitoring, Data storage and retrieval, Environmental policy.*

BOCANIOV, S.A.[1], YERUBANDI, R.[2], LEON, L.F.[2], and SCAVIA, D.[1], [1]Graham Sustainability Institute, University of Michigan, 625 E. Liberty, Suite 300, Ann Arbor, MI, 48104; [2]S&T/WHERD/Integrated Modeling, Environment Canada, 867 Lakeshore Rd, Burlington, ON, L7R 4A6. **Managing the hypoxia in Lake Erie: Simulating the effect of nutrient reductions with a 3-D model.**

Hypoxia in lakes is commonly linked to eutrophication caused by excessive nutrient loadings. Nutrient-driven eutrophication creates a potential for hypoxia but the full realization of this potential to a large degree depends on lake physical conditions and internal dynamics driven by external factors (e.g. meteorology, etc.) that are, in many cases, beyond of management control. Therefore, one option to reduce the potential for hypoxia is via nutrient loading reductions. As nutrient reduction measures are costly, the decision-makers should be informed on the expected ecological improvements resulting from the proposed measures to make a cost-effective decision. The forecasting of hypoxia can be based on the application of numerical models. Such models are powerful tools which can provide the realistic insights into predictions of the future behavior of a complex system that would be impossible from empirical observations alone. In this study we employ a 3-D coupled hydrodynamic and water quality model, previously calibrated and validated for Lake Erie, to develop a load-response curve by quantifying the response of hypoxia to various nutrient loading scenarios in Lake Erie. The assumptions and uncertainties in the estimates of the load-response curve will be discussed. *Keywords: Lake Erie, Hypoxia, Nutrients, Load-response curve, Management, Annex 4.*

BOEHM, G.D., VIAL, B.S., HALPERIN, S.E., CABLE, R., and DUHAIME, M.B., University of Michigan, Kraus Natural Sciences, N. University Ave, Ann Arbor, MI, 48103.

**Great Lakes' Microplastics: Developing novel methods of microplastic extraction and quantification.**

The accumulation of plastic debris in natural ecosystems is "one of the most ubiquitous and long-lasting recent changes to the surface of our planet" (1). Potential ecological impacts include adsorption of organic pollutants onto plastics, threatened organismal survival via entanglement or ingestion, and increased habitat ranges of non-native species. Due to the small size of plastic debris - 81% of plastics in the Great Lakes are <1mm - and the lack of accurate, efficient extraction and separation methods, the presence and distribution of plastics in freshwater systems is poorly understood. To minimize an acute knowledge gap in microplastic separation procedures, we have developed novel methods for the extraction, quantification, and identification of microplastics from freshwater samples. Between May and August of 2014, we collected 114 samples from 41 stations across Lake Erie, Lake St. Clair, Lake Superior, and Lake Huron; samples were subsequently processed through manual separation and enzymatic digestion, quantified with fluidic imaging, and identified via microspectroscopy. Methods to accurately and efficiently quantify microplastics will elucidate the ecological and environmental health risks of plastics in the Great Lakes. 1. Barnes, DK, et al. (2009) Philos Trans R Soc Lond B Biol Sci 364, 1985-998. *Keywords: Pollutants, Methods, Ecosystem health, Microplastics.*

BOHLING, M.E.[1], VACCARO, L.E.[2], MANNY, B.A.[3], READ, J.G.[2], BENNION, D.[3], KENNEDY, G.W.[3], ROSEMAN, E.F.[3], BOASE, J.[4], THOMAS, M.V.[5], DROUIN, R.[6], and DIANA, J.S.[7], [1]MSU Extension Sea Grant, Southgate; [2]UofM Water Center, Ann Arbor; [3]USGS Great Lakes Science Center, Ann Arbor; [4]US FWS, Alpena; [5]MI DNR, Harrison Township; [6]Ontario Ministry of Natural Resources, London; [7]Michigan Sea Grant, Ann Arbor. **Using Adaptive Management to Create Sustainable Great Lakes Fish Communities via Habitat Restoration.**

Fish communities in the international waterways that flow between Lakes Huron and Erie have suffered greatly since the arrival of the first Europeans over 300 years ago. In the late 1800s and early 1900s, the waterways of the St. Clair River, Lake St. Clair and Detroit River supported large populations of lake sturgeon, lake whitefish and a highly profitable commercial fishery. Construction of shipping channels and hardening of shorelines during the early 1900s to improve conditions for commercial shipping removed or covered highly productive fish spawning and nursery areas, contributing to fish population declines. Overfishing and pollution also played a role in the decline but ecological studies indicate that today, access to suitable habitat continues to be one of the key factors limiting the recovery of native fishes. To mitigate historical habitat losses, Michigan Sea Grant and a broad coalition of partners have conducted habitat restoration of 5 rock-rubble fish spawning beds in the St. Clair and Detroit Rivers, with plans for 2-3 more. Using an adaptive management approach, the team seeks to continually improve and inform future projects. This session will explore over 10 years of adaptive management assessments, lessons learned, project modifications, and monitoring improvements. *Keywords: Coastal ecosystems, Adaptive management, Fish populations, Habitats.*

BOLINGER, R.A.[1], GRONEWOLD, A.D.[1], and KOMPOLTOWICZ, K.[2], [1]NOAA Great Lakes Environmental Research Laboratory, 4840 S. State Rd, Ann Arbor, MI, 48108; [2]U.S. Army Corps of Engineers, Detroit, MI. **Improving Climate Inputs into Operational Lake Level Forecasts.**

The U.S. Army Corps of Engineers currently forecasts six months of water levels for the Great Lakes by relying on output from two statistical models and a hydrologic model (AHPS) provided by the Great Lakes Environmental Laboratory (GLERL). These models are initiated by temperature and precipitation values that are estimated from an analysis of the Climate Prediction Center's long-term outlooks. A new methodology is proposed to increase efficiency and accuracy in the inputs that these water level forecasts are dependent upon. This new forecast method grabs climate model forecasts, selects the gridpoints over

the individual lakes, and estimates a lake basin averaged forecast of temperature and precipitation. A skill assessment of the various climate model estimates, as well as the current operational estimates, is performed to determine which model most accurately captures the climate variability over the Great Lakes region. *Keywords: Climatic data, Model testing.*

BOUCHER, M.A.[1], LAROUCHE, B.[2], and ST-HILAIRE, A.[3], [1]Université du Québec à Chicoutimi, 555 boul de l'Université, Saguenay, Qc, G7H2B1; [2]Rio-Tinto-Alcan, Énergie Électrique, Carré Davis, Saguenay, Qc, G7S4R5; [3]Institut National de la Recherche Scientifique, Centre Eau, Terre, Environnement, 490 Rue de la Couronne, Québec, Qc, G1K9A9. **Assessing the hydrological uncertainty for optimal management of Lake St-Jean.**

The aluminum producer Rio Tinto Alcan (RTA) manages seven hydropower plants on the Saguenay-Lac-St-Jean watershed in Quebec, for a total installed capacity above 3000 MW. The hydropower production also relies on three reservoirs, among which the Lake St-Jean. With an area of 1 053 km2 and a volume of 5 400 hm3, this lake is one of the largest in the province.The lake is also one of the primary recreational and touristic attraction of the region. This presentation will first present the current operational practices at RTA regarding lake St-Jean management, including: hydrometeorological network, database infrastructure, hydrological forecast and optimization tools. Then, four key issues addressed by an ongoing research project regarding the improvement of the operational hydrological model CEQUEAU will be discussed. Through the implementation of multiple routines for snow and evapotranspiration modeling, as well as particular filter data assimilation, It is expected that CEQUEAU will become especially appropriate for forecast uncertainty assessment, which is crucial for optimal lake management. *Keywords: Hydrologic budget, Ensemble forecasts, Uncertainty, Hydropower.*

BOURGEAU-CHAVEZ, L.L.[1], BATTAGLIA, M.J.[1], ENDRES, S.L.[1], MILLER, M.E.[1], LAUBACH, Z.M.[1], BANDA, E.C.[1], CHOW-FRASER, P.[3], and HIGMAN, P.[2], [1]Michigan Tech Research Institute, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [2]Michigan Natural Features Inventory, Lansing, MI; [3]McMaster University, Hamilton, ON. **Development of a bi-national Great Lakes coastal wetland map for resource management.**

Mapping methods using extensive field data and three season Landsat and PALSAR imagery were developed to map wetland type and identify potential wetland stressors (i.e. adjacent land use) for the United States and Canadian Laurentian coastal Great Lakes. Mapped area included the coastline to 10 km inland to capture the region hydrologically connected to the Great Lakes. This effort represents the first comprehensive wetland delineation of the bi-national coastal Great Lakes using a consistent mapping technique. It includes detection of select invasive plant species (e.g. *Typha* spp., *Schoenoplectus* and *Phragmites australis*). Maps were developed in cooperation with the overarching Great Lakes Consortium plan to provide a comprehensive regional baseline map suitable for coastal wetland assessment and management by agencies at the local, tribal, state and federal levels and serve to augment previously completed *Phragmites* mapping funded by the USFWS and USGS Great Lakes Science Center. The project goal was to provide not only LULC baseline data at moderate resolution (20-30 m), but a repeatable methodology to monitor change into the future. *Keywords: Phragmites australis, Wetlands, Remote sensing.*

BOWEN, G.S.[1], CHOMICKI, K.M.[1], and TAYLOR, W.D.[2], [1]Toronto and Region Conservation Authority, 5 Shoreham Dr, Toronto, ON, M3N 1S4; [2]University of Waterloo, 200 University Ave W, Waterloo, ON, N2L3G1. **Variability In Phosphorus At Western Durham, Lake Ontario: Patterns And Potential Sources.**

In the 1960s and 1970s, lakewide eutrophication and shoreline algal fouling were major issues threatening the health of the Lower Laurentian Great Lakes. After reductions in land-based nutrient loadings, water quality conditions improved; however, recently there has been a resurgence of algal fouling occurring in the nearshore regions of all of the Lower Great Lakes, including the region by Western Durham, Lake Ontario. The nearshore of Western Durham has a variety of potential nutrient sources including storm drain outlets, four rivers/creeks, and a sewage treatment plant. The Toronto and Region Conservation Authority has been monitoring water quality in the nearshore environment of Western Durham approximately 5 to 8 times per year during the ice off season since 2007. This talk will examine the variability in and distributions of total phosphorus and soluble reactive phosphorus in the nearshore, and highlight patterns near potential nutrient sources. In addition, we will explore time-trends in phosphorus concentration in the nearshore. Long term monitoring programs are wise investments and lead to informed decision making and management efforts. *Keywords: Algae, Distribution patterns, Nearshore, Nutrients.*

BOWEN, K.L. and CURRIE, W.J.S., Fisheries and Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7S 1A1. **An Ecosystem Gradient Approach to Classifying Impairment of Plankton Communities.**

One of the most challenging obstacles faced by researchers working in Great Lakes Areas of Concern (AOCs) is the lack of suitable reference sites. AOCs such as the Bay of

Quinte and Hamilton Harbour are ecologically and geographically unique large embayments with coastal wetlands and river mouths, and no similar unimpacted areas exist in the Great Lakes basin. This leads to uncertainty in the development of ideal zooplankton and phytoplankton restoration targets for these AOCs. Since baseline data of pristine conditions are usually lacking, we are compiling long term lower food web, nutrient and physical data from coastal areas and embayments across the Great Lakes. We will examine how zooplankton and rotifer communities change over time across a range of locations and trophic gradients. This approach can highlight zooplankton indicator species or important environmental drivers. It will also show how an AOC compares to other ecosystems across the nutrient gradient and whether the plankton community is moving in the desired direction over time. We welcome further collaborations with other agencies that can contribute data from a variety of coastal ecosystems of large eastern North American lakes. *Keywords: Zooplankton, Coastal ecosystems, Spatial analysis.*

BOZIMOWSKI, A.A.[1], MURRY, B.A.[2], KOURTEV, P.S.[1], and UZARSKI, D.G.[1], [1]Central Michigan University, Mount Pleasant, MI, 48859; [2]US Fish and Wildlife Service, San Juan, PR, 00921. **Aquatic Macroinvertebrate Co-occurrence Patterns in the Coastal Wetlands of the Great Lakes.**

Aquatic macroinvertebrate assemblages within Great Lakes coastal wetlands represent a community that may be governed by competition. The harsh-benign hypothesis predicts competition intensity should increase as natural disturbance decreases. With harsh and benign habitats persisting within coastal wetland systems we tested different co-occurrence hypotheses. Yearly macroinvertebrate species data from 1999-2012 were reformulated into presence-absence matrices for harsh and benign sites and compared using null model analysis. Species data were further separated and analyzed within functional feeding group. The effects of predation by fish as an alternative to competition based assembly rules were explored through exclosures. Competition was expected to be more likely in benign sites. Furthermore, competitive structure within functional feeding groups consistent with resource competition was also expected; however, species co-occurrence within harsh and benign ecosystems as well as within functional feeding groups was calculated to be largely random or unstructured. The removal of fish predation significantly affected community assembly in harsh sites while having no significant effect in benign sites. Results could be explained by fish community differences between sites as well as the marked abiotic differences. *Keywords: Environmental effects, Predation, Coastal wetlands.*

BRACKETT, M.L.[1], DANIEL, S.E.[2], and HINCHEY, E.[1], [1]U.S. EPA GLNPO, 77 W. Jackson Blvd, Chicago, IL, 60604; [2]Great Lakes Center at SUNY Buffalo State, 1300 Elmwood Avenue, Buffalo, NY, 14222. **Engaging K-12 students in benthic ecology through self-designed, in situ critter collector.**

The world of benthic invertebrates is rarely integrated into early childhood classrooms, consequently the general public may have little understanding of this science. To address this issue, we have created a fun, inexpensive, and easy "do it yourself" method to collect benthic organisms from lotic freshwater systems. The collectors, made from simple materials such as mesh bags, bricks, and rope, can be easily created and deployed by educators, parents, general public, nature centers, and anyone interested in benthic ecology. Students can bring materials from home into the classroom and assemble the critter collector before deployment. To help develop the methods and provide a foundation for what may be sampled, we deployed our critter collector in the Fox River in McHenry, Illinois in early spring. Throughout the season, we took biweekly samples until early autumn and collected over 2000 individuals from 12 different taxonomic orders. By identifying benthic invertebrates with practical keys and knowing their typical habitat requirements students will be able to learn about water and habitat quality. This simple low-cost educational tool may help engage students in science and in local environmental issues. *Keywords: Water quality, Education, Benthos.*

BRADLEY, D.[1], KOCH, K.R.[1], and AUER, N.A.[2], [1]LimnoTech, 501 Avis Dr., Ann Arbor, MI, 48108; [2]Michigan Tech University, Dept. Biological Sciences, Houghton, MI, 49931.
**Great Lakes Larval Fish and Egg Key: New Interactive Tool for Identifying Fish Species.**

This project was initiated to develop a web-based taxonomic key for the Great Lakes to identify larval fish and eggs in order to assist the power industry to comply with new 316(b) regulatory requirements for the characterization and quantification of entrained fish species. The web-based key is structured around existing print keys developed by Nancy Auer (Michigan Tech), with updates from Howard Kowalyk (SENES), review support from Paul Patrick (SENES) and others. This Electric Power Research Institute funded project is initially developed as an updated regional resource to support compliance efforts, however it is openly accessible to anyone who interested in larval and egg species identification. The electronic tool is based on LUCID's taxonomic database suite and offers taxonomic descriptions, hand drawings and photo images for the identification of 26 families and 150 species of fish commonly found in the Great Lakes. The website and tool is publically-

accessible and may be expanded in the future to include keys from other regional coastal areas. Presentation will demonstrate the key, discuss its use and next steps. *Keywords: Fish identification, Data storage and retrieval, Taxonomic identification, Fish.*

BRADY, V.J.[1], DUMKE, J.D.[1], KOVALENKO, K.E.[1], GEARHISER, M.[1], JOHNSON, L.B.[1], CIBOROWSKI, J.J.H.[2], and GATHMAN, J.P.[3], [1]Natural Resources Research Institute, University of Minnesota Duluth, 5013 Miller, Duluth, MN, 55811; [2]Dept. of Biological Sciences, University of Windsor, Windsor, ON; [3]Department of Biology, University of Wisconsin River Falls, River Falls, WI. **Macroinvertebrate Sampling and Condition Indicator Development of Great Lakes High Energy Coasts.**

Sparsely vegetated, rocky and sandy shorelines dominate the Great Lakes coasts. These high energy coastlines are notoriously difficult to sample, particularly when they are rocky. Thus, the 0.5 to 5-m depth zone has been understudied, and there is a need to identify reliable, cost-effective sampling methods and condition assessment indicators for these coastal ecosystems. During three different projects, we sampled high-energy coastal margin habitats using a variety of methods, including D-frame dip nets and rock scrubs in the shallowest water, and petite ponar grabs and artificial substrates in deeper water. Sample richness was higher than expected, particularly for artificial substrate collections. Assemblage composition depended on both sampling method and natural substrate composition, but Chironomidae and Oligochaeta dominated in all methods. Each method had its pros and cons, reflecting the effort required and the substrates and depths for which it was effective. In assemblages collected by D-net, we found that clingers and oligochaetes were responsive to the amount of agriculture in the coastal catchment, whereas proportions of omnivores and burrowers reflected the amount of development in the adjacent coastal catchment. *Keywords: Coastal ecosystems, Macroinvertebrates, Indicators.*

BRAMBURGER, A.J. and REAVIE, E.D., Natural Resources Research Institute, University of Minnesota Duluth, Duluth, MN, 55812. **The Nature of Phytoplankton in the Epilimnion and Summer Deep Chlorophyll Layers in the Great Lakes.**

The formation of deep chlorophyll layers (DCL) during summer stratification in the Great Lakes has been well-documented. Floristic and ecological differences between the epilimnetic and DCL algal communities have not been extensively investigated. Consequently, we do not adequately understand the form and function of DCLs. Here, we examine changes in Great Lakes epilimnetic algal communities from 2001 through 2012, and relate these to differences between Great Lakes summer epilimnetic and DCL algal communities from 2007 through 2012. Pooled results from the Great Lakes show a decadal increase in the contribution of the cyanophyta to the overall biovolume of the summer epilimnetic algal community concurrent with decreases in relative and absolute biovolume contributions from diatoms. Additionally, taxon-specific cell biovolumes are lower among siliceous algal taxa (diatoms and chrysophytes) from epilimnetic samples than from those in DCL samples. The opposite trend is exhibited for cyanophytes. These findings, along with consistently dense spring diatom blooms and steadily-increasing integrated epilimnetic water temperatures in all lakes, suggest that diatom sinking loss rates are becoming accelerated due to steepened epilimnetic water density gradients, thereby allowing competitive release for more buoyant cyanobacteria. *Keywords: Algae, Physical limnology, Climate change, Phytoplankton.*

BRATTON, J.F., LimnoTech, 501 Avis Drive, Ann Arbor, MI, 48108. **Connections between algal blooms, land use history, and glacial lake plains in the Great Lakes.**

The Great Lakes have been heavily impacted by harmful algal blooms (HABs) in recent years due to excess phosphorus delivery from watersheds. This situation, however, is most extreme in areas that are predisposed to HAB formation due to three factors: (1) watersheds that drain former glacial lake plains, (2) historical ditching and regional lowering of the water table to permit agriculture, and (3) restricted circulation and long residence time of nutrients in receiving waters of shallow and seasonally warm embayments (e.g., western Lake Erie, Saginaw Bay). Examples exist in the basin where one or two of these factors are present, without significant development of HABs. The presence of all three, however, creates a "perfect storm" of conditions, which also makes mitigation of HABs in these settings extremely challenging, given that two of the three conditions (#1, geology of the watershed; and #3, geometry of the lake) are natural. Decisions about alteration of agricultural activities and implementation of best management practices (BMPs) to address the problem of non-point source pollution and resultant HABs in the Great Lakes must include consideration of these preexisting conditions in the basins that are targets for restoration in order to be most effective. *Keywords: Harmful algal blooms, Deglaciation, Hydrogeomorphology, Agriculture, Watersheds, Groundwater.*

BRIDGEMAN, T.B., QIAN, S.S., and GOLNICK, P.C., University of Toledo, 2801 W. Bancroft, Toledo, OH, 43606. **Apples to Apples: A Bayesian Approach for Comparing Water Quality Measurements.**

Chlorophyll a (chla) and total phosphorus (TP) concentrations are important water quality parameters for Lake Erie and have been measured by many agencies and organizations, often using different sampling protocols and/or analytical methods. To better quantify spatial distribution and temporal trends of chla and TP, we need to integrate data from multiple sources. We used Bayesian hierarchical ANOVA to analyze past monitoring data (2008-2013) from major laboratories operating in the western Lake Erie region. Using results from analyzing historical data, we designed a sampling study to test further test the differences in the historical data. We present our initial model results as well as field sample verification and subsequent updates of the differences in TP and chla due to different sampling and analytical methods. *Keywords: Monitoring, Lake Erie, Comparison studies.*

BRILAND, R.B., CULVER, D.A., and LUDSIN, S.A., Aquatic Ecology Laboratory at The Ohio State University, 1314 Kinnear Rd, Columbus, OH, 43214. **Zooplankton community response to re-eutrophication and *Microcystis* blooms in Lake Erie.**

Changing land-use practices and precipitation patterns have caused the amount of bioavailable phosphorus to increase in Lake Erie since 1995. In turn, the lake has shown symptoms of re-eutrophication, as evidenced by extensive cyanobacteria (*Microcystis* spp.) blooms during summer. The impact of these changes on Lake Erie's zooplankton community remains unknown, however. Herein, we used a long-term (1995-2012) monitoring dataset from western and central Lake Erie (n=8 sites/basin) to determine how zooplankton seasonal succession patterns changed during this time. In concordance with nutrient and phytoplankton trends, sub-dominant taxonomic groups (small-bodied Cladocera and Calanoida species) increased in abundance during early summer, whereas all major zooplankton groups increased in abundance during late summer. Additional spatial analyses also showed that zooplankton abundance and diversity were higher at sites with high versus low *Microcystis* biomass. Overall, our analyses indicate that the Lake Erie zooplankton community has responded positively to recent increases in nutrient inputs and phytoplankton production. Our findings also suggest that Lake Erie zooplankton populations can thrive in the face of widespread *Microcystis*-dominated blooms for a number of potential reasons discussed herein. *Keywords: Trophic level, Plankton, Eutrophication.*

BRONTE, C.R., LANE, A.A., WEBSTER, J.L., PANKOW, K.W., MANN, K.A., and KORNIS, M.S., U.S. Fish and Wildlife Service, Great Lakes Fish Tag and Recovery Laboratory, 2661 Scott Tower Drvie, New Franken, WI, 54229. **An Overview of the Great Lakes Mass Marking Program.**

Over 20 million salmonines are annually stocked in the Laurentian Great Lakes to support sport fisheries, restore native fishes, and control invasive species. However, little is known about hatchery-reared fish survival and contribution to fisheries, or about levels of natural reproduction by naturalized salmonines. To address these issues, the Council of Lake Committees (CLC) of the Great Lakes Fishery Commission requested a basin-wide program to tag/mark all stocked salmonines. The Great Lakes Fish Tag and Recovery Lab (GLFTRL) was established to design and implement the program, and began using automated fish tagging trailers to coded-wire tag and adipose fin clip hatchery-reared Chinook salmon and lake trout in 2010. Here, we provide a description to raise awareness about this basin-wide program. To date, the lab has tagged/marked 16 million Chinook salmon and 28.5 million lake trout stocked in the Great Lakes. Tag recovery teams work with state Depts. of Natural Resources to recover tags and collect biological data from angler-harvested fish. Fish snouts, containing tags, are sent to the GLFTRL for tag extraction, and thus far over 46,000 coded-wire tags have been recovered. Analysis of recovery data is underway, and will further inform fishery management decisions as tagged fish age and move through the fishery. *Keywords: Salmon, Fisheries, Experimental design.*

BROOKS, C.N.[1], GRIMM, A.G.[1], SHUCHMAN, R.A.[1], SAYERS, M.J.[1], and CHOW-FRASER, P.[2], [1]Michigan Technological University, Michigan Tech Research Institute, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [2]Department of Biology, McMaster University, 1280 Main St., Hamilton, ON, L8S 4K1. **Satellite-based assessment of nutrient status and benthic algae distribution in eastern Georgian Bay.**

Satellite remote sensing data were used to produce a suite of water quality and vegetation products for the eastern portion of Georgian Bay, including a time series of submerged aquatic vegetation (SAV) distribution maps and monthly maps of lake surface temperature and color producing agents. The overall purpose of this initiative was to summarize and synthesize environmental information on the study area that is available from existing remote sensing products developed by MTRI and to fine-tune those products for Georgian Bay conditions. Field data collected in southeastern Georgian Bay in July 2014 were used to validate these products. The data indicate that while water clarity has greatly increased in the Bay in recent decades, the expansion in SAV cover has been limited, in contrast with the nuisance growth in many other parts of the Great Lakes Basin. At the same time, the chlorophyll concentration in the Bay has declined steadily since the early 2000s. *Keywords: Georgian Bay, Monitoring, Water quality.*

BROOKS, C.N., SHUCHMAN, R.A., SAYERS, M.J., GRIMM, A.G., and BILLMIRE, M.G., Michigan Technological University, Michigan Tech Research Institute, 3600 Green

Ct., Ste. 100, Ann Arbor, MI, 48105. **Developing and Applying User-Friendly Web Portals for Sharing Great Lakes Remote Sensing Data.**

In recent years, more satellite-derived remote sensing products have become available for the Great Lakes, and several related efforts have developed to enable greater sharing of these valuable data. Working closely with NOAA Great Lakes CoastWatch and the Great Lakes Observing System (GLOS) Data Management and Communications (DMAC) group, MTRI has been applying a combination of custom portals, standardized data sharing methods, appropriate metadata, and useful symbolization to make these data more available to end users and other stakeholders. At MTRI's "Satellite-Derived Great Lakes Remote Sensing" portal (http://www.greatlakesremotesensing.org/), MTRI Color Producing Agent Algorithm (CPA-A) products such as chlorophyll, dissolved organic carbon, and suspended minerals along with Harmful Algal Bloom (HABs) maps can be viewed for the satellite cloud-free season (usually April - October). A process is underway with NOAA to make the CPA-A data available for display and download through the Great Lakes CoastWatch node. The GLOS Data Portal has been working through its DMAC committee to make remote sensing data available, along with recent ship-based data, thermistor chain data, and optical properties information. *Keywords: Data storage and retrieval, Remote sensing, Outreach.*

BROTHERS, S.M. and SIBLEY, P.K., University of Guelph, Gordon St., Guelph, ON, N1G 2W1. **From the Bottom Up: Integrating the Benthos for a Fuller Understanding of the Laurentian Great Lakes.**

Recent work suggests that benthic primary production may currently represent as much as one third of the total annual primary productivity in the Great Lakes. This emerging understanding of the important and expanding ecological role of the benthic environment may have multiple and far-reaching implications for research in these ecosystems. I will describe how the increasing role of benthic primary production over the past 40 years may help shape our understanding of food web structure, regime shift theory, ecological crises (such as the recurrent anoxia in the Central Basin of Lake Erie), and large-scale shifts in carbon cycling and ecosystem metabolism. A broader understanding of the functioning of these ecosystems is not only essential to understand the relationship between multiple stressors over time, but also the policy responses which will be necessary to address long- and short-term changes to these systems. *Keywords: Carbon cycle, Benthos, Productivity.*

BROWN, T.N. and BRADY, V.J., Natural Resources Research Institute, 5013 Miller Trunk Hwy, Duluth, MN, 55811. **Data management for large projects collecting diverse environmental field data.**

Four distinct data management approaches are compared: prescriptive data structure, abstract data storage, cheap schema changes, and cataloged file storage. The "cheap schema changes" approach has been applied to three large multi-discipline multi-investigator multi-site multi-year projects - its costs and benefits are discussed. Two aspects turn out to be harder than they seem, site status / selection and GPS / data linking. CSW (Catalog Service for Web) is presented as a possible end of project data archiving pathway. General conditions required for effective large project data management are also discussed. *Keywords: Data storage and retrieval, Ecoinformatics.*

BRUCE, J.L., RODDICK, T.M., MYERS, E.S., and NEWSON, J.K., USGS Wisconsin Water Science Center, 8505 Research Way, Middleton, WI, 53562. **Mapping Metadata: A New Tool for Exploring and Cataloging Great Lakes Science and Research.**

In the Great Lakes basin, there are numerous organizations undertaking scientific monitoring and research efforts with the goal of identifying threats and evaluating management strategies that will protect and restore the Great Lakes ecosystem. Coordination among all these stakeholders is a challenge, and having a centralized location where researchers and managers can identify relevant scientific activities and access fundamental information about these activities is crucial for efficient management. To meet this need, the USGS has developed the Science in the Great Lakes (SiGL) Mapper, a data-discovery tool that captures information about a wide range of scientific activities and provides details on how to access associated data and products. SiGL can help researchers and managers strategically plan, implement, and analyze monitoring and restoration activities by providing easy access to current and historical project metadata, connecting them with project leads and data repositories, and assisting in the identification of spatial and topical gaps in previous and ongoing monitoring efforts. SiGL provides a user-friendly and efficient way to explore projects and data through robust search options and an interactive mapping interface, in the hope of encouraging coordination and collaboration among Great Lakes stakeholders. *Keywords: Outreach, Metadata, Regional analysis.*

BRUESTLE, E.[1] and GORSKY, D.[2], [1]Great Lakes Center, 1300 Elmwood Ave, Buffalo, NY, 14222; [2]U.S. Fish & Wildlife Service, 1101 Casey Road, Basom, NY, 14013.
**Investigating lake sturgeon habitat use and residency in the Lower Niagara River.**

Lake sturgeon (*Acipenser fulvescens*) were once abundant throughout the Great Lakes but widespread overharvest and habitat degradation extirpated many stocks. Recent surveys conducted by the U.S. Fish & Wildlife Service in the Lower Niagara River (LNR) suggest that the river contains a recovering population. The LNR is clearly important to the population but how they utilize the river is poorly understood. The purpose of this study is to investigate short-term and seasonal movements of lake sturgeon in the LNR and to identify important habitats. To address this knowledge gap, lake sturgeon were captured, tagged with acoustic transmitters, and released. Movements of tagged individuals were detected by an array of passive acoustic receivers. Using the detection data from the receivers, short-term centers of activity and home range estimates at different time-scales were generated. Lake sturgeon reside in the river during the spring and early summer and move out to Lake Ontario in late summer. They also occupy deeper waters than was observable using radio telemetry. This study characterizes lake sturgeon use of the LNR and establishes their baseline habitat needs and may help inform future management activities.
*Keywords: Fish tagging, Niagara River, Acoustics.*

BUNNELL, D.B.[1], HÖÖK, T.O.[2], TROY, C.D.[2], MADENJIAN, C.P.[1], ZISCHKE, M.T.[2], HONSEY, A.E.[2], and LUI, W.[2], [1]USGS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105; [2]Purdue University, West Lafayette, IN, 47907. **Synchronicity in Recruitment Among Lake Michigan Fish Populations.**

Recent studies have demonstrated that Great Lakes fish species exhibit a larger scale of population synchrony than predicted by meta-analyses. For example, populations of yellow perch and bloater are synchronous at the scale of up to 150 and 400 km, respectively, spanning multiple lakes. Regional climate patterns that can influence fish populations at a similar scale (i.e., Moran effect) are the most parsimonious explanation for this synchrony. We hypothesized that if broad-scale climate can influence fish populations across lakes, it also could be synchronizing the year-class strength of multiple fish species within a lake. We compiled long-term indices of year-class strength for eight Lake Michigan fish species (alewife, bloater, rainbow smelt, lake whitefish, yellow perch, deepwater sculpin, slimy sculpin, ninespine stickleback) and evaluated whether any inter-species synchrony was detected. We then related the temporal patterns of synchrony with annual indices of the physical environment of the lake (i.e., temperature, circulation, upwelling, ice cover).
*Keywords: Mathematical models, Climates, Fish populations.*

BURKHOLDER, S.L., University at Buffalo, 114 diefendorf hall, buffalo, ny, 14214.
**Confined Disposal Facilities as Accessible Urban Habitat.**

There are over 3500 acres of waterfront land in the Great Lakes Basin in the form of Confined Disposal Facilities designed to hold dredged sediment. The majority of these facilities are filled to capacity and now sit quietly adjacent to the urban core. The process of dredging has led to the creation of a collection of landscapes teeming with pioneering and migratory species. Many of these landscapes are the most biologically rich areas within the urban region. The Cleveland Lakefront Nature Preserve, Buffalo's Times Beach and Pointe Mouillee south of Detroit are all examples of disposal facilities that have become hotbeds of habitat (and subsequently ecotourism). As accessibility was not initially considered, a range of ad-hoc systems have been created to connect people to these landscapes. This presentation will examine the various modes of accessibility and the range of occupation -- human and non-human, planned and unplanned -- that take place on these resultant coastal landscapes and present both successes and failures. It will also speculate future accessibility opportunities with the understanding that these facilities provide not only some of the most significant urban habitat in the basin but also, due to their urban location, also one of the best opportunities for accessible habitat and education. *Keywords: Urban areas, Accessibility, Sediments, Habitats.*

BURLAKOVA, L.E.[1], KARATAYEV, A.Y.[1], BARBIERO, R.P.[2], and DANIEL, S.E.[1], [1]Great Lakes Center, SUNY Buffalo State, 1300 Elmwood Abe, Buffalo, NY, 14222; [2]CSC, 1359 W. Elmdale Ave, Suite #2, Chicago, IL, 60660. **Integrating Environmental Effects of Multiple Stressors in the Great Lakes: Dynamics of OTI.**

Biological monitoring using benthic macroinvertebrate communities is among the most reliable and cost-effective approaches for detecting the cumulative effects of multiple stressors in aquatic systems due to the community's sensitivity to environmental disturbances and the broad range of interspecific pollution tolerances. The Oligochaete Trophic Index (OTI) was developed by Howmiller and Scott (1977) and modified by Milbrink (1983) to evaluate trophic conditions in the Great Lakes using oligochaete diversity, abundances, and the individual species responses to organic enrichment. Dynamics of OTI values during 1997-2012 consistently reflected the trophic status for all of the Great Lakes, with Lake Superior having the lowest OTI and therefore being the most oligotrophic and Lake Erie being the most eutrophic with the highest index value. However, this relationship appears to break down for the different basins of Lake Erie, as the average OTI of the eastern basin is consistently higher than in other basins, which contradicts pelagic gradients in chlorophyll a and water clarity values. We present the changes in OTI and major trophic oligochaete groups for each of the Great Lakes in the recent decades and discuss potential drivers of the changes. *Keywords: Benthos, Indicators, Trophic level.*

# C

CAI, M., BROWN, T.N., and REAVIE, E.D., Natural Resources Research Institute, 5013 Miller Trunk Hwy, Duluth, MN, 55811. **Land Use Patterns Across the Great Lakes' Basin, 1790-present, as Drivers of In-lake Change.**

Land cover / land use in the Great Lakes basin is summarized from 1790-present. Land use data (population, agriculture, mining) collected for the U.S. and Canada for all five Great Lakes, is integrated into a spatial analysis framework which allows spatial generalization and temporal interpolation. A pilot project for the Lake Superior basin allowed the approach to be evaluated from a temporal perspective, the large data set for all five lakes allows broader spatial patterns to be investigated. Visualization options and data availability and limitations are discussed. *Keywords: Paleolimnology, GIS, Ecosystem modeling.*

CAI, Y.J.[1], GONG, Z.J.[1], LU, Y.J.[2], CHEN, Y.W.[1], JIANG, J.H.[1], and LU, Y.[2], [1]Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing, CHINA; [2]Nanjing Hydraulic Research Institute, Nanjing, CHINA. **Community Structure and Additive Diversity Partitioning of Zoobenthos in China's Five Largest Lakes.**

China's five largest freshwater lakes with a total surface area of 10349 km$^2$ that account for 37.3% of total freshwater lake area in China. However, few studies were focused on benthic communities in spite of heightened anthropogenic disturbance has become the most prominent problem. In this study, we try to elucidate community structure and diversity components of macrozoobenthos in these lakes. The results indicated that taxa richness and composition differed among these lakes, with bivalves and gastropods dominated the communities in Lakes Poyang and Dongting, C. fluminea, N. oligobranchia, N. latericeus and Gammarus sp. dominated the community in Lake Hongze, while Lakes Taihu and Chaohu was mainly dominated by oligochaetes and chironomids. Lakes Poyang, Dongting and Taihu show the higher taxa richness of macrozoobenthos compared with Lakes Hongze and Chaohu. Beta diversity represented 58-86% of total γ-diversity at lake and region scale. This suggests that benthic assemblages are more heterogeneous than expected both at lake and regional scales. Our results have implications for benthic diversity conservation in shallow lakes along the Yangtze River. *Keywords: Biodiversity, Zoobenthos, Macroinvertebrates.*

CAMPBELL, S.E. and MANDRAK, N.E., University of Toronto, 1265 Military Trail, Scarborough, ON, M1C 1A4. **Changes in Functional Diversity of Fish Species in the Great Lakes Basin, 1870-2010.**

In the Great Lakes basin, the introduction of non-native species and extirpation of native species have increased over time, with a total of 35 non-native species having become established, while 3 taxa and 18 native species are now extirpated. Although changes in diversity have been studied extensively in a taxonomic framework in many systems, taxonomic diversity may not necessarily coincide with changes in functional diversity, and it has become increasingly important to understand these functional diversity changes in relation to the introduction and establishment of non-native species. Through understanding the role trait composition plays in the establishment of non-native species and extirpation of native species, management efforts will be better informed and more effective. Furthermore, many studies are limited in the number of temporal replicates due to a lack of historical data. We analyze how functional diversity has changed in relation to the extirpations of native species and establishment of non-native species in each of the Great Lakes from 1870-2010 by decade. These analyses will elucidate changes in spatial and temporal patterns of diversity over time, allowing for an examination of the drivers and implications of these changes. *Keywords: Invasive species, Functional diversity, Great Lakes basin.*

CARBERRY, B.C.[1], LANGEN, T.A.[1], TWISS, M.R.[1], HEINTZELMAN, M.D.[1], WELSH, J.R.[2], CHANDLER, D.G.[2], HWANG, K.[2], and WEBB, M.[2], [1]Clarkson University, Potsdam; [2]Syracuse University, Syracuse. **Evaluating Wetland Restoration Success and Its Impact on Landowners in the St. Lawrence River Valley.**

This study focuses on 50 wetland restoration projects constructed through public private partnerships with the National Resources Conservation Service, U.S. Fish and Wildlife Service, and Ducks unlimited, along with 18 natural reference wetlands. At each site we conducted biodiversity surveys using biotic indicators including turtles, frogs, fish, birds, and plants. Each site was then sampled for water quality analysis including algal and bacterial community composition, pH and alkalinity, and nutrient analysis. Furthermore, we installed sensors at a subset of 20 sites for hydrological analysis with the hydrogeomorphic approach. The results of these surveys will be combined with input from landowners and neighbors as well as an economic valuation using hedonic regression to create a better understanding of restoration success factors as well as landowner motivation and impact on property values. *Keywords: Amphibians, Wetlands, Habitats.*

CASAS-MONROY, O.[1], LINLEY, R.D.[1], CHAN, P.S.[2], GERLOFSMA, J.[1], VANDEN-BYLLAARDT, J.[1], and BAILEY, S.A.[1], [1]Fisheries and Oceans Canada, 867 Lakeshore Rd., Burlington, ON, L7S-1A1; [2]Trojan UV Technologies, 3020 Gore Rd., London, ON, N5V-4T7. **Examining Cold Temperature Effects on the Efficacy of UV Ballast Water Treatment.**

The use of Ballast Water Management Systems (BWMS) on board ships will be required soon to meet national and international standards aimed to reduce the risk of ballast-mediated invasions. Type approval testing of BWMSs is typically conducted at summer temperatures when plankton density is highest, despite the fact that ships operate globally at all times of the year. Extreme temperatures such as those encountered in winter in the Great Lakes or the Arctic, could impact treatment efficacy through changes in biological metabolic rates or chemical reaction rates. Here, we examine the efficacy of UVc irradiation treatment at different temperatures on phytoplankton and zooplankton populations. Filtration+UV irradiance is listed as one of the most common ballast water treatment methods, but it effectiveness, particularly at lower temperatures needs to be assessed. Organisms from two size classes (>10 to <50um - >50um) were identified and quantified using epifluorescence, culture techniques and microscopy. The response of organisms to UV irradiation was evident at 18, 12 and 2 degrees. A significant decrease between controls and treated samples for both populations was recorded. Additionally, after 14 days of incubation, the expected number of viable organisms (>10 to <50um) was within national and international discharge standards. *Keywords: Invasive species, Ultraviolet radiation, Plankton, Ballast.*

CASTANEDA, R.A. and MANDRAK, N.E., University of Toronto, 1265 Military Trail, Toronto, ON, M1C 1A4. **Novel detection techniques for rare freshwater fishes.**

The ability to properly assess species abundances, distributions and diversity is crucial for successful conservation management. However, detection of rare species poses difficulties for conservation planning. Rare species, such as species at risk and early invaders, must be detected in order to increase the predictive power of occupancy estimations-important for effecting suitable protected areas or early detection and rapid response. Sampling for rare fishes, such as species at risk, may be restricted due to potential stress and mortality from handling in the field. The inability to sample fishes at risk reduces our ability to properly monitor populations after recovery strategies and action plans have been implemented. Therefore, developing new detection methods that do not require physical handling of these species at risk is required. Underwater visual analysis (UWVA) is one such passive method gaining popularity in freshwater systems. The UWVA method could also be used to detect early invaders and optimize the success of eradication attempts. To develop this novel detection tool, we compare traditional sampling methods (seine and fyke nets) to the novel method (UWVA) in Canadian and South African watersheds. We evaluate the use of underwater cameras (GoPros) in detecting and quantifying fishes in ponds and streams. *Keywords: Detection, Cameras, Fish.*

CHAFFIN, J.D.[1] and DAVIS, T.W.[2], [1]Stone Laboratory, Ohio State University, PO Box 119, Put-in-Bay, OH, 43456; [2]NOAA Great Lakes Environmental Research Laboratory, 4840 S State St, Ann Arbor, MI, 48108. **Cyanobacteria Growth and Microcystin Production Response to Nitrogen Form and Loading Rate.**

Nitrogen (N) constrains biomass accumulation of *Microcystis* and *Planktothrix* in Lake Erie and these cyanobacteria are capable of assimilating many forms of N. We evaluated the growth response and microcystin production in response to additions of a single large pulse of nitrate, ammonium, and urea and low continuous pulses of each N form. *Planktothrix*-laden Sandusky Bay water and *Microcystis*-laden Maumee Bay water was collected during summer 2014. In the laboratory, the water was subject to 1 of 8 nutrient enrichment treatments and incubated for 48 hours: 100 umol/L nitrate, ammonium, and urea and 1 umol/L phosphate added at beginning of experiment, 8.3 umol/L every 4 hours nitrate, ammonium, and urea, and a control. In all experiments, final chlorophyll and microcystin concentrations in bottles that received N were greater than control and phosphate. Chlorophyll in the *Planktothrix* experiment did not differ among N form or pulse rate, whereas *Microcystis* had highest chlorophyll in the ammonium treatments. Microcystin in both experiments was greater in the nitrate and urea treatments than ammonium treatments. These results suggest that blooms are equally equipped to assimilate N during high pulses and low continuous pulse, such as following storms flushes and internal recycling. *Keywords: Nutrients, Toledo, Cyanophyta, Microcystin, Eutrophication.*

CHAPRA, S.C.[1] and DOVE, A.[2], [1]Civil and Environmental Engineering, Tufts University, Medford, MA, 02155; [2]Environment Canada, 867 Lakeshore Road, Burlington, ON, L7S 1A1. **Total Phosphorus Model for the Lower Great Lakes.**

As part of the Annex 4 Ensemble Modeling effort, we have developed a long-term total phosphorus (TP) budget model for the three basins of Lake Erie and for Lake Ontario.

The model, which accounts for transport between basins as well as in-lake sedimentation losses, yields off-shore total phosphorus concentrations as a function of time. Chlorophyll a concentration and Secchi disk depth are then computed with empirical correlations. The model's reliability is corroborated by comparison with Environment Canada monitoring data. In addition to predicting trends, the model is also expressed as steady-state loading-response matrices. These matrices will be highly valuable for Great Lakes managers as they can be used to assess future scenarios to select optimal eutrophication control measures at a minimum cost. *Keywords: Phosphorus, Lake management, Model studies.*

CHIANDET, A.S.[1], RUSACK, J.A.[2], SHERMAN, R.K.[1], and HOWELL, E.T.[3], [1]Severn Sound Environmental Association, 67 Fourth St., Midland, ON, L4R 3S9; [2]Ministry of Environment and Climate Change, 1026 Bellwood Acres rd., Dorset, ON, P0A 1E0; [3]Ministry of Environment and Climate Change, 125 Resources rd., Toronto, ON, M9P 3V6.
**Comparing In Situ Fluorometric Measurements of Phytoplankton with Conventional Methods.**

The Fluoroprobe (FP, bbe Moldaenke) is increasingly being used to determine the composition and extent of algal communities, providing total chlorophyll a concentrations (chl), pigment concentrations for 4 phytoplankton classes, and yellow substances (chromophoric dissolved organic matter). Evaluations of the instrument have been mixed, and extensive comparisons between in situ FP-measured chl (FP-chl), chl obtained by acetone extraction (AE-chl), and abundance using microscope counts are lacking. Using data from Severn Sound and inland lakes, we examine the accuracy of the FP in estimating chl, and whether this accuracy varies over space and time, or is influenced by sample complexity (composite vs. discrete samples). The FP's ability to distinguish phytoplankton groups is assessed by comparisons to microscope counts. Overall, in situ FP-chl correlated reasonably well with AE-chl ($r2=0.57$ for Severn Sound sites, $r2=0.74$ for inland lakes). The strength of the relationship between FP-chl and AE-chl varied by sample location, but did not change appreciably over 4 years. The FP's ability to distinguish between groups showed variable results, with phycocyanin-rich cyanobacteria identified most reliably. Despite some limitations in resolving phytoplankton groups, the FP provides reasonably accurate estimates of chl in situ. *Keywords: Measuring instruments, Harmful algal blooms, Fluoroprobe, Algae.*

CHILD, M.[1], BEJANKIWAR, R.[1], BENOY, G.[2], and DEMPSEY, D.[3], [1]International Joint Commission, 100 Ouellette Avenue, Windsor, ON, N9A 6T3; [2]International Joint Commission, 234 Laurier Street, Ottawa, ON, K1P 6K6; [3]International Joint Commission, 2000 L St. NW, Washington, DC, 20036. **Lake Erie's Western Basin: What are the Factors and Influences Driving Harmful Algal Blooms?**

Six months before the City of Toledo's 2014 drinking water crisis, the International Joint Commission issued a report of its Lake Erie Ecosystem Priority (LEEP). In this presentation, the factors and influences that led to contamination of Toledo's source water with harmful algal blooms (HABs) will be examined. The science will be reviewed as it relates to the sources and forms of phosphorus to Lake Erie and the major factors driving HABs in the lake and Maumee Bay. The presentation will conclude with a brief examination of science and public policy actions that, if implemented, would contribute to a reduction in HABs in Lake Erie and thus provide a safer source of drinking water in the future. *Keywords: Lake Erie, Harmful algal blooms.*

CHIU, C.[1] and HAMLET, A.F.[2], [1]Environmental Change Initiative, University of Notre Dame, South Bend, IN, 46617; [2]Department of Civil and Environmental Engineering and Earth Sciences, University of Notre Dame, Notre Dame, IN, 46556. **Macro-Scale Correction of Precipitation Gauge Undercatch in the Midwest/Great Lakes Region.**

Self-consistent and temporally homogeneous long-term data sets of precipitation and temperature over the entire Great Lakes and Midwest regions are needed to provide inputs to hydrologic models, assess historical trends in hydroclimatic variables, and downscale global and regional-scale climate models. To support these needs a new hybrid gridded meteorological dataset at 1/16 degree resolution based on data from coop station records, the U. S. Historical Climatology Network, the Historical Canadian Climate Database, and Precipitation Regression on Independent Slopes Method has been assembled over the Great Lakes and Midwest regions from 1915-2013 at daily time steps. Preliminary hydrologic simulations using the Variable Infiltration Capacity hydrology model showed that precipitation gauge undercatch was a very significant issue throughout the region, especially for winter snowfall. Macroscale post processing techniques were developed to adjust the regridded precipitation product from 1950-2013 forwards, accounting for undercatch as a function of wind speed simulations obtained from NCAR Reanalysis. Comparisons of simulated and observed streamflow over several river basins were used to evaluate this datasets constructed using different combinations of meteorological station inputs, with and without undercatch corrections. *Keywords: Great Lakes basin, Model testing, Watersheds.*

CHOMICKI, K.M. and BOWEN, G.S., Toronto and Region Conservation Authority, Toronto, On. **Nutrient Distributions And The Interaction Between Coastal Wetlands And The Nearshore of L. Ontario.**

Three drowned-river mouth marshes located by the outlets of the Rouge River, Duffins Creek, and Carruthers Creek, and one barrier beach lagoon marsh (Frenchman's Bay marsh) intercept waters on route from Western Durham watersheds to Lake Ontario. These coastal wetlands aid in the retention of sediments and cycling of nutrients from the watersheds prior to their entry into the nearshore. Although studies have examined these wetlands and their associated nearshore areas individually, there has been little focus on the interactions of the two systems and how the dynamics and characteristics of each system influence the nutrient patterns observed. This talk will look at nutrient distributions (e.g. total phosphorus, soluble reactive phosphorus, nitrate+nitrite) and E. coli in the marshes and nearshore during the ice-off season and explore how nearshore dynamics affect the observed patterns. It will also examine whether there are differences between the coastal nutrient nearshore patterns observed near drowned river mouths and beach barrier marshes.
*Keywords: Coastal wetlands, Nearshore, Nutrients, Water quality.*

CIBOROWSKI, J.J.H.[1], KOVALENKO, K.E.[2], HOST, G.E.[2], HOWE, R.W.[3], REAVIE, E.D.[2], BROWN, T.N.[2], BRADY, V.J.[2], DANZ, N.[4], NIEMI, G.L.[2], CAI, M.[2], and JOHNSON, L.B.[2], [1]University of Windsor, Dept of Biological Sciences, Windsor, ON, N9B 3P4; [2]University of Minnesota Duluth, Natural Resources Research Institute, Duluth, MN, 55811; [3]University of Wisconsin - Green Bay, Department of Natural and Applied Sciences, Green Bay, WI, 54311; [4]University of Wisconsin - Superior, Department of Natural Resources, Superior, WI, 54880. **Developing Bioindicators of Environmental Condition & Recovery Relative to Watershed-Based Stress.**

Bioassessment typically entails comparing a test site to the reference defined by characteristics of 'best available' sites and associated biota, and the complementary 'degraded condition' (sites whose environmental characteristics are deemed unacceptable ('most disturbed') by consensus. We derived taxon-specific bioindicators of reference-degraded conditions at Great Lakes coastal margins (assemblages of birds, aquatic vegetation, fishes, aquatic invertebrates and diatoms). Titan threshold analyses of taxon losses or gains often identified 2 thresholds on a stress gradient. At one, many sensitive species disappeared, suggesting biodiversity loss; at another tolerant taxa increasingly dominated. All assemblages were affected at approximately the same threshold, suggesting significant ecosystem functional alteration at these points. Biological indices can be calibrated to identify these

critical points as "biological criteria". We propose that the non-degraded/degraded threshold be a suitable operational target to define the boundary between impaired and non-impaired conditions needed to delist Beneficial Use Impairments at AOCs. The reference/non-reference threshold may be a suitable operational target to define the boundary between biodiverse and less biodiverse conditions. *Keywords: Wetlands, Bioindicators, Indicators.*

CLAPSADL, M.D., PÉREZ-FUENTETAJA, A., SNYDER, R., and FLECK, S., Buffalo State College, 1300 Elmwood Ave, Buffalo, NY, 14222. **Energy Content and Diet of the Emerald Shiner From Lakes Erie, Ontario and the Niagara River.**

The emerald shiner (Notropis atherinoides) is an important forage fish in the Great Lakes. The energy content of this fish is influenced by their diet and their condition. However, there are differences in food availability in different habitats and these differences can influence the energy content of the shiners. In this study we compared shiners collected in eastern Lake Erie, western lake Ontario and the upper and lower sections of the Niagara River to determine how diet affects energy content and, therefore, the energetic value of this species as a forage item for sport fish and fish-eating birds. *Keywords: Fish diets, Lake Erie, Niagara River.*

CLINE, M.T.[1], BECKER, R.H.[1], BRIDGEMAN, T.B.[1], and LEKKI, J.[2], [1]University of Toledo, Toledo, OH, 43606; [2]NASA GRC, Cleveland, OH. **Analysis of coincident HICO and airborne hyperspectral images over Lake Erie Western Basin HABs.**

Harmful algal blooms (HABs) produce waterborne toxins that pose a significant threat to people, livestock, and wildlife. 40 million people in both Canada and the U.S. depend on Great Lakes water. In the summer of 2014, in the Lake Erie Western Basin, an HAB of the cyanobacteria Microsystis was so severe that a water-use ban was in effect for the greater Toledo area, Ohio. The goal of our investigation is to examine bloom intensity and make-up by comparing hyperspectral data from NASA's HICO and NASA GRC's HSI imagers to on-lake ASD radiometer measurements using in situ water quality testing as ground reference data, all acquired on a single day during the bloom in 2014. HICO imagery acquired on Aug 15, 2014 was spatially georeferenced and atmospherically corrected using both the 6S atmospheric model and empirical line method technique utilizing on-lake ASD spectra. HSI imagery were processed in a similar way. Atmospheric correction techniques were evaluated relative to coincident on lake measurements and measured ground targets. Consistency between HICO and HSI imagery was evaluated. *Keywords: Harmful algal blooms, Remote sensing, Lake Erie.*

COCHRAN, J., PÉREZ-FUENTETAJA, A., SNYDER, R., CLAPSADL, M.D., FISHER, J., FLECK, S., OSBORNE, C., and LANG, J., SUNY Buffalo State, 1300 Elmwood Ave., Buffalo, NY, 14222. **Ecology of the Young-of-the-Year Emerald Shiner (*Notropis atherinoides*) in the Niagara River.**

One of the key factors in determining the status of fish communities in an ecosystem is to gain an understanding of their early life stages. Therefore, aspects of young-of-the-year (YOY) fish ecology is the focus of this study, as it has been relatively understudied in the upper Niagara River (NY, USA). Species assemblages will be analyzed throughout the river at various sampling sites representing marsh, island, creek mouth, and marina habitat types. Species composition and diversity indices will be utilized to compare habitat types. Analysis of length-frequency distributions of assemblages and populations will give insight into growth and potential size-assorted shoaling of YOY fish communities over temporal and spatial gradients throughout the river. Research will be focused on the emerald shiner (*Notropis atherinoides*), a small planktivorous pelagic fish that is an ecologically and economically important forage species within the Great Lakes region. Larval emerald shiner appearance and adult gonadosomatic index data will be utilized to determine the currently unknown spawning season within the river. Results from this study will be novel to the upper Niagara River and will establish a foundation for early life stage emerald shiners in this corridor waterway, benefiting the future research of this species. *Keywords: Emerald shiner, Niagara River, Young-of-the-year, Fish.*

COHRS, M.G., HORGAN, M., LEATHEM, M., and NELSON, H., Fluid Imaging Technologies, 200 Enterprise Drive, Scarborough, ME, 04074. **Continuous Imaging Flow Cytometer for Detection and Research of Cyanobacterial Blooms.**

Various technologies utilize fluorescence measurements to detect cyanobacteria and estimate biovolume or cell counts within a water system. While useful in trending applications, results from these instruments can be significantly skewed by turbidity and the presence of other fluorescing pigments. However little more is gained than an unverifiable generalization of the population dynamics of the type of organism present in cyanobacterial blooms. Fluid Imaging Technologies has recently adapted their imaging flow cytometer, the FlowCam, so that it can detect the presence of the phycocyanin pigment in cyanobacteria and, through imaging, verify the results of the analysis. Further analysis into organism identification, biovolume calculation, growth rate monitoring, health of the population, and many other population specific dynamics can be monitored providing increased insight into the dynamics of Freshwater Harmful Algal Blooms. Here we present an overview of the

technology along with data demonstrating the efficacy of the instrument to measure these various attributes. *Keywords: Water quality, Cyanophyta, Algae.*

COLBORNE, S.F., BARKLEY, A., and FISK, A.T., Great Lakes Institute for Environmental Research, University of Windsor, 401 Sunset Avenue, Windsor, ON, N9B 3P4. **Establishing Tissue Discrimination Values for the Use of Sulphur Isotopes in Freshwater Systems.**

Stable isotope analysis has become commonplace in studies of aquatic communities, including numerous studies of communities in the Great Lakes. Most of these studies are based solely on inferences from carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes alone, but there are limitations to what can be inferred from two isotopes. Recently there has been interest in the addition of sulphur ($\delta^{34}S$) isotopes to freshwater foraging studies because of the increased precision that may be added to isotope mixing models. For isotopes to provide reliable diet inferences we must have an understanding of the processes that determine isotopic composition. We examined the isotopic variation of all three isotopes between consumers and their resources (i.e. diet discrimination factor) on a tissue-specific basis in a common fish from the Great Lakes region. Bluegill sunfish (*Lepomis macrochirus*) were held under controlled diets for a 145 day period and the diet discrimination factors between the fish and isotopically stable diets were examined, as well as variation among different tissues (white muscle, liver, fin, whole blood). By applying the information learned from laboratory-based studies we will be able to reliably infer resource use of wild fish using carbon, nitrogen, and sulphur isotopes. *Keywords: Isotope studies, Fish diets, Stable isotopes.*

COLLART, L.P., HU, C., BRILAND, R.B., LEE, J., and LUDSIN, S.A., The Ohio State University, 1314 Kinnear Road, Columbus, OH, 43212. **Phylogenetic and Nitrogen Growth Analyses of Lake Erie *Microcystis* Strains.**

Lake Erie's harmful algal blooms (HABS) are largely composed of nontoxic and toxic (microcystin producing) strains of the cyanobacteria *Microcystis*, which are irregularly affected by nitrogen (N) availability. N does not seem to directly affect microcystin production, but can affect the growth rate of cells and indirectly predicts intracellular microcystin concentrations. Since different strains have yielded various results pertaining to the effect of N limitation and microcystin production, we investigated the phylogenetic categorization of strains cultured from the harmful algal blooms of Lake Erie's Western Basin and selected nontoxic and toxic strains to conduct N limiting growth rate analyses. Two phylogenies were created based on the *mcyA* and PC-IGS regions, which included cultured strains and whole water samples. For the N growth analyses, each of the strains were separately grown in batch cultures with a series of nitrogen concentrations for each strain. Growth analyses were also conducted in which N was added in pulses over time and the microcystin concentrations were quantified. With increasing concern over the contamination of drinking water sources, a deeper understanding of microcystin production at the strain level may lead to more effective water management strategies. *Keywords: Harmful algal blooms, Genetics, Microcystis.*

COLLINGSWORTH, P.[1], KRAUS, R.[2], MAY, J.[3], and WARREN, G.J.[3], [1]Department of Forestry and Natural Resources, Purdue University, 715 W.State Street, West Lafayette, IN; [2]USGS Lake Erie Biological Station, 6100 Columbus Avenue, Sandusky, OH; [3]USEPA-GLNPO, 77 W. Jackson Blvd, Chicago, IL. **What is the spatial extent of hypoxia in Lake Erie?**

Seasonal hypoxia is a regularly-occurring, natural phenomenon in the bottom waters of the central basin of Lake Erie. However, there is increasing evidence that hypoxic conditions are influenced, at least in part, by tributary loading of nutrients. In order to fully account for such anthropogenic contributions, baseline estimates of the spatial extent and severity of hypoxia are required. Here, we present preliminary results from a monitoring program designed to provide a high-resolution estimate of the spatial extent of hypoxia in central Lake Erie. During the summer of 2014, in conjuncture with CSMI field efforts in Lake Erie, we deployed an array of 25 dissolved oxygen loggers throughout the central basin of Lake Erie, with an emphasis on near shore areas. Our initial results indicate that the hypoxic zone is dynamic, particularly along its edge and that rapid intrusions of hypoxic water into near shore areas are common. We conclude with a comparison of our estimates of the size of the hypoxic zone to previously published estimates based on measurements taken from EPA historical data and discuss the implications of dynamic hypoxia for Lake Erie's fisheries. *Keywords: Ecosystem health, Hypoxia, Eutrophication.*

COLLIS, L.M.[1], WATKINS, J.M.[1], O'MALLEY, B.P.[2], SAAVEDRA, N.E.[1], WEIDEL, B.C.[3], and RUDSTAM, L.G.[1], [1]Cornell Biological Field Station, Department of Natural Resources, Cornell University, 900 Shackelton Point Rd., Bridgeport, NY, 13030; [2]Rubenstein School of Environment and Natural Resources, University of Burlington Vermont, Burlington, VT; [3]U.S. Geological Survey, Great Lakes Science Center, Lake Ontario Biological Field Station, 17 Lake St., Oswego, NY, 13126. **Determining the spatial and temporal distribution of *Dreissena* veligers in Lake Ontario.**

The early life ecology (i.e., veliger stage) of the invasive zebra and quagga mussel (*Dreissena polymorpha* and *Dreissena rostriformus bugensis*) is not well understood, despite these mussel's significant impact on the Laurentian Great Lakes since their introduction in the 1980s. Multiple near shore and off shore zooplankton tows were taken in the epilimnion, metalimnion, and hypolimnion of Lake Ontario between April 2013 and October 2013. Veliger size, density, and biomass was estimated for each month in each strata to determine the seasonal spatial distribution of *Dreissena* veligers within the water column and throughout the lake, and then compared with lake-wide temperature and chlorophyll-a data to determine the impact of water temperature and lake productivity on veliger distribution and abundance. Additionally, the proportion of *Dreissena* veligers to crustacean zooplankton was calculated to determine the relative importance of zebra and quagga mussels on the Lake Ontario zooplankton community. Epilimnetic tows taken throughout Lake Ontario in 2003 and 2008 were also examined to observe changes in veliger abundance over time. The results of this study will further the understanding of the early life history of dreissenids and their impacts on the lower trophic levels of freshwater systems. *Keywords: Dreissena, Veliger, Lake Ontario, Zooplankton.*

COMER, B., SUNY College of Environmental Science and Forestry, 1 Forestry Drive, Syracuse, NY, 13210. **Air pollution in the Great Lakes region: Implications for environmental justice.**

Despite successes in reducing harmful air emissions from stationary and mobile sources, air pollution continues to impact human health and the environment in the Great Lakes region. Air pollution is not evenly distributed throughout the region, and many urban coastal areas endure impacts from multiple land-based and water-based sources. The vast natural resources of the region, including the lakes themselves, produce a unique landscape that enables activities such as trade, manufacturing, energy generation, and transportation. While these activities produce economic benefits, they also produce air pollution emissions from both stationary and mobile sources that entail serious health consequences for human communities and ecosystems. This paper examines the relationship between air pollution concentrations and sociodemographic factors in the Great Lakes region using geographic information systems (GIS), ambient air quality monitoring data, census data, and geospatial statistics; the environmental justice implications of these dynamics are discussed. *Keywords: GIS, Environmental justice, Human health, Air quality, Pollution load.*

CONFESOR, R.B., JOHNSON, L.T., BAKER, D.B., and KRIEGER, K., NCWQR, Heidelberg University, 310 E Market St., Tiffin, OH, 44883. **Reducing nutrient loading: are we targeting the right sources and implementing the right solutions?**

Identification and placement of agricultural best management practices (BMPs) is necessary in reducing nutrient runoff from agricultural lands to achieve desired ecological responses in Lake Erie. Limited funding prevents subsidized watershed-wide application of BMPs, and most implementation programs focus on agricultural areas that are most vulnerable to nutrient and sediment loss. These critical source areas (CSAs) are usually characterized by soil type, land use and cover, and terrain. A detailed SWAT setup that incorporated 4-year crop rotations and corresponding agricultural management practices for each crop was used to identify CSAs in the Sandusky watershed in northwest Ohio. Results showed that the CSAs of nutrients, especially DRP, are not static but change both temporally and spatially. The CSAs were highly dependent on weather conditions as well as the crop planted and its associated management practices in a given year. The results indicate that targeting specific areas may not be effective in significantly reducing DRP loads. A watershed-wide approach that focuses on cultural and management practices (e.g., 4R principle, fertilizer application methods), rather than structural (e.g., filter strips, grassed waterway, etc.) might lead more effectively to a sustainable reduction DRP loads. *Keywords: Nutrients, Best management practices, Model studies, Critical Source Areas, Loadings.*

COOPER, M.J.[1], COSTELLO, G.M.[2], FRANCOEUR, S.N.[2], and LAMBERTI, G.A.[1], [1]University of Notre Dame, 100 Galvin Life Sciences Center, Notre Dame, IN, 46556; [2]Eastern Michigan University, 441 Mark Jefferson, Ypsilanti, MI, 48197. **Nitrogen Limitation of Algal Biofilms in Coastal Wetlands of Lakes Michigan and Huron.**

Coastal wetlands are particularly susceptible to nutrient runoff given their proximal location to inflows. We used nutrient diffusing substrata (NDS) to determine whether nitrogen (N), phosphorus (P), or both nutrients limited algal biomass accrual in 54 wetlands of Lakes Michigan and Huron. Nitrogen was the most common limiting nutrient, with 43% of wetlands exhibiting N limitation, 18% exhibiting N+P co-limitation, 3% exhibiting P limitation, and 36% exhibiting neither N nor P limitation. The magnitude of nutrient limitation was negatively correlated with water column nutrient concentrations and surrounding agricultural, suggesting that anthropogenic nutrient loading partially relieved nutrient limitation in many locations. We also analyzed benthic algal community structure to determine whether N-fixing taxa were associated with N-limited wetlands. Nitrogen-fixing algae were common in our study wetlands and their abundance was related to nutrient concentrations and nutrient limitation. Our results demonstrate that anthropogenic N loading, which receives considerably less management attention than P in the Great Lakes, can affect coastal wetland algal communities. Since benthic algae represent an important energy source for coastal wetland food webs, impacts associated with N loading may have broad implications. *Keywords: Nutrients, Nitrogen, Coastal wetlands, Phosphorus.*

CORBIERE, M.M. and TORBICK, N.M., Applied GeoSolutions, 55 Main Street, Suite 125, Newmarket, NH, 03857. **Mapping urban sprawl in the northeast USA for the past four decades to support lake management.**

Impervious surfaces (IS) are known to adversely impact water quality, volume, and flow rates. IS metrics are used in many watershed health assessment protocols and different techniques for deriving IS have been successfully applied. The goal of this research was to map spatiotemporal changes in urban extent and IS for the past four decades to support watershed assessment and lake resource management. Relationships between NLCD 2011 IS values and corresponding Landsat TM Tasseled Cap transformations were used to map IS values across the study areas. A Classification And Regression Tree (CART) was implemented utilizing the random forest (Brieman 2001) algorithm to classify the Landsat imagery into land use/cover maps. A spatiotemporal analysis routine identified rates of urban sprawl and IS dynamics at pixel and watershed scales. Cross validation of the random forest CART performed using withheld samples had an overall accuracy and kappa of 0.67% and 61% for the 15 NLCD 2011 classes. Producer's and User's accuracy for Developed Open Space, Developed Low, Medium, and High Intensity were 0.40, 0.69, 0.80, 0.92, and 0.60, 0.71, 0.84, 0.95, respectively. The regression approach to use Landsat Tasseled Cap indices to map IS across the northeast was relatively robust with strong measures of performance R2: 0.89 (p-value <0.0001). *Keywords: Urbanization, Remote sensing, Watersheds.*

CORSI, S.R.[1], DE CICCO, L.A.[2], BALDWIN, A.K.[1], ALVAREZ, D.A.[3], LENAKER, P.L.[1], and REIF, D.M.[4], [1]U.S. Geological Survey, Wisconsin Water Science Center, 8505 Research Way, Middleton, WI, 53562; [2]U.S. Geological Survey, Center for Data Analytics, 8505 Research Way, Middleton, WI, 53562; [3]U.S. Geological Survey, Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO, 65201; [4]North Carolina State University, Department of Biological Sciences, 4219 Broughton Hall, Raleigh, NC, 27695. **Organic Contaminants in Great Lakes Tributaries: Watersheds and Chemicals of Greatest Concern.**

Trace organic contaminant concentrations in some Great Lakes tributaries indicate potential for adverse impacts on aquatic organisms. Chemicals used in agriculture, industry, and households enter surface waters via urban and agricultural runoff, sewage systems, and combined sewage overflows to name a few. Water samples were collected and passive samplers deployed between 2010 and 2013 at 57 tributaries to the Great Lakes for the Great Lakes Restoration Initiative. Sites represented a range of land use from forested to agricultural to urban. Water samples were collected over variable hydrologic conditions and analyzed for a suite of 69 contaminants; passive samplers were deployed for 30 days and analyzed for 155 contaminants. Analytes included pesticides, polycyclic aromatic hydrocarbons (PAHs), pharmaceuticals, fire retardants, detergent metabolites, plasticizers, personal care products and others. Concentrations of many contaminants were positively correlated to the amount of urban land use in a watershed. Contaminant concentrations were compared with multiple bioassay endpoint concentrations retrieved from the ToxCast™ database that are relevant to aquatic life. Results were used to rank tributaries by their potential impact on aquatic life, with prioritization of the most influential contaminants. *Keywords: Environmental contaminants, Tributaries, Ecosystem health.*

COUSINO, L.K., BECKER, R.H., and ZMIJEWSKI, K.A., University of Toledo, 2801 Bancroft St, Toledo, OH, 43606. **Modeling the Effects of Climate Change on Water, Sediment, and Nutrient Yields from the Maumee River.**

Harmful algal blooms (HABs) in the Western Basin (WB) of Lake Erie have been linked to nonpoint pollution from agricultural watersheds. The Maumee River watershed is the largest in the Great Lakes region and delivers the biggest sediment and nutrient load to Lake Erie. Climate change could alter the magnitude and timing of sediment and nutrient delivery to the WB. Data from 4 CMIP5 models were inputted into a calibrated SWAT model of the Maumee River watershed to determine the effects of climate change on watershed yields. Tillage practices were also altered within the model to test the success of conservation practices under historical and future climate scenarios. Moderate climate change reduced annual flow (up to -24%) and sediment (up to -26%) yields, while more extreme scenarios showed smaller decreases in flow (up to -10%) and increased sediment loads (up to +11%). No-till practices had a negligible effect on annual flow, but produced 16% lower sediment loads than scenarios using current watershed conditions. At high implementation rates, no-till practices show the potential to offset any future increases in annual sediment loads, but they may have varied seasonal success. Regardless of the intensity of climate change, increased remediation efforts will be likely be necessary to significantly reduce HABs in the WB. *Keywords: Sediment load, Sediment quality, Climate change.*

CRANE, T. and PEARSON, R.A., Great Lakes Commission, Ann Arbor, MI, 48104.
**Tracking Human Uses of the Great Lakes-St. Lawrence River Water Resources.**

Since 1987, the Great Lakes Commission has been the repository for the Great Lakes-St. Lawrence River Regional Water Use Database, publishing 21 annual water use data reports. Over the years, the Great Lakes states and provinces have contributed aggregated water use data by lake or St. Lawrence River watershed for ten water use sectors to the regional database. After two decades of collecting water use data and issuing the annual water use reports under the Great Lakes Charter, the database has been revised and upgraded to meet the requirements set forth by the Great Lakes-St. Lawrence River Basin Water Resources Compact and Great Lakes St. Lawrence River Basin Sustainable Water Resources Agreement. The Compact Council and Regional Body adopted the new water data collection and reporting protocols in 2009. The protocols offer guidance to ensure that water use data provided to the database repository by the states and provinces is accurate, of the highest quality, and reported in a common and consistent manner. The 2013 annual water use report - the latest report - presents the second dataset that was assembled using the 2009 water use data collection and reporting protocols. In 2013, the total withdrawal amount for the Basin was 42,380 million gallons per day (mgd). *Keywords: Watersheds, Water resources, Regional analysis, Water use, Data acquisition.*

CRIMMINS, B.S.[1], MILLIGAN, M.S.[2], XIA, X.[1], PAGANO, J.J.[3], HOPKE, P.K.[1], and HOLSEN, T.M.[1], [1]Clarkson University, Potsdam, NY; [2]SUNY Fredonia, Fredonia, NY; [3]SUNY Oswego, Oswego, NY. **Identifying Emerging Contaminants in Lake Erie Trout using Atmospheric Pressure GC-QTOF-MS.**

The Great Lakes Fish Monitoring and Surveillance Program is currently developing a spectral database for the discovery of emerging chemicals in lake trout. Lake Erie trout populations in the western basin have recently recovered to the point where active monitoring of contaminants in this species is underway. One of the tools currently employed for new contaminant discovery is the Atmospheric Pressure Gas Chromatograph (APGC) equipped with a Quadrupole Time of Flight (QToF) Mass Spectrometer. The mass spectrometer is currently configured to collect, paired, high and low energy spectra during each cycle. For Lake Erie trout, this technique was used to confirm chemicals discovered by multidimensional GC as well as identify species of concern using the high resolution data alone. Results from Lake Erie will be discussed and the effectiveness of this technique evaluated as a standalone discovery tool in future monitoring program endeavors. *Keywords: Fish, Environmental contaminants, Mass spectrometry.*

CRUZ-FONT, L.[1], VEILLEUX, M.A.N.[2], HLEVCA, B.[1], MIDWOOD, J.D.[2], WELLS, M.G.[1], COOKE, S.J.[2], DOKA, S.E.[3], LAPOINTE, N.W.R.[4], and ROUS, A.M.[2], [1]University of Toronto, Scarborough, ON, M1C 1A4; [2]Carleton University, Ottawa, ON, K1S 5B6; [3]Department of Fisheries and Oceans, Burlington, ON; [4]Nature Conservancy of Canada, Ottawa, ON. **Upwelling Events in Toronto Harbour: Do Fish Really Care?**

In large lakes such as Lake Ontario, relatively protected areas of the littoral can be impacted by cold upwelling events during the summer season. These events are characterized by large fluctuations of water temperature over short periods of time (hours), some representing a drop of more than 10 °C in ~ 5 hours. A preliminary study on the horizontal distribution of fish in the Toronto Harbour showed that fish of three species (northern pike, largemouth bass, and common carp) with different thermal preferences made small horizontal movements in response to cold upwelling events. However, when movement was detected, it was typically inconsistent among species. In the current study, we expand the previous research with additional information on depth occupancy and fish body temperature. These fish were studied over the summer of 2012 using acoustic telemetry. By considering different spatial scales, we can better explain how these fish cope with rapid temperature changes. The results from this study will aid in our understanding of fish habitat selection in response to an environmental change that is drastic but recurrent during the summer. *Keywords: Fish behavior, Upwelling, Lake Ontario, Temperature, Fish tagging, Acoustic telemetry.*

CZAJKOWSKI, K., JOHANSEN, R., REYNOLDS, E., AMES, A., JURSKI, A., LI, X., GALLAGHER, K., and KOFI-OPATA, E., University of Toledo, 2801 W. Bancroft St., Toledo, OH, 43606. **Mapping drain tile to assess agricultural contribution to nonpoint source pollution in Lake Erie.**

Agricultural tile drains pose a potential pathway for nutrient delivery to Lake Erie and may have contributed to the water crisis in the City of Toledo in the summer of 2014. Tile drains a pipes under agricultural fields that act to drain the fields of excess water. Tile drains allow farmers to produce crops in areas that would otherwise be inundated with water. In recent years, farmers have increased installation of tile drains. In this presentation, we will show our work to date mapping tile drains using remotely sensed imagery. We use heads-up digitizing to map the drains and to determine tile spacing and total extent; variables that are needed for hydrologic modeling of the area. We also we present preliminary results of an automated system to map the tiles using object oriented image analysis (OBIA). *Keywords: Water quality, Nutrients, Watersheds.*

CZESNY, S.J.[1], HAPPEL, A.[1], and RINCHARD, J.[2], [1]University of Illinois, 400 17th Street, Zion, IL, 60099; [2]The College at Brockport - State University of New York, Brockport, NY.

**Biochemical data reveal that sea lamprey feed on a variety of species.**

Despite being an abundant top predator in the Great Lakes, knowledge of sea lamprey feeding ecology remains hindered by methodological constrains. Particularly, our knowledge of sea lamprey diet habits relies on wounding rates of commercially caught fish. Biochemical methods provide means to extract diet information from sea lamprey themselves. Of particular interest is the use of stable isotope and fatty acid data to qualitatively describe foraging patterns of sea lamprey. Adult Sea lamprey were captured throughout the Lake Michigan basin during spring spawning migrations into rivers, and analyzed for both stable isotope ratios and fatty acid profiles. Exploratory multivariate analyses were used to investigate the existence of feeding guilds amongst the captured individuals. In general, we noted a large range in biochemical values suggesting a wide range in host species preferred by individual sea lamprey. Comparing the range of biochemical tracers with published data on host species, we conclude that some sea lamprey likely feed on sucker species while other focus on salmonid and burbot hosts. Thus, sucker and burbot may offer a buffer for sea lamprey, allowing high populations and further obstructing salmonid restoration efforts. *Keywords: Lake Michigan, Sea Lamprey, Stable isotopes, Fatty acids, Predation.*

# D

DAHMER, S.C.[1], HOWELL, E.T.[2], BOYD, D.[2], and BOWEN, G.S.[1], [1]Toronto and Region Conservation Authority, 5 Shoreham Drive, North York, ON, M3N 1S4; [2]Ontario Ministry of the Environment and Climate Change, 125 Resources Road, Toronto, ON, M9P 3V6.

**Long-term trends in nearshore water quality parameters along the Central Toronto waterfront.**

Toronto and Region was designated as a Great Lakes Area of Concern (AOC) in 1987 due to significant degradation of environmental quality and impairment of beneficial

uses, including Eutrophication or Undesirable Algae. Historically nutrient enrichment observed in the nearshore was attributed to anthropogenic influences. Considerable progress has been made within the AOC to counteract the impacts of human development. Inputs from combined sewer overflows (stormwater mixed with sewage) and storm sewers continue to degrade water quality in the lower portions of the Don and Humber Rivers, and along the central waterfront following heavy rain. This presentation will examine the temporal trends in nearshore water quality parameters and trophic response variables from two Ontario Ministry of the Environment and Climate Change (MOECC) Index Stations located along the Central Toronto waterfront (Toronto Inner Harbour and Humber Bay). The results indicate total phosphorus concentrations have declined in recent years. Current conditions are indicative of a more mesotrophic environment. However, high spatial and temporal variability remain and exceedances of water quality guidelines are not uncommon. Relationships between water quality patterns and important drivers (e.g., dreissenid mussels, physical mixing, etc.) will be discussed. *Keywords: Water quality, Nutrients, Eutrophication.*

DANIEL, S.E., BURLAKOVA, L.E., KARATAYEV, A.Y., and TULUMELLO, B.L., Great Lakes Center, SUNY Buffalo State, 1300 Elmwood Avenue, Buffalo, NY, 14222.

**Effect of *Dreissena* on Profundal Oligochaeta Community.**

Since the mid-1990s, the US EPA within the Great Lakes Biological Monitoring Program has collected annual benthic samples from all lakes, and density is recorded for all taxa identified. With this data, the Oligochaete Trophic Index (OTI) has been used to determine and detect shifts of trophic status over the years. The index uses the relative abundance of Oligochaeta species that are easy to identify and relatively common. However, at the end of 1990s OTI values for sites in the eastern basin of Lake Erie tended to be more eutrophic than the central or western basin sites (SOLEC 2012). A possible reason for this increase could be the benthification and filtration activity of dreissenids that remove suspended particles from the water column and enhance deposition of organic material. To address the effect of *Dreissena* on Oligochaeta we studied their vertical distribution along with the organic matter content in benthic cores collected from the eastern basin. In addition we compared Oligochaeta density, biomass, and species composition from samples with and without *Dreissena* collected throughout the lake in 2014. *Keywords: Benthos, Dreissena, Bioindicators.*

DAVIS, T.W.[1], BOYER, G.L.[2], GOSSIAUX, D.[1], STUMPF, R.P.[3], WYNNE, T.T.[3], ZIMBA, P.[4], and GUTIERREZ, D.[5], [1]NOAA Great Lakes Environmental Research

Laboratory, 4840 South State Road, Ann Arbor, MI, 48108; [2]SUNY-College of Environmental Science and Forestry, 1 Forestry Drive, Syracuse, NY, 13210; [3]NOAA National Centers for Coastal and Ocean Science, 1305 East West Highway, Silver Spring, MD, 20910; [4]Texas A&M University Corpus Christi, 6300 Ocean Drive, Corpus Christi, TX, 78412; [5]Vanderbilt University, 2201 West End Avenue, Nashville, TN, 37235. **Investigating the Ecology and Toxicity of the CyanoHAB during the 2014 Toledo Drinking Water Crisis.**

On August 2, 2014 a 'do not drink' advisory was issued from the municipality of Toledo affecting roughly 500,000 Ohio residents and closing many businesses. During this time a dense, toxic cyanobacterial bloom had formed, likely dominated by the cyanobacterium *Microcystis*, and was constrained by prevailing winds around the Toledo water intake structure. On August 4th, an intensive sampling effort occurred that included eight sites throughout the western basin including the Toledo water intake. Satellite imagery and modeling indicated little movement of the bloom through the weekend of the advisory; therefore these samples give an accurate snapshot of the bloom conditions when the advisory was implemented. Concentrations of microcystins (MCs) were determined using an LC-MS screening method against 14 common congeners. MCs were also analyzed by HPLC-PDA to detect high concentrations of other congeners. A parallel set of MC samples was analyzed using commercial ELISA kits for comparison between the detection methods. Other cyanotoxins, including anatoxin-a, homoanatoxin-a, cylindrospermopsin (CYN), epi-CYN, deoxy-CYN and beta-N-methylamino-L-alanine (BMAA) were tested for using LC-MS and/or LC-MS/MS. We report these results in context with other toxin and water quality data collected throughout the 2014 bloom season. *Keywords: Harmful algal blooms, Toxicity, Microcystis, Lake Erie.*

DE VRIES, E.K., Lake Champlain Sea Grant, Burlington, VT, 05401. **Watershed Wise: Teacher trainings bring water quality education program to a school near you.**

*Watershed Wise: Watershed Alliance Teacher Training* is a professional development experience for Lake Champlain Basin educators that are using or want to use Lake Champlain Sea Grant - Watershed Alliance stream assessment and stewardship curriculum to teach watershed health and promote environmental literacy. Trainings integrate local watershed knowledge, place-based activities and field work to equip teachers with the tools and skills necessary to create a water quality education program in their classroom. New stream habitat assessments, modeled off of EPA and Project WET were created for these training. Teachers work in and out of the stream to collect data on the physical, biological

and chemical attributes, exactly as their students would do. Teachers also become familiar with downloading data onto an interactive website and developing an outreach or stewardship project. An educator's handbook provides detailed information on pre/post stream assessment activities and curriculum, needed equipment and materials as well as field safety tips and potential funding resources for teachers to start their own water quality education program. *Keywords: Water quality, Environmental education, Watersheds.*

DEAN, D.B., Michigan Technological University, Michigan Tech Research Institute, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105. **Applying Geospatial Technology to Oil Spill Response Planning in the Western Basin of Lake Erie.**

Area Contingency Plans (ACPs) and their associated Geographic Response Plans (GRPs) are site-specific documents designed to outline steps to be taken by responders to protect sensitive sites after an oil or chemical spill. They are designed to improve the speed and efficiency of a response during the critical first few hours after a spill. Existing paper based plans and their associated maps, tables and graphics can be difficult to update and expensive to distribute on paper. The result can be response maps and supporting data tables that may not be up to date, leaving response and command personnel with an incomplete picture of conditions during an incident. This paper describes work done in collaboration with the Western Lake Erie Area Committee, US and Ohio EPA and the US Coast Guard Marine Safety Unit Toledo to create a GIS based dataset of protection strategies for ecologically and economically sensitive sites in the event of an oil spill in the western basin of Lake Erie. The work also provides a framework for development of GIS based protection strategies and spill response plans elsewhere in the Great Lakes. *Keywords: Lake Erie, Oil Spill, Planning, Risks.*

DELLINGER, J.A.[1], FAUSTMAN, E.M.[2], FOLDY, S.L.[3], SHAPIRO, H.[4], TAKARO, T.K.[5], and BOEHME, J.R.[6], [1]Concordia University Wisconsin, 12800 N. Lake Shore Drive, Mequon, WI, 53097-2402; [2]University of Washington, Dept.of Environ. & Occupational Health Sciences, 4225 Roosevelt Way NE, Suite #100, Seattle, WA, 98105; [3]Medical College of Wisconsin, 3061 North Marietta Avenue, Milwaukee, WI, 53211; [4]Toronto Public Health, 18th Floor, 44 Victoria Avenue, Toronto, ON, M5C 1V2; [5]Simon Fraser University, 8888 University Dr. Blusson Hall 11518, Burnaby, BC, V5A 1S6; [6]IJC Great Lakes Regional Office, 100 Ouellette Avenue, Windsor, ON, N9A 6T3. **Analysis of Cyanotoxins and Human Health Impacts in the Great Lakes.**

Despite the human health threat posed by cyanobacteria, the connection between harmful algal bloom events and human health outcomes is not well understood. Events with the water system in Toledo, OH, highlighted the need for additional operations guidance and numeric criteria for drinking water treatment plant operators and beach managers. To address these gaps, the Health Professionals Advisory Board of the International Joint Commission has undertaken a literature review and survey of national poison control data to draw connections between four cyanotoxins and human health outcomes. Results from an assessment of current available testing, monitoring capacity and technology for microcystin-LR, anatoxin-a, cylindrospermopsin and saxitoxin will be described. Finally, provisional numeric standards for these four toxins in drinking water and recreational water in North America and internationally were examined, and will inform discussion of the status of regulatory numerical standards development for these toxins. *Keywords: Harmful algal blooms, Human health.*

DEPEW, D.C.[1], KOEHLER, G.[2], WASSENAAR, L.I.[2], and HIRIART-BAER, V.P.[1], [1]Environment Canada, 867 Lakeshore Rd, Burlington, ON, L7R 4A6; [2]Environment Canada, 11 Innovation Blvd, Saskatoon, SK. **Investigating Lake Erie near shore P dynamics using 18O-PO4 isotopes.**

Despite the clear importance of phosphorus (P) to human society, and the implications of perturbations of the P cycle to aquatic ecosystems, understanding of the sources and reaction mechanisms controlling biogeochemical cycling of P within aquatic ecosystems remains limited. A critical reason for this is the lack of inherent tracers for analyzing the sources and metabolism of P in aquatic ecosystems. The stable oxygen isotope ratio ($\delta^{18}O\text{-}PO_4$) has recently emerged as a novel and potentially powerful tracer for the sources and metabolism of P in aquatic ecosystems. In this presentation, we report on our efforts to apply this novel and potentially powerful tool to elucidate the proximate sources of P impacting *Cladophora* blooms in the near shore regions of eastern Lake Erie. *Keywords: Phosphorus, Lake Erie.*

DEPINTO, J.V.[1] and SCAVIA, D.[2], [1]LimnoTech, 501 Avis Drive, Ann Arbor, MI, 48108; [2]University of Michigan, 625 E. Liberty St., Ann Arbor, MI, 48104. **An Ensemble Modeling Approach to Setting Target Loads for Lake Erie.**

Annex 4 of the GLWQA calls for the target phosphorus loads to the Great Lakes to be reviewed and revised as necessary. This effort began by establishing an Objectives Task Team to undertake the review and revision for Lake Erie. The group developed an ensemble modeling approach to support that effort. Several talks in this session present the models employed in creating that ensemble. The overall concept has been to use the models to develop load-response curves in which the load is an appropriate spatial and temporal definition of phosphorus load and the response is an appropriate metric of an identified eutrophication response indicator (ERI) in Lake Erie. ERI's include cyanobacteria blooms in the Western Basin, hypoxia in the Central Basin, and Cladophora growth in the Eastern Basin. This talk will present an overview of the ensemble modeling process, it implementation, and a brief summary of the results. *Keywords: Ecosystem modeling, Lake Erie, Phosphorus.*

DI PIERDOMENICO, L.L.[1], HAFFNER, G.D.[1], and PATERSON, G.[2], [1]Great Lakes Institute for Environmental Research, 401 Sunset Ave, Windsor, ON, N9B 3P4; [2]State University of New York / College of Environmental Science and Forestry, 1 Forestry Drive, Syracuse, NY, 13210. **Contaminant dynamics in the lower pelagic food webs amongst Lake Huron's basins.**

The present study investigated contaminant dynamics in the lower trophic levels of Lake Huron's pelagic food web. This system is currently experiencing low fish abundances and a decrease in energy density on a lake-wide scale. The upper levels of this offshore food web are well-studied; as such, our research investigated dynamics within the lower levels, specifically of zooplankton, invertebrates and the forage fish communities (*Coregonus hoyi* and *Osmerus morda*). In order to investigate trophic level dynamics across the three basins, PCBs were used as tracers. In addition, foraging behaviour was investigated using gut content and stable isotope analysis. Results indicate that the three basins of Lake Huron are acting independently rather than as a whole. Gut content analysis for *C. Hoyi* showed differences in food sources amongst the basins. This trend was also observed in the biomagnification factors for SUM PCB (Main Basin = 6.87, Georgian Bay = 2.35, North Channel = 0.37). *Keywords: Biomagnification, Lake Huron, PCBs.*

DIJKSTRA, M.L.[2], AUER, M.T.[1], GAWDE, R.K.[2], and AUER, N.A.[3], [1]Civil and Environmental Engineering, Michigan Technological University, 1400 Townsend Drive, Houghton, MI, 49931; [2]Great Lakes Research Center, Michigan Technological University, 1400 Townsend Drive, Houghton, MI, 49931; [3]Department of Biological Sciences, Michigan Technological University, 1400 Townsend Drive, Houghton, MI, 49931. **BIG HEAT and BIG CHILL: Impact on the Timing and Magnitude of Primary Production in Lake Superior.**

Water temperature affects primary production directly by placing organisms in an environment closer to or further removed from their preferred temperature. Thermal structure also impacts primary production indirectly by segmenting the water column into layers differing in temperature, light and nutrient conditions. These impacts on thermal structure influence vertical production profiles and lead to inter-annual differences in system response. Opportunities to carefully characterize the impact of climatic extremes on these and their effect on primary production are rare in the natural environment. In 2012 and 2014, the Great Lakes Research Center at Michigan Tech led a collaborative effort to characterize the thermal regime of Lake Superior resulting from striking differences in annual meteorological forcing conditions: what has become known as the "BIG HEAT" and "BIG CHILL". These years manifested markedly differing thermal regimes and nutrient-plankton dynamics: specifically, the time course of biomass accrual, the formation and duration of the deep chlorophyll maximum and the duration of the upper mixed layer production desert. Annual production is compared for 2012 and 2014 facilitating consideration of the relative importance of thermal structure and phosphorus pool size in mediating this feature of ecosystem behavior. *Keywords: Productivity, Climate change, Ecosystem modeling.*

DILLON, R.A.[1], PADDOCK, R.W.[2], and STOCKWELL, J.D.[1], [1]University of Vermont, 3 College St, Burlington, VT, 05401; [2]University of Wisconsin-Milwaukee, 600 E Greenfield Ave, Milwaukee, WI, 53204. **A Video Camera to Estimate Benthic *Mysis* Densities in Lake Champlain over 24-hour Periods.**

The omnivorous macroinvertebrate *Mysis* is integral to large lake food webs. *Mysis* exhibits diel vertical migration to avoid visual predators during the day and feed in the water column at night. Standard sampling to estimate *Mysis* density and biomass typically consists of pelagic net tows at night. Recent research and historical observations, however, indicate some proportion of *Mysis* populations remain on the bottom at night, suggesting a potential underestimation of population size in many studies. We used a video camera to continuously observe *Mysis* on the bottom of Lake Champlain for two 24-hour periods in October 2014. We hypothesized that benthic *Mysis* densities would be greater during the day than at night, but *Mysis* would be observed on the bottom at all times. We found *Mysis* densities at 100-m were greatest from 01:00 to 07:00, declined slightly and remained steady from 07:30 to 14:00, and then steeply declined and remained low from 14:30 to 24:00. *Mysis* densities were more variable at a 61-m site than at a 100-m site. Higher densities were observed during nighttime hours, though *Mysis* were found on the bottom every hour observed. Future population studies should take into account the behavior of *Mysis* for more accurate population estimates. *Keywords: Cameras, Mysis diluviana, Diel vertical migration, Lake Champlain.*

DIOP, H.E.[1], WHALEN, J.K.[1], MADRAMOOTOO, C.[2], and MICHAUD, A.R.[3], [1]Department of Natural Resource Sciences Mcgill University, 21, 111 Lakeshore Rd, Ste-Anne-de-Belle-Vue, QC, H9X3V9; [2]Department of Bioresource Engineering McGill University, 21, 111 Lakeshore Rd, Ste-Anne-de-Belle-Vue, QC, H9X3V9; [3]Institut de recherche et de développement en agroenvironnement (IRDA), 2700, rue Einstein Québec, Quebec, QC, G1P3W8. **Can Earthworms Increase Nutrient Losses from Tile Drained Fields in the Pike River Watershed?**

Earthworm burrowing affects water movement and nutrient transport in soil layers to a depth of more than 1 m, which is where subsurface tile drains are found. Subsurface tile drainage changes the soil moisture regime and is expected to alter the abundance as well as the composition of earthworm populations.The objective of this study was to evaluate how earthworm abundance and composition was affected by the presence of subsurface tile drainage, and how the relationship was modulated by soil type and cropping systems at two farms in the Pike River watershed. The spatial distribution of earthworms was considered in two 3m triangles located on top and between tile drain lines, which were the sampling points for earthworm collection by formalin extraction and hand sorting. We expect that earthworm species will respond differently to the presence of tile drain lines and anticipate an increase in earthworm populations above the tile drain lines, particularly of anecic species. The potential contribution of these earthworms to solute movement from tile-drained fields, in the Pike River watershed will be discussed. *Keywords: Nutrients, Assessments, Annelids.*

DITTMAN, D.E.[1], CHALUPNICKI, M.A.[1], and ABBETT, R.[2], [1]USGS, Tunison Laboratory of Aquatic Science, 3075 Gracie Road, Cortland, NY, 13045; [2]IAP Worldwide Services, Tunison Laboratory of Aquatic Science, 3075 Gracie Road, Cortland, NY, 13045. **Habitat Distribution and Modeling in the Genesee River within the Rochester Embayment AOC, NY.**

The Genesee River is one of the major tributaries to Lake Ontario and has suitable spawning habitat for migratory sport fish including walleye and salmonids. This rivermouth system is the site of an ongoing experiment in lake sturgeon restoration applying supplementation as a management tool. We sampled the large bodied fish community, habitat, and benthos at standardized sites from 1999-2014. A more intensive (0.5 km intervals) systematic sampling was included in 2010 and 2011. We measured depth, flow, temperature, oxygen, pH, substrate composition, and the macroinvertebrate community. We applied semivariance analysis and kriging to model the variability and distribution of habitat measurements using ESRI ArcMap 9.2. Maps of the modeled habitat variables including the water chemistry variables and benthic macroinvertebrate indices (diversity, benthic index of biotic integrity) were analyzed. We applied the results to calculate habitat suitably indices for migratory fish. Understanding the long term distribution and quality factors of fish habitat in the Genesee River over time is part of the environmental stewardship of the Rochester Embayment Area of Concern as native fish communities are restored to improve ecosystem health for wildlife and people. *Keywords: Species composition, Monitoring, Habitats, Benthos.*

DITTRICH, M.[1], LIANG, A.[1], CUI, Y.[1], CHEN, J.[1], FATHOLLAHZADEH, H.[1], CONTENTO, F.[1], ARHONDITSIS, G.B.[1], MORLEY, A.[2], MUGALINGAM, S.[3], KEENE, B.[4], GEATER, K.[5], WATSON, S.B.[6], and BOURBONNIERE, R.[6], [1]University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A4; [2]Ministry of Environment and Climate Change, 1259 Gardiners Road, Kingston, ON, K7M 8S5; [3]Quinte Conservation, 2061 Old Hwy #2, Belleville, ON, K8N 4Z2; [4]Lower Trent Conservation, Trenton, ON; [5]Great Lakes Areas of Concern, Environment Canada, Toronto; [6]Environment Canada, Watershed Stressors and Nutrients, Burlington, ON. **Dynamics of phosphorus at the sediment-water interface in lakes of different trophic states.**

Sediments can either be a source or sink of contaminants and nutrients in lakes. In order to understand the role of sediments in water quality, it is crucial to predict a part of phosphorus in sediments that may return to the water column. In this presentation the results of field studies and diagenetic modeling for Bay of Quinte, Hamilton Harbor and Georgian Bay will be presented. Our main aim is to identify the dynamics of phosphorus (P) in sediments and gain insight into the mechanism of P release from sediments under varying conditions. Sequential fractionation of sediments, pore-water profiling and micro-sensor measurements have been performed during winter, fall and summer stratification. Phosphorus was divided into four functional groups: inert phosphorus, organic phosphorus, inorganic phosphorus and phosphorus dissolved in pore water. Using the flux of organic and inorganic matter as dynamic boundary conditions, the model results in agreement with the measured flux of total phosphate to the system and the fractionation data of phosphorus binding forms. This talk will present and discuss the results of two years studies about P dynamics at the at the sediment-water interface in three lakes. *Keywords: Biogeochemistry, Bay of Quinte, Phosphorus, Georgian Bay, Sediments.*

DOAN, P.T.K.[1], NEWMAN, A.G.[1], ARHONDITSIS, G.B.[1], WATSON, S.B.[2], and DITTRICH, M.[1], [1]Department of Physical and Environmental Sciences, University of Toronto Scarborough, 1265 Military Trail, Toronto, On, M1C 1A4; [2]Environment Canada, National Water Research Institute, 867 Lakeshore Rd, Burlington, On, L7R 4A6.
**Application of reactive-transport modeling to estimation of internal P loading in the Bay of Quinte.**

Sediments play an important role of contaminants and nutrients in lakes. In order to understand the role of sediments on water quality, it is crucial to predict a part of phosphorus in sediments that may return to the water column. Reactive-transport models represent a convenient framework to study diagenetic processes in time and space. We applied a dynamic diagenetic model to gain insight into the dynamics of phosphorus internal loading from sediments of the Bay of Quinte, a Bay on the north eastern shore of Lake Ontario, Canada. Three basins of the Bay was investigated with differences in their phosphorus release, reflecting the distinct spatial temporal patterns of land use and urbanization levels in the watershed. Using the fluxes of organic and inorganic matter as dynamic boundary conditions, we simulated the depth profiles of solute and solid components. The model closely reproduced the measured data of phosphorus binding forms and soluble reactive phosphorus. Phosphorus diagenesis has been studied under various conditions regarding past human and natural impact on the Bay of Quinte. Keywords: Phosphorus, Internal loading, Bay of Quinte *Keywords: Internal loading, Phosphorus, Bay of Quinte.*

DOBIESZ, N.E., Michigan State University, 293 Farm Lane, Room 153, East Lansing, MI, 48824. **Standardization, sharing, and ownership: key areas of concern for Great Lakes database integration.**

Great Lakes monitoring and management programs have generated large volumes of data but the capacity to collate, store, and synthesize comparative data is generally inadequate. However, there is increasing need to integrate current and historical fisheries management and environmental data to examine patterns of change as ecosystem-based fisheries management is recognized as an important management objective. A workshop was held in April 2014 to identify the data management challenges and prioritize activities to address these concerns. The workshop brought together fisheries and environmental managers and researchers from the Laurentian Great Lakes and Lake Victoria, East Africa. Thirty-one data management challenges were identified and prioritized by participants with many topics being inter-related or broadly characterized. To consolidate this list into succinct categories, nine areas of concern were identified -- Usability, Standardization, Funding,

Security, Data sharing, Technology, Data types, Data gaps, and Ownership. Each challenge was associated with one or more areas of concern and priorities were calculated for the areas of concern. The key area of concern was Standardization followed by Sharing and Ownership. Here, we discuss the workshop findings and methods to address the data management challenges. *Keywords: Data storage and retrieval, Great Lakes basin, Fisheries.*

DOKA, S.E.[1], TANG, R.W.K.[1], GERTZEN, E.L.[1], and NEIGUM, L.M.[1], [1]DFO - GLLFAS, 867 Lakeshore Rd., Burlington, ON, L7R 1S1; [2]Consultant, Edmonton, AB.

**Dissolve Oxygen Tolerance Guilds of Lake Ontario Fish Species for Fish Habitat Modeling In Hamilton.**

Hamilton Harbour Area of Concern (AOC) is an embayment located at the western end of Lake Ontario. Fish populations within the harbour are affected by low dissolved oxygen (DO) levels, which results in the loss of suitable fish habitat. To assess AOC Remedial Action Plan (RAP) targets for DO, a fish habitat assessment modeling approach was used. We compiled an extensive review of DO tolerances for Great Lakes fishes and categorized DO tolerance values as lethal (e.g. death) or sublethal (e.g. behaviour) effect groups at 3 negative-affect levels (Starting effects, 1-49% and 50-100% response) across different life stages (e.g. egg, fry, adult). We used 30 indices to determine the optimal number of tolerance clusters. Fish species in Lake Ontario were best described by three distinctive guilds with varying DO tolerance thresholds: intolerant, moderate and tolerant. K-means cluster analysis was applied for sublethal, lethal and combination effects for the 50-100% effect level for mean DO tolerances (mg/l) in adult fishes. The guild classifications were then compared to other fish tolerance indices (not just DO) in a decision tree to determine the best final DO tolerance classification for each species. The results of this study will be implemented in a Hamilton Harbour fish habitat assessment model for determining habitat supply. *Keywords: Fish, Assessments, Oxygen.*

DOVE, A., RICHARDSON, V., BAILLARGEON, J., NARAYAN, J., BURNISTON, D., and BACKUS, S.M., Environment Canada, 867 Lakeshore Road, Burlington, ON, L7S 1A1.

**Updated nutrient loadings to Lake Erie from Canadian tributaries.**

As part of the Great Lakes Nutrient Initiative, Environment Canada has undertaken monitoring of Canadian nutrient loadings to Lake Erie. Infrastructure and automated samplers have been installed, supplemented by grab samples at other sites, in order to quantify total loadings to the lake from selected tributaries. Major improvements to previous loadings estimates are the inclusion of winter and spring sampling and the assessment of the different phosphorus species, including soluble reactive P. In addition, monitoring of nutrient loads entering the western basin of Lake Erie via the Detroit River is being initiated. In this talk, current loadings are put into the context of previous estimates and total lake loads to determine the importance of current tributary loadings with respect to lake targets. *Keywords: Loadings, Tributaries, Nutrients, Lake Erie.*

DRIEDGER, A.G.J., DÜRR, H.H., and VAN CAPPELLEN, P., University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1. **Macroplastic Debris along Shorelines of the Great Lakes.**

Plastic debris is a pervasive and persistent pollutant along the shorelines of the Great Lakes. Monitoring the types, abundance, and distribution of plastic debris is important for identifying its sources and guiding removal efforts to reduce its impacts on the shoreline environment. Non-profit organizations including the Alliance for the Great Lakes and the Vancouver Aquarium in partnership with the World Wildlife Fund organize volunteer-led cleanups of beaches and coastal areas. Volunteers report the quantity and types of litter collected, providing a key source of data about shoreline plastics. In 2012, an average 86% of litter collected was comprised of plastics. The most commonly reported plastic debris items were cigarette filters followed by food wrappers and containers. Plastic debris concentrations at cleanup sites ranged from 0 to 23 items/m. At sites where 5 or more cleanups took place, mean plastic debris concentration was significantly related to neighboring population. The highest frequency of cleanups occurred in the summer (June to September), hence possibly introducing sampling bias. *Keywords: Pollutants, Spatial analysis, Lake management.*

DUHAIME, M.B.[1], WIGGINTON, K.[1], BELETSKY, D.[1], BELETSKY, R.[1], RIOS MENDOZA, L.M.[2], CHEN, Z.[1], SANO, L.[1], DALEY, J.[1], BURTON, G.A.[1], and CABLE, R.[1], [1]University of Michigan, Kraus Natural Sciences, N. University, Ann Arbor, MI, 48103; [2]University of Wisconsin-Superior, 1605 Catlin Avenue, Superior, WI, 54880.
**Multidisciplinary approach to assessing the impact of microplastics on Great Lakes ecosystem health.**

Reports of the Great Pacific Garbage Patch, an amalgam of human generated trash in the North Pacific gyre, have brought attention over the last decade to the dangers of plastic in ocean systems. Recently, plastic has been documented in the Great Lakes at concentrations higher than in the oceans. While the accumulation of plastic debris in nature is one of the most pervasive environmental concerns of our time, too little is known about the fate of this plastic and its role in ecosystem dynamics to predict the inevitable impacts on one fifth of the world's fresh water and valuable national security asset, the Great Lakes. To address this critical knowledge gap, we are taking a cross-disciplinary approach and will present early data on (1) new methods for processing and quantifying plastic debris from a high resolution study in Lake Erie, (2) hydrodynamic model predictions of the transport of plastics through the system, (3) surface polymer studies that confirm environmental conditions are critical for polymer-toxin behavior, (4) analysis of plastics found in fish stomachs, and (5) plastic-dwelling microbial community composition. These data are intended to feed into a risk assessment framework to better understand holistic ecosystem impacts of plastics in the Laurentian system and ultimately inform policy and management. *Keywords: Microplastics, Microbiological studies, Environmental health.*

DUNLOP, E.S.[1] and YOUNG, J.[2], [1]Ontario Ministry of Natural Resources and Forestry, Peterborough; [2]Ontario Ministry of the Environment and Climate Change, Toronto. **Spatial dynamics of the pelagic communities of Georgian Bay and Lake Simcoe.**

Complementary multi-frequency acoustic surveys were completed in 2014 in 3 embayments within Georgian Bay and Lake Simcoe. Both day-time and night-time surveys were completed in Parry Sound (Georgian Bay), Severn Sound (Georgian Bay), and Kempenfelt Bay (Lake Simcoe). Three acoustic frequencies were run (38 kHz, 120 kHz, and 333 kHz) to target multiple components of the pelagic food web. Companion netting that targeted the pelagic fish community was also conducted, together with preliminary sampling of the plankton community. Surveys revealed differences in species composition among the three embayments. The pelagic fish community was dominated by rainbow smelt and alewife in Parry Sound, by rainbow smelt in Severn Sound, and by cisco in Lake Simcoe. The spatial dynamics of the pelagic fish community will be compared among locations and related to temperature, depth, and characteristics of the plankton community. *Keywords: Acoustics, Alewife, Smelt.*

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EANES, F.R., University of Wisconsin-Madison, 550 N. Park St, Madison, WI, 53706.
**Bottom-Up: Tools for integrating community knowledge and values in natural resource decision making.**

Emerging research in environmental psychology continues to reveal linkages between people's sense of place, place-based values, and their pro-environmental behavior.

Recognizing this, the Wisconsin Geotools Explorer project empowers residents of the Green Bay region to document and share local knowledge of the bay and its surrounding bioregion. Participants make these observations (including photos, short text descriptions, and audio and video clips) with a custom-built iPhone app, which uses the phone's GPS capabilities to geolocate each observation in an interactive map. Observations include places of ecological interest, aquatic invasive species, rare species, recreational activities, place-based memories, bird/waterfowl migrations, degraded areas, keystone species, unique geology/landforms, and ecological restoration initiatives. When collated into the interactive online map, these observations collectively tell dynamic, rich, place-based stories that capture the complexity and uniqueness of the bay ecosystem. Results from this participatory project indicate that the app and its associated interactive map are effective tools for eliciting coastal residents' values, interests, and concerns, and deepening their sense of place. Content generated by users has proved useful to natural resource decision makers. *Keywords: Environmental education, Local knowledge, Green Bay, Place-based values, Public participation, Sense of place.*

EDDOWES, D.B.[1], LOISELLE, S.[2], HALL, C.[2], and BAILEY, N.[2], [1]Earthwatch Institute, 114 Western Ave., Boston, MA, 02134; [2]Earthwatch Institute, Mayfield House, 256 Banbury Road, Oxford, OX2 7DE, ENGLAND. **FreshWater Watch: Lessons from a Global Mass Citizen Scientist Program.**

FreshWater Watch (FWW) is a global citizen science project carrying out research into freshwater ecosystems in 32 urban areas across the globe. Following a globally consistent training program, citizen scientists work with local research partners, collecting data to answer research questions related to freshwater quality and ecosystems. All measurements follow a common methodology and quality control process and are uploaded to one global database using smartphone technologies and online tools. Volunteers initially become involved through participation in a training day, meeting the research scientists and other participants. A key focus has been to develop mechanisms that keep both participants and scientists motivated to maximise the benefits of the project. The initial training is complemented by an online platform which has a wide range of functionalities: forums, blogs, online learning, leader boards and reward points. Participants from around the globe actively collaborate with one another and with the scientists. Over 4000 participants have taken part in FWW over the last 2 years collecting over 6000 datasets. The data collected are being used to identify the drivers of water quality degradation on a global scale and demonstrate the capacity of committed citizens in monitoring the global freshwater system. *Keywords: Citizen science, International, Urban watersheds.*

EDER, T. and JENSEN, E.S., Great Lakes Commission, 2805 S. Industrial Hwy., Suite 100, Ann Arbor, MI, 48104. **Overview of the Invasive Mussel Collaborative: Connecting People, Science and Management.**

Scientists have been searching since the early 1990s for effective methods to control invasive zebra and quagga mussels (*Dreissena polymorpha* and *D. rostriformis bugensis*, respectively) as a way to help mitigate their negative impacts. Recent advances in biocontrol technology represent an exciting potential technique to manage invasive mussels. These advances are also leading to new questions and opportunities for managers and scientists. In light of this new opportunity, diverse management goals must be identified and understood and knowledge gaps addressed in order to move forward with a joint and strategic approach to managing invasive mussels. This presentation will focus on a new Invasive Mussel Collaborative, initiated in late 2014, that is providing a framework for communication and coordination to share information and lessons learned, guide supporting research, and inform management actions. This collaborative approach is helping to identify the needs and objectives of resource managers, prioritize the supporting science, recommend communication strategies, and ultimately align science and management goals into a common agenda. *Keywords: Invasive species, Dreissena, Zebra mussels.*

EDWARDS, W.J.[1], ALEXANDER, K.[1], ATKINSON, J.F.[2], and DELAVAN, S.K.[2], [1]Department of Biology, Golisano Center, Niagara University, NY, 14109; [2]Civil, Structural, and Environmental Engineering, University at Buffalo, SUNY, 230 Jarvis Hall, Buffalo, NY, 14260. **Alteration of Near-Bed Velocity and Nutrient Dynamics by Dreissenid Mussels in the Near Shore.**

Harmful algal blooms have returned to the Great Lakes and in many other nearshore ecosystems around the world. Specifically, in Lake Erie, the recovery from the HABs of the 1960s and 1970s has been challenged by the threats of climate change, landscape use change, and invasive species, altering water quality, light climate and physical forcings on bloom dynamics. Invasive dreissenid mussels have shunted carbon and nutrients into the nearshore and altered nearshore transparency, and released N and P into the near bed region and water column contributing to changes in water quality causing blooms of Cladophora and cyanophytes respectively. The goal of this project is to determine the mechanisms and ability of the mussels to influence the fate of P in the water column and how the transport in the

nearshore can be altered by the changes in bottom roughness characteristics. This change in dynamics may alter the times scale of P retention in the water column input by agriculture and land use in the watershed. We quantify water quality and velocity characteristics near the sediments in relatively shallow sites in Lake Erie that have been colonized by invasive dreissenid mussels and to compare them to non-colonized sites in both the eastern and western basins, Lake Erie. We collected water quality, current, and baythymetry data concurr *Keywords: Phosphorus, Hydrodynamics, Invasive species.*

EDWARDS, W.J.[1], HARE, M.J.[1], and MASON, S.A.[2], [1]Niagara University, Niagara Falls, NY; [2]SUNY Fredonia, Fredonia. **Plastic Microdebris in the Lower Great Lakes.**

Over the past decade, microplastic pollution has become a growing concern due to their presence in every day personal care products have replaced the natural exfoliants found in facial cleansers. Ten samples were collected from the Great Lakes of North America during Pangaea Exploration's One Water story, on the 72' sailboat Sea Dragon. Samples were collected using a 333-µm mesh manta trawl, and analyzed for plastic debris. During analysis, any plastic found when is removed and collected to determine the microplastics concentration. Plastics were dried and enumerated using microscopy. Microplastic debris was found in every sample. The highest samples contained 181 particles, corresponding to a density of 326,000-particles/ sq. km. Many microplastics that were found were pellets- hard, rounded, plastic particles, suspected to be from consumer's products, specifically used as exfoliants in our personal care products. *Keywords: Environmental contaminants.*

ELSKUS, A.A.[1], INGERSOLL, C.G.[2], KEMBLE, N.E.[2], ECHOLS, K.R.[2], BRUMBAUGH, W.G.[2], HENQUINET, J.W.[3], and WATTEN, B.J.[4], [1]U.S. Geological Survey, S.O. Conte Anadrmous Fish Research Laboratory, Maine Field Office, Orono, ME; [2]U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO; [3]Henquinet Consulting, LLC, Houghton, MI; [4]U.S. Geological Survey, Leetown Science Center, S.O. Conte Anadromous Fish Research Laboratory, Turners Falls, MA. **A NaOH-based ballast water treatment system for freshwater ships: residual toxicity and chemistry.**

To prevent the spread of invasive species through ballast water, an ideal BW treatment system (BWTS) would kill 100% of BW organisms with minimal residual toxicity to organisms in receiving waters. The residual toxicity and chemistry of a BWTS for freshwater ships was evaluated: sodium hydroxide was added to elevate pH to > 11.5 to kill BW organisms, then reduced to pH<9 by sparging with wet-scrubbed diesel exhaust (the source of $CO_2$). Cladocerans (*Ceriodaphnia dubia*), amphipods (*Hyalella azteca*), and fathead minnows (*Pimephales promelas*) were exposed for 2 days to BWTS water under an air atmosphere (pH drifted to ≥ 9), or a 2.5% $CO_2$ atmosphere (pH 7.5 to 8.2) then transferred to control water for 5 days to assess delayed effects. Chemical concentrations in the BWTS water met vessel discharge guidelines except for small amounts of copper. There was little to no residual toxicity to cladocerans or fish, but the BWTS water was toxic to amphipods. Maintaining a neutral pH and diluting BWTS water by 50% eliminated toxicity to the amphipods. Toxicity of BWTS water would likely be minimal due to rapid dilution in the receiving water with sub-surface release likely preventing pH rise. This BWTS has the potential to become a viable method for treating BW released into freshwater systems. *Keywords: Ballast, Hyalella azteca, Water quality, Alkalinity, Invasive species, Ballast discharge permit.*

ENDRES, S.[1], BROOKS, C.N.[1], BATTAGLIA, M.J.[1], BOURGEAU-CHAVEZ, L.L.[1], and WALKER, R.[2], [1]Michigan Technological University, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [2]Leidos, 6100 Columbus Avenue, Sandusky, OH, 44870. **Evaluating wetland hydroperiod for northwest Ohio wetlands using multi-source remote sensing imagery.**

We are expanding on a first-year effort to apply multi-source remote sensing capabilities for estimating and measuring hydroperiod and the relative soil moisture of wetlands at NASA's Plumbrook Station in northwest Ohio. A changing regional climate has several potential risks for wetland ecosystem function, including shorter average hydroperiod and reduced soil moisture, depending on seasonal precipitation patterns and total precipitation amounts. Analyses underway by the project team to understand these risks include helping with development of an index of potential wetland vulnerability, creating a date-linked table of wetland extent, and completing a geospatial analysis of wetland connectivity. We are using radar satellite data to improve an analysis of relative soil moisture using fully polarimetric radar data. By performing decompositions on polarimetric data, information is being gathered about scattering mechanisms of the target areas. Understanding the scattering mechanisms of specific environments aids in the determination of hydroperiod and wetland type. Under NASA funding, we are working with environmental scientists at the Plum Brook Station in a continued effort focusing on understanding how a changing climate is affecting, and likely to affect, wetlands at the Station. *Keywords: Wetlands, Remote sensing, Hydrologic cycle.*

ENGEL, D.D.[1], EVANS, M.A.[2], LOW, B.S.[1], and SCHAEFFER, J.[2], [1]School of Natural Resources and Environment, University of Michigan, 440 Church St, Ann Arbor, MI, 48109;

[2]U.S. Geological Survey Great Lakes Science Center, 1451 Green Rd, Ann Arbor, MI, 48105.
**Resource Management in the Great Lakes Region: Understanding Ecosystem Services Integration.**

We conducted a survey of federal, state, provincial and tribal resource managers in the Great Lakes region to determine how they consider ecosystem services (ES) in their work. Survey questions were designed to gather information on the background of resource managers, their familiarity with ES, and the relevance of ES to their work. Preliminary analysis suggests several interesting themes: 1) Although 74% of resource managers are at least moderately familiar with the concept of ES, only 36% are at least moderately familiar with methods for quantifying ES; 2) Only 31% of resource managers currently consider economic values of ES, but 79% said they would use economic information on ES if they had access to it; 3) ES-related information was generally considered inadequate for managers' needs. Additionally, hierarchical analysis revealed that managers in supervisory roles reported more conceptual consideration of ES, but this trend did not follow for economic consideration of ES. Survey results indicate a desire among managers to transition from considering ES concepts to quantifying economic metrics, indicating a need for practical and accessible valuation techniques. *Keywords: Resources management, Decision making, Ecosystem services, Policy making, Economic evaluation, Hierarchical analysis.*

EUCLIDE, P.T., STRAYER, N., and STOCKWELL, J.D., University of Vermont, 3 College Street, Burlington, VT, 05401. **Is Mysis in decline across the Laurentian Great Lakes?**

*Mysis diluviana* (mysid) is a mid-trophic, macroinvertebrate important to the Great Lakes food web. Over the past four decades the Great Lakes have experienced significant environmental changes including invasion of multiple exotic species and changes in nutrient inputs. These changes have caused declines of some native species such as the burrowing amphipod *Diporeia*. Another species that may be impacted are mysids. We synthesized mysid data from the 1970s to present from across the Great Lakes and tested the hypothesis that mysid density has declined over the last five decades. We then used Pearson's correlations to determine if a top-down or bottom-up description best explained our results. We found normalized mysid density among lakes declined over the last four decades in areas $\geq$ 75 m and mysid density in Lake Ontario has decreased in the same depth stratum since the mid-1980s. Lake Ontario mysid density positively correlates with prey fish density and total phosphorous input suggesting bottom-up pressures impact mysids. However, similar trends were not found in Lake Michigan where mysid populations have remained variable but stable. We conclude that bottom-up pressures are likely caused mysid declines throughout the Great Lakes and suggest that a long term monitoring program for mysids be created. *Keywords: Amphipods, Mysis, Invasive species, Trophic level.*

EVANS, M.A.[1], DURIS, J.[2], FRANCY, D.S.[3], GIVENS, C.[2], STELZER, E.A.[3], and LOFTIN, K.[4], [1]USGS Great Lakes Science Center, 1451 Green Rd, Ann Arbor, MI, 48105; [2]USGS Michigan Water Science Center, 6520 Mercantile Way, Suite 5, Lansing, MI, 48911; [3]USGS Ohio Water Science Center, 6480 Doubletree Avenue, Columbus, OH, 43229; [4]USGS Kansas Water Science Center, 4821 Quail Crest Blvd, Lawrence, KS, 66049.

**Harmful Algal Bloom (HAB) initiation and phenology.**

Determining environmental cues for HAB initiation and the seasonal progression of blooms, in terms of chemistry, algal composition, dissolved and total toxin content, is important to both an ecological understanding of bloom controls and to forecasting HABs for management purposes. To explore controls on bloom initiation and phenology, and coinciding with the 2014 Lake Erie CSMI (Cooperative Science and Monitoring Initiative), we collected spring sediment samples mapping the distribution of *Microcystis* seed populations across the western basin and summer time-series water quality, phytoplankton, and genetic data for several stations along the western shoreline. Several distinct peaks in phytoplankton abundance were detected through the summer including local (occurring at only a few stations) and widespread blooms. Blooms were associated with summer increases in total phosphorous and ortho-phosphate was found to spike during inter-bloom periods, suggesting reactive phosphorous release from lysing cells. *Keywords: Harmful algal blooms, Phytoplankton, Genetics.*

EWING, H.A.[1], WEATHERS, K.C.[2], CHIU, K.[3], CHROBOT, B.B.[4], MIHALKO, J.D.[3], and BORRE, M.A.[2], [1]Bates College, 7 Andrews Road, Lewiston, ME, 04240; [2]Cary Institute of Ecosystem Studies, Box AB, Millbrook, NY, 12545; [3]Binghamton University, Binhghamton, NY, 13902; [4]Massachusetts Institute of Technology, Cambridge, MA, 02139.

**Lake Observer: A Mobile App for Crowdsourcing Lake- and Water-Related Data Across the Globe.**

Mobile apps for data entry and display are rapidly gaining ground as effective tools for collection and display of scientific data. The Lake Observer app began in 2010 as a partnership among computer, ecosystem, and citizen scientists to allow for easy submission of geo-referenced data using a smartphone or tablet. This mobile app allows users to record and submit data on weather, water quality measurements, ice cover, and aquatic vegetation.

Of particular interest to local lake associations and research scientists is the collection of data on cyanobacteria blooms. Data from 2012-2014 collected by research scientists, undergraduates, and citizen volunteers in the northeastern US reveal considerable spatial and temporal variability in the timing and extent of cyanobacterial blooms. These data highlight the way that understanding of cyanobacterial blooms could be enhanced with the greater spatial and temporal coverage possible through crowd-sourcing data. A collaboration among the Global Lake Ecological Observing Network, Esri, and the US Geological Survey, as part of the White House Climate Data Initiative, is aimed at further development of the geospatially referenced database to create a crowdsourcing platform that will facilitate the collection and sharing of lake- and water-related information across the globe. *Keywords: Citizen science, Water quality, Data acquisition.*

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FAHNENSTIEL, G.L.[1], SAYERS, M.J.[1], SHUCHMAN, R.A.[1], POTHOVEN, S.[2], and YOUSEF, F.[3], [1]Michigan Tech Research Institute, Ann Arbor, MI; [2]NOAA/GLERL Lake Michigan Field Station, Muskegon, MI; [3]Great Lakes Research Center, Michigan Tech University, Houghton, MI. **Long-term trends in lake-wide phytoplankton productivity in the Upper Great Lakes: 1998-2013.**

Lake-wide estimates of phytoplankton productivity in the Great Lakes are almost non-existent due to their large size and limited sampling. In order to overcome these limitations, a field-validated remote sensing approach was used to estimate lake-wide phytoplankton productivity for lakes Superior, Huron and Michigan. The Great Lakes Primary Production Model (GLPPM)(slight modification of original Fee model) was used to provide areal and volumetric estimates of primary production using satellite-derived measures of KdPAR, chlorophyll, and temperature. Photosynthetic irradiance parameters (Pmax and alpha) were estimated using empirical models based on historical measurements and simple satellite derived input variables (i.e., temperature, Julian Day, depth, season, etc.). Modeled production estimates revealed large production changes in lakes Huron and Michigan but not Lake Superior. These changes and their relationship to important drivers (i.e., nutrients, mussels, climate change, etc.) will be discussed. *Keywords: Productivity, Phytoplankton, Remote sensing.*

FARRELL, C.[1], HOLDA, T.J.[1], JUDE, D.[2], WARNER, D.M.[3], BOWEN, K.L.[4], WATKINS, J.M.[1], BARBIERO, R.P.[5], and RUDSTAM, L.G.[1], [1]Cornell University, Bridgeport, NY, 13030; [2]University of Michigan, Ann Arbor, MI, 48109; [3]USGS Grea Lakes Science Center, Ann Arbor, MI, 48105; [4]Fisheries and Oceans Canada, Burlington, ON, L7R 4A6; [5]CSC and Loyola University, Chicago, IL, 60660. **Comparing mysid abundance and growth rates across the Great Lakes.**

With the large decline in Diporeia in three lakes - Michigan, Huron and Ontario - there is concern of a similar decline in mysids as a result of lower primary productivity, habitat alteration by quagga mussels, increased light penetration, and/or increased predation by fish related to the loss of Diporeia as prey. We used available data from collections from 2006 to 2013 from these three lakes and Lake Superior to test if mysids have declined and if that decline is specific to the lakes with declining Diporeia populations. Declines in some lakes but not others allows us to speculate in the causes for declines as Lake Superior does not have large mussels populations and has not seen large declines in Diporeia or changes in nutrient levels, Lake Huron and Lake Michigan has seen declines in nutrient levels, high mussel populations, increased light penetration, and declines in Diporeia, and Lake Ontario has the same changes but no decline in nutrient levels during this time period. We also present data on growth rates by comparing size distribution in spring and summer. *Keywords: Lake Ontario, Mysids, Lake Huron, Lake Superior, Lake Michigan.*

FARRELL, J.L.[1], KINKEAD, L.[2], FIEST, A.[3], MEYERS, J.[1], RESLER, S.[4], and NIERZWICKI-BAUER, S.[1], [1]Rensselaer Polytechnic Institute, Darrin Fresh Water Institute, Department of Biological Sciences, 5060 Lakeshore Drive, Bolton Landing, NY, 12814; [2]Rensselaer Polytechnic Institute, Tetherless World, 110 Eighth Street, Troy, NY, 12180; [3]Emma Willard School, 285 Pawling Avenue, Troy, NY, 12180; [4]InnerSpace Scientific Diving, 273 S. Main Avenue, Albany, NY, 12208. **Ecology of Asian Clams on the Northern Edge of Their Geographical Range.**

Following the discovery of Asian clams (*Corbicula fluminea*) in Lake George in 2010, a considerable amount of time and effort was focused on the management of this invasive species. Concurrent with these efforts have been studies of the ecological niche of Asian clams in Lake George, to establish a fundamental understanding of the role this invasive species plays in the environment on the Northern edge of their current geographical range. Asian calm growth rates were calculated from mark recapture studies and verified with measurements on a monthly from distinct locations to identify the overall growth rate of the adult population. Growth rates were approximately ~1mm/week mid-summer but varied

based on clam size and time of year. The population structure was analyzed by measuring 200 clams at 13 individual locations in late September to determine if there were any distinct size distribution groups amongst studied sites. The timing, frequency and abundance of reproduction was evaluated using microcosm studies and weekly dissections of clams to identify the presence or absence of juveniles. The results of these studies will be compared to known literature values for populations in more temperate climates and used to inform future management efforts of clam populations. *Keywords: Population Dynamics, Asian clam, Life history studies.*

FEINER, Z.S., COULTER, D.P., and HÖÖK, T.O., Purdue Department of Forestry and Natural Resources, 195 Marstellar St., West Lafayette, IN, 47907. **Does overwinter temperature regulate maternal condition and offspring quality in yellow perch?**

In fish, ambient temperature exhibits strong influences on processes such as energy allocation and the timing of reproduction. Importantly, anthropogenic impacts such as power plant effluents and climate change can dramatically alter natural thermal regimes, especially during winter months. These shifts in temperature could thereby influence recruitment variation in species that allocate energy toward reproduction over winter, as past research suggests abnormal temperatures may lead to improper egg development. For example, percids are thought to require long, cold winters to successfully reproduce. However, information on the importance of winter temperature to maternal condition, egg size, and egg composition is lacking. We exposed female yellow perch to three overwinter temperature regimes (4°C, 8°C, and 13°C) for ~150 days, hypothesizing that females in the warmest treatment would exhibit decreased body condition and lower quality eggs. In contrast to past studies, we found little effect of temperature on egg quality, even as females held at 13°C exhibited decreased lipid stores. We suggest that the temperatures experienced during winter may be less influential to yellow perch reproduction compared to winter duration, and that egg size and composition may exhibit relatively little plasticity in this species. *Keywords: Life history studies, Environmental effects, Yellow perch.*

FENG, Y.[1], VERHAMME, E.M.[2], ATKINSON, J.F.[1], DEPINTO, J.V.[2], and BOYER, G.L.[3], [1]University at Buffalo, 207 Jarvis Hall, Buffalo, NY, 14260; [2]LimnoTech, Avis Dr., Ann Arbor, MI, 48108; [3]SUNY College of Env. Science and Forestry, Syracuse, NY, 13210. **Hydrological Response of Spatial and Temporal Variation of Nutrients in Sodus Bay, NY.**

Blue-green algal blooms became a serious concern to Sodus Bay, NY, after a bay-wide outbreak in 2010. The two main considerations were its economic value as a water recreation destination, and the health risk posed by the toxin released from the bloom. To help understand the conditions that set up the bloom and assist proactive management, a coupled hydrodynamic and ecological model was set up to analyze the spatial and temporal variance of the nutrients as a response to the hydrological circulation driven by weather, tributary inflows, and Lake Ontario water level fluctuation. A general pattern of nutrient concentration variation was identified, which provides valuable information for future monitoring programs, and from the multiple year data, a reference nutrient level is suggested to help evaluate the effectiveness of watershed management options. *Keywords: Hydrodynamics, Ecosystem modeling, Model studies.*

FERA, S.A.[1], DRAKE, D.A.R.[2], HUNT, L.M.[3], and JOHNSON, T.B.[1], [1]Ontario Ministry of Natural Resources and Forestry, 41 Hatchery Lane RR#4, Glenora, ON, K0K2T0; [2]University of Toronto Scarborough, 1265 Millitary Trail, Toronto, ON, M1C 1A4; [3]Ontario Ministry of Natural Resources and Forestry, 955 Oliver Rd, Thunder Bay, ON, P7B 5E1.

**Assessing the Risk of Aquatic Invasive Species Spread Under Projected Climate Change Scenarios.**

Changing climatic conditions are likely to impact the dispersal and establishment of aquatic invasive species (AIS) in the Great Lakes basin. Using a suite of IPCC climate models, we conducted a risk assessment of potential species introductions across the basin by assessing the temperature suitability for survival, reproduction and growth of fish. Spread was evaluated for key fish species are at risk of invading the system, or that have already established (e.g. round gobies, Asian carps), as well as broad categories with temperature requirements characteristic of warm, cool and cold water classes to account for all potential invaders. Additionally, predicting AIS introductions requires a thorough understanding of the pathways of spread, which includes socioeconomic factors that facilitate species movement. By overlaying the temperature requirements with an empirical model of the accessibility of waters to people (the primary method of species spread) we evaluated the overall likelihood of introduction and establishment of new species on the Ontario side of the basin. The analysis was conducted at three timelines: short (by 2040), medium (by 2070) and long (by 2100). These predicted futures allow adaptive management practices to be developed under multiple possible climate change scenarios. *Keywords: Invasive species, Risk assessment, Climate change, Human movement, Fish.*

FERGUSON, D.J.[1], BAILEY, S.A.[2], and MACISAAC, H.J.[1], [1]Great Lakes Institute for Environmental Research, University of Windsor, 401 Sunset Ave, Windsor, ON, N9B3P4; [2]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7R4A6. **Early detection of aquatic invasive species using automated imaging particle analysis (FlowCAM).**

Aquatic invasive species (AIS) are a major threat to the biodiversity of inland and coastal aquatic ecosystems, resulting in increased pressure for rapid early detection and effective management programs. Successful early detection requires tools that are cost-effective and can rapidly distinguish between native and alien species. Automated imaging particle analysis (FlowCAM) is proposed as an early detection method for AIS as it utilizes a combination of flow cytometry, microscopy and image analysis to rapidly process large quantities of samples. A total of 20 invertebrate AIS were identified as 'species of interest' due to their current or possible invasions of North American lakes and coastal waters. Target species were spiked into ballast water, a major transport vector of AIS, at concentrations mimicking early introduction. Samples were processed using the FlowCAM creating high resolution images that were compared to an image reference library and automatically sorted for desired target species. In addition, target species were added to communities of known numbers and biodiversity to determine the accuracy of results generated. There is high potential for the FlowCAM to accurately screen for invertebrate AIS in transport vectors, allowing for mitigation or aiding management programs during the early stages of an invasion. *Keywords: Invasive species, Ballast, Zooplankton.*

FIORENTINO, L.A., University of Minnesota - Duluth- LLO, 2205 E 5th St., Duluth, MN, 55812. **Understanding the Circulation During the 2014 Lake Erie HABs Using Lagrangian Coherent Structures.**

During the summer of 2014, Lake Erie was plagued by continuous harmful algal blooms (HABs) that left several major cities without clean drinking water. A previously unused tool for circulation analysis in the Great Lakes is the analysis of Lagrangian coherent structures (LCS), which represent the most attracting material lines that control mixing and transport in fluid flows. Using geometric tools, LCSs are extracted from Great Lakes Coastal Forecasting System 2D nowcast model-produced currents of Lake Erie. Then these are compared to Moderate Resolution Imaging Spectroradiometer (MODIS) images of cyanobacteria concentrations, as well as numerical drifter trajectories, to show how LCSs act as skeletons of fluid flow and how they can be used to understand pollution distribution in

the Great Lakes. *Keywords: Dynamical systems, Hydrodynamics, Lagrangian coherent structures, Harmful algal blooms, Lake Erie, Circulation.*

FISK, A.T.[1], WEBBER, D.[2], DEL PAPA, J.[1], LEADLEY, T.[1], and HALFYARD, E.A.[1], [1]University of Windsor / GLIER, 401 Sunset Avenue, Windsor, ON, N9B 3P4; [2]Vemco, 20 Angus Morton Drive, Bedford, NS, B4B 0L9. **Characteristics and Application of an Acoustic Telemetry Tag Designed to Detect Predation Events.**

Acoustic telemetry provides a useful tool to estimate the behaviour, movements and survival of aquatic animals, but relies on the assumption that telemetered data represent the movement of live target animals and not tags within the gut of predators. Identifying predation events can be difficult and has, to date, involved post-hoc analyses of tag movement data that; is reliant on a priori assumptions of 'normal' prey movement and expected predator movement, is prone to underestimating predation rates, and may not be suitable for many studies. We report the testing of an acoustic tag that has been specifically designed to detect predation events. Our objective was to test the performance of predation tags in Great Lakes fish, using two prey species (Yellow Perch, *Perca flavescens* and Rainbow Trout, *Oncorhynchus mykiss*) being consumed by a predator (Largemouth Bass, *Micropterus salmoides*) at three water temperatures. The predation tag was 94% successful (n=65) at identifying predation, with a time lag between consumption and first transmission positively correlated with water temperature but not prey species (ranged from 9.2 hours for Rainbow Trout at 22ºC to 26.5 hours for Yellow Perch at 12ºC). After three weeks of testing, the false positive rate was 0%. *Keywords: Fish behavior, Fish, Acoustics.*

FITZPATRICK, M., MUNAWAR, M., and NIBLOCK, H., Fisheries & Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7S 1A1. **Towards a Broader Understanding of the Structure and Function of Algal Blooms in the Great Lakes.**

Algal blooms are complex entities that vary greatly in terms of their size, structure and dynamics on both spatial and temporal scales. Nitrogen and Phosphorus have long been identified as key factors regulating algal growth while efforts to control algal blooms in the Great Lakes have tended towards phosphorus abatement. Examples of algal blooms from Hamilton Harbour and the Bay of Quinte in Lake Ontario were chosen as case studies. In addition to nutrients and chlorophyll a, we will also consider taxonomic composition, size fractionated primary productivity, microbial loop composition and bacterial growth rates. During August 2010, we observed both Cyanobacteria (*Aphanocapsa, Gloeotrichia, Microcystis*) and Diatom (*Aulacoseira*) blooms occurring simultaneously in the Bay of Quinte despite

similar concentrations of total phosphorus (46-53 µg/l) and Nitrate+Nitrite (5-9 µg/l). Furthermore, while the organic carbon pool was primarily autotrophic, heterotrophs contributed as much as 30% to the total. The goal of this paper is to provide a broader view of the structure and function of algal blooms in order to achieve improvements in water quality. *Keywords: Photosynthesis, Eutrophication, Carbon.*

FLOOD, B.[1], WELLS, M.G.[1], DUNLOP, E.S.[2], and YOUNG, J.[3], [1]Department of Physical and Environmental Sciences, University of Toronto, 1265 Military Trail, Toronto, ON, M1C1A4; [2]Aquatic Research and Monitoring Section, Ontario Ministry of Natural Resources and Forestry, 2140 East Bank Drive, Peterborough, ON, K9J7B8; [3]Ontario Ministry of the Environment and Climate Chnage, 125 Resources Road, Toronto, ON, M9P3V6. **Large internal waves structure the thermal habitat of coldwater fish in Kempenfelt Bay, Lake Simcoe.**

The deep waters of Kempenfelt Bay in Lake Simcoe, Canada provide significant habitat for cold-water fish species. We present new observations that detail the spatial variability of thermocline movements within Kempenfelt Bay from 18 August to 29 September, 2014. Ten days of hydro-acoustic surveys also detail the spatial variability of fish abundance within Kempenfelt Bay. The thermocline depth displays considerable variability in response to the large wind-driven internal seiches in Lake Simcoe. The dominant periods of the thermocline movements were 70 hours and 4 hours, and the amplitudes were in excess of 15m. We show that Coriolis forces strongly influence the propagation of these internal waves within Kempenfelt Bay. Coriolis forces result in a geostrophic balance whereby there was a lateral tilt of the thermocline of as much as 8m across the 2-3 km width of the bay. Cold-water fish species such as Cisco, Lake Trout and Lake Whitefish have optimal growth in oxygen-rich water below 12°C, so the spatial dynamics of these fish could respond to these large amplitude internal waves. We will present preliminary statistics correlating the spatial abundance of these fish with the variability of the thermocline depth, and discuss the potential biological implications of these persistent thermocline movements. *Keywords: Cold-water fish, Coriolis force, Internal waves, Lake Simcoe.*

FOYLE, A.M.[1] and JUSTIK, M.W.[2], [1]Environmental Science Program, Penn State Erie - The Behrend College, 4205 College Drive, Erie, PA, 16563; [2]Chemistry Program, Penn State Erie - The Behrend College, 4205 College Drive, Erie, PA, 16563. **Groundwater and Surface Water Linkages on a Holocene Spit Complex, Presque Isle, Pennsylvan.**

Great Lakes climate change is expected to result in a decline in Lake Erie water levels going forward. The expected trend contrasts with transgression during the 20th Century during which Presque Isle strandplain wetlands developed. Understanding the present hydrogeologic regime of this low-lying coastal strandplain will permit better prediction of coastal wetland behavior as climate and lake levels change across the Great Lakes. In 2014, five large beach-ridge sets on Presque Isle, representing distinct post-1950 strandplain growth phases, were selected for monitoring. Groundwater parameters are being tracked using shallow piezometers, P-T sensors (every 12 min) and electronic tape (bi-weekly), seasonal geochemical analyses, and slug and permeameter tests. Lake levels adjacent to the strandplain are being tracked using surfzone sensor and NOAA gauge data (every 6 & 12 min). Lake and atmospheric parameters (pH, SC, T, DO, turbidity, wind) are being tracked using nearshore buoy data (every 20-30 min). The project aims to answer the following questions: Is the modern wetland system a groundwater discharge, flow-through, or recharge setting? Does this configuration change temporally? Are wetlands connected across the strandplain or are they compartmentalized? If 21st Century lake levels decline, how will wetlands respond? *Keywords: Coastal processes, Hydrogeomorphology, Lake Erie.*

FRANKS, B.S., SINGER, J., and CLAYTON, K., Buffalo State College, 1300 Elmwood Ave, Buffalo, NY, 14222. **Water Elevation Changes in the Fox River, Green Bay, Wisconsin.**

The Fox River begins at Lake Winnebago and flows northeast for 63 km (39 miles) where it enters Green Bay and Lake Michigan. OU 4 is the lowermost stretch of the Fox River between the De Pere Dam and Green Bay. The Fox River is the site of the largest cleanup of PCBs from a waterway in the US. This investigation builds upon prior studies about sediment transport in the Fox River and an oscillation behavior documented in the Buffalo River (Buffalo, NY). It aims to answer the question: Does the Lower Fox River oscillate and if it does, is its pattern similar or different than the oscillation that occurs in the Buffalo River? To answer these questions, two water level recorders with temperature sensors were deployed in the Fox River from June 21 to November 16, 2013. One recorder was placed near the mouth of the river; the second recorder was placed ~8 km upriver. Measurements were collected every 5 minutes. These data reveal that OU 4 of the Fox River displays several distinct patterns including: seiche-driven changes in river elevation, non-seiche related elevation changes, and minimal variation in river elevation. To explain the cause(s) of these patterns we are utilizing other available data, including wind velocity and direction, river velocities, and gage heights recorded at the USGS Oil Tank Depot at Green

Bay, WI. *Keywords: Data storage and retrieval, Hydrodynamics, Water level fluctuations, Seiche, Green Bay, Elevation.*

FREDRICK, N.D.[1], LI, W.[2], MCCARTHY, M.J.[3], ZHU, G.[2], CHEN, Y.W.[2], QIN, B.[2], GARDNER, W.S.[3], and HELLWEGER, F.L.[1], [1]Northeastern University, Boston, MA, 02115; [2]Nanjing Institute of Geography and Limnology, Nanjing, CHINA; [3]University of Texas Marine Science Institute, Port Aransas, TX, 78373. **Nitrogen Cycling Dynamics in Lake Taihu Explored With Mathematical Modeling.**

Nitrogen biogeochemistry is intimately coupled to phytoplankton ecology (i.e., nitrogen fixing vs. non-nitrogen fixing cyanobacteria). We use mathematical modeling to understand nitrogen dynamics in Lake Taihu, China, which is plagued by cyanobacteria blooms. A three-dimensional hydrodynamic model is coupled with a biogeochemical model, which has two sediment layers and state variables for nutrients (phosphorus, nitrogen, silica), and phytoplankton (with variable nutrient quotas). The nitrogen cycle includes PON, DON, $NH_4$, $NO_3$, $NO_2$ and phytoplankton N with both nitrogen-14 and -15 for all species, and processes for nitrification, denitrification, phytoplankton uptake and excretion, ammonia regeneration (DON>NH4), and DNRA. We use the full model to simulate the whole lake. The laboratory sediment core incubations experiments were spiked with nitrogen-15 isotopes and produce "potential" rates, which are not directly comparable with the model. Therefore, we use the model (without hydrodynamics) to simulate each core experiment, calibrate the rate constants to the observations and then use those parameters in the full model. The core incubation simulations use the same model processes, and as in the actual experiments, they take their initial conditions directly from the whole lake model. *Keywords: Ecosystem modeling, Nutrients, Cyanobacteria.*

FREEMAN, C.E. and AUSTIN, J.A., Large Lakes Observatory, University of Minnesota Duluth, Duluth, MN, 55812. **Recent Observations of the Physical Limnology of Lake Malawi.**

A large amount of thermal and circulation data was collected from Lake Malawi between 2011 and 2015, providing new insight into the physical limnology of this large, tropical lake. Data was collected primarily with two moorings, located in the north and south ends of the lake. We observe a strong annual cycle in stratification, ranging from a 6 K temperature difference in the austral summer to a 0.5 K difference in the austral winter. Complete mixing does not occur during the period of study. From 2011 to 2013, the average deep water temperature increased by 0.02 K, consistent with previous results. A time series of heat content gives insight into the heat budget and the relatively small net heat flux in the lake throughout the year. An internal seiche is evident when viewing temperature data, with the thermocline depth being 180° out of phase between the northern and southern ends of the lake. This internal seiche was observed in 2011, but was absent in 2013. Spectral analysis of pressure sensor data shows a strong first- and second-order external seiche as well as a variety of higher order seiche modes and tides. Current data collected with an ADCP shows flows of up to 40 cm/s along the axis of the lake. Intensity data from the ADCP shows strong diurnal variability, suggesting the presence of strong diel migrators. *Keywords: Africa, Physical processes, Hydrodynamics, Thermal structure.*

FRIEDMAN, K.B., ATKINSON, J.F., MAKAREWICZ, J.C., LUZADIS, V.A., LEWIS, T.W., HWANG, H.H., FENG, Y., and THIEL, E., Universisty at Buffalo Regional Institute, 77 Goodell Street, Suite 302, Buffalo, NY, 14203. **Integrating science, policy & economic considerations in understanding and managing nearshore waters.**

Despite heavy investment in phosphorous abatement programs in the 1980s in response to mandates established with the Great Lakes Water Quality Agreement, eutrophication has re-emerged as a significant concern in shallower, nearshore regions of the Great Lakes - the "Fifth Coast" of North America. This problem highlights the complexities of Great Lakes ecosystems as they respond to natural stresses and human management, often in unexpected ways. In this project a team of social scientists, natural scientists, planners, lawyers and engineers developed preliminary data to integrate human and environment subsystems (HES) modeling so that decision-makers, resource managers, scientists, and stakeholders can better understand, adapt to, and manage coastal ecosystems under multiple stresses. In particular, the project examined the Genesee River watershed within the Lake Ontario nearshore ecosystem as a case study to gather data and develop a preliminary model that integrates social science (network analysis, demographic mapping and surveys) with natural science and engineering modeling in the nearshore ecosystem, with a specific focus on eutrophication. *Keywords: Social sciences, Ecosystem modeling, Lake Ontario.*

FRIES, K.J. and KERKEZ, B., University of Michigan, Ann Arbor, MI. **Ship Data for Spatio-temporal Estimates of Hydrometeorological Conditions Across the Great Lakes.**

NOAA's Great Lakes Environmental Research Lab (GLERL) has been collecting hydrometeorological data from various shipping, research, and Coast Guard vessels dating back to 1987. We show how to assimilate these data into models for better estimates of hydrometeorological variables, in particular evaporative fluxes. Given the Lagrangian nature of the data, as well as its sporadic availability, we discuss methods by which to best assimilate these readings into spatial models. *Keywords: Air-water interfaces, Spatial analysis, Great Lakes basin.*

FRY, L.[1], BOLINGER, R.A.[2], KOMPOLTOWICZ, K.[1], LEWIS, J.[1], GRONEWOLD, A.D.[2], and ALLIS, J.T.[1], [1]U.S. Army Corps of Engineers Detroit District, 477 Michigan Ave., Detroit, MI, 48226; [2]NOAA Great Lakes Environmental Research Laboratory, 4840 S. State Rd, Ann Arbor, MI, 48108. **Assessment of U.S. Army Corps of Engineers Monthly Net Basin Supply Forecasting Methods.**

Each month, the U.S. Army Corps of Engineers (USACE) and Environment Canada (EC) produce independent water level forecasts, which are then coordinated and reported in the Great Lakes Monthly Bulletin. Within the USACE forecasting process several models are used to predict Net Basin Supply (NBS), including a regression model and a trend model, both developed by USACE, and the Great Lakes Advanced Hydrologic Prediction System (AHPS), developed by NOAA's Great Lakes Environmental Research Laboratory (GLERL). In light of advancements in hydrologic forecasting since the implementation of these models within the USACE process, a rigorous assessment of each of these models, as they have been employed by USACE, is a necessary step toward identifying potential improvements to USACE water budget and water level forecasting. This presentation will provide background on the NBS models currently in place for producing the USACE contribution to the coordinated monthly forecast, discuss results from an analysis evaluating the skill of models as they have been used to simulate Net Basin Supply for the monthly forecast, and provide recommendations for improving operational forecasting at USACE. *Keywords: Hydrologic budget, Great Lakes basin, Model testing.*

# G

GABORIT, E.[1], HUNTER, T.[2], FRY, L.[4], DURNFORD, D.[1], FORTIN, V.[1], GRONEWOLD, A.D.[2], and TOLSON, B.[3], [1]Environmental Numerical Prediction Research, CMC, Environment Canada, 2121 Transcanadian road, Dorval, QC, H9P1J3; [2]Great-Lakes Environmental Research Laboratory, NOAA, Ann Harbor, MI; [3]Department of civil and environmental engineering, University of Waterloo, Waterloo, ON; [4]U.S. Army

Corps of Engineers, Detroit, MI. **Great-Lakes Runoff Inter-comparison Project for lake Ontario (GRIP-O).**

The project aims at comparing two very different hydrological models in their ability to simulate the river runoff to Lake Ontario. It follows the GRIP-M project focused on lake Michigan, and will hopefully extend to the remaining Great Lakes. Accurate predictions of the lake Ontario level and of the St. Lawrence river flow downstream of the lake require efficient tools for modeling the lake's direct runoff. To this aim, two very different simulation platforms are compared using the same observations, spatial framework and objective function: the Large-Basin Runoff Model (LBRM in its lumped conceptual form), used by GLERL, and the *Modélisation Environnementale de la Surface et de l'Hydrologie* model (MESH- distributed, physically based), used by EC. This study will help determine which model to use depending on the targeted application. In order to assess the sensitivity of the results to the precipitation forcing, the MESH experiments are performed with two precipitation datasets: the CAnadian Precipitation Analysis (CAPA) which only benefits from observations available in real-time, and a gridded dataset of (dense) gauge observations obtained from the NOAA climate archive.Finally, this work brought significant improvements to the MESH model, which has many potential applications to environmental prediction problems. *Keywords: Hydrodynamic model, Runoff simulation, Lake Ontario, Calibration schemes, Comparison studies, Meteorological forcings.*

GADEN, M., Great Lakes Fishery Commission, 2100 Commonwealth Blvd. Ste. 100, Ann Arbor, Mi, 48105. **Cross-border Great Lakes Fishery Management: Cooperation Through a Non-binding Agreement.**

Fishery management authority on the Great Lakes is spread among eight states, the Province of Ontario, and Native American tribes. These jurisdictions are, at times, in conflict over their fishery management, as they have differing management philosophies, needs, constituent pressures, and political dynamics. To avoid chaos, some degree of transboundary governance must occur. To work within this paradigm, the jurisdictions adhere to A Joint Strategic Plan for Management of Great Lakes Fisheries, a non-binding, consensus-based agreement. This paper analyzes the Plan according to four indicators: compliance, functional intensity, stability and resilience, and legitimacy. This paper concludes that the plan's transboundary governance capacity ranks high on all four institutional indicators: it contains effective compliance mechanisms that enhance the chances that what is agreed to will be implemented, it fosters deep ongoing interactions, it is robust, and it is reliant on a strong community of fishery management professionals who participate voluntarily and view the process as legitimate. One significant weakness is noted: the Plan fares less well in terms of coordinating fishery management with other Great Lakes policy goals (such as water quality improvement and habitat protection), though integration is improving. *Keywords: Policy making, Governance, Fish management, Regional analysis.*

GAGNON, V.S.[1], GORMAN, H.S.[1], MORRISON, M.H.[1], and NORMAN, E.S.[2], [1]Michigan Technological University, Houghton, MI; [2]Northwest Indian College, Bellingham, WA. **Collaborative Research Tools in Keweenaw Bay: Workshops, Focus Groups, and Talking Circle Views.**

Addressing complex problems requires new methods for doing collaborative research and creating mutually beneficial projects between researchers, agencies, and community members. This paper focuses on the ways collaborative research has been facilitated in Keweenaw Bay, with forums such as workshops, focus groups, and talking circles transforming community concerns into a scientific question: "When will the fish be safe to eat?" These forums, developed as part of multidisciplinary research project at Michigan Tech University titled "Managing Impacts of Global Transport of Atmosphere-Surface Exchangeable Pollutants (ASEPs) in the Context of Global Change," also helped to generate collaborative views among the participants as the importance of the question emerged. Strategically structured, the purpose of these forums were to enhance discussions of the global transport of ASEPs and their management in the Great Lakes, increase understanding of ASEP issues from diverse perspectives, and to develop future collaboration opportunities between the project research team, agency partners, and community members in Keweenaw Bay. This paper argues that such forums are crucial for facilitating the type of collaborative research that is necessary to address problems as complex as those associated with Great Lakes toxic contamination. *Keywords: Environmental policy, Collaborative research, Environmental contaminants.*

GARDNER, W.S.[1], MCCARTHY, M.J.[1], LU, K.[1], and NEWELL, S.E.[2], [1]The University of Texas Marine Science Institute, 750 Channel View Drive, Port Aransas, TX, 78373; [2]Wright State University, 263 Brehm Lab, Dayton, OH, 45435. **Reduced-nitrogen may Stimulate Microcystis Blooms in Lakes Taihu and Lake Erie.**

Community Ammonium Demand (CAD), the difference between "Potential" and "Actual" uptake rates for ammonium in isotope dilution experiments with 15N-ammonium, provides a powerful tool to determine the occurrence and degree of reduced-nitrogen (RN) limitation in aquatic ecosystems. A survey of CAD values from shallow eutrophic systems worldwide suggests that RN-limitation (high CAD values) prevails in hypereutrophic systems, due in part to loss of N via nitrification/denitrification. High RN-limitation occurs in the regions of Lakes Erie and Taihu where blooms of non-N-fixing Microcystis are common. Waters with high CAD in light often show negative CAD (higher regeneration than potential uptake rates) in dark incubations, suggesting that the microbial community may switch from assimilating RN for growth ("phytoplankton-function") to mineralizing more N ("bacterial function") depending on light conditions. Light/dark experiments suggest that cyanobacteria, such as Microcystis, may outcompete other organisms for urea and use it for biomass production in the light but not in extended darkness. We hypothesize that high inputs of RN, such as ammonium, urea, or other organic N compounds (e.g. from agriculture or domestic wastes or internal recycling) stimulate seasonal Microcystis blooms in shallow regions of polluted lakes. *Keywords: Algae, Harmful Algal blooms, Nutrients, Lake Taihu, Coastal ecosystems, Lake Erie.*

GARNER, A.J. and PAGANO, J.J., State University of New York at Oswego, Environmental Research Center, Oswego, NY, 13126. **Concentrations, Trends, and Elimination Rates of PCDD/F and DL-PCB in Lake Ontario Salmonid Eggs.**

Polychlorinated dibenzodioxins (PCDD), polychlorinated dibenzofurans (PCDF) and dioxin-like PCBs (DL-PCB) are ubiquitous contaminants in the Great Lakes watershed. Chinook and Coho salmonid eggs were collected (2005-2014) from the Salmon River hatchery in Altmar, NY. Each year juvenile salmon raised at the hatchery are released, spend 3-4 years feeding in Lake Ontario accumulating contaminants, and return to the hatchery to spawn and die. For this project, egg samples were analyzed utilizing USEPA isotope dilution techniques with high resolution gas chromatography and high resolution mass spectrometry to assess contaminant trends for 17 PCDD/F and 4 DL-PCBs. The majority of total PCDD/F concentrations were comprised of 2378-TeCDD, 2378-PeCDF, and 23478-PeCDF. Total PCDD/F TEQ (WHO2005) values ranged between 10.3 - 1.6 pg-TEQ/g (w/w). Total DL-PCB TEQ values ranged between 35.3 - 5.6 pg-TEQ/g (w/w). Coho and Chinook egg trend and elimination half-lives (t1/2) were determined for 2378-TeCDF, 2378-TeCDD and DL-PCB-126 with values ranging from 6-9 years and 7-12 years, respectively. *Keywords: Polychlorinated dioxins and furans, PCBs, Dioxin-like PCBs, Lake Ontario, Trends and elimination rates.*

GARNER, C.[1], MCCARTHY, F.M.G.[1], NICKEL, M.[1], DRLJEPAN, M.[2], KIELB, S.[3], and HUBENY, J.B.[3], [1]Brock University, St. Catharines, ON, L2S 3A1; [2]University of Western

Ontario, London, ON; [3]Salem State University, Salem, MA. **Non-pollen Palynomorphs as Indicators of Anthropogenic Impact on Small and Large Lakes.**

Non-pollen palynomorphs in slides prepared for pollen analysis record primary productivity (various types of algae) and consumers -aquatic planktonic and benthic heterotrophs (protists and small invertebrates, primarily arthropods)- as well as terrigenous flux into lakes (e.g., fungi and pollen). The greatest environmental impact on lakes has been human disturbance of the watershed. This is evident in the microfossil record of ragweed pollen-rich sediment of a small urban lake in Massachusetts (Sluice Pond) and a large lake in rural New York State (Lake George). A sharp decline in abundance and diversity of NPP with the increase in ragweed pollen in the 115 cm-long core from Paradise Bay records a surprisingly marked impact of recreational use on water quality in this secluded embayment of Lake George over the last few centuries; prior to that time, a diverse assemblage of algal palynomorphs particularly rich in *Botyrococcus* spp. characterized Paradise Bay. A similar decline in algal biomass accompanies increased ragweed flux and other physical/ chemical proxies of anthropogenic impact in the meromictic Sluice Pond in Lynn, MA, and the low diversity microfossil assemblage contains taxa very rare in lower parts of the core, e.g., *Codonella cratera* and *Radiosperma* sp. *Keywords: Microfossils, Algae, Bioindicators.*

GAWDE, R.K.[1], AUER, M.T.[2], DIJKSTRA, M.L.[1], and AUER, N.A.[3], [1]Great Lakes Research Center, Michigan Technological University, 1400 Townsend Drive, Houghton, MI, 49931; [2]Department of Civil and Environmental Engineering, Michigan Technological University, 1400 Townsend Drive, Houghton, MI, 49931; [3]Department of Biological Sciences, Michigan Technological University, 1400 Townsend Drive, Houghton, MI, 49931.
**Big Heat, Big Chill: Impact of Climate Change on the Thermal Regime of Lake Superior.**

The physical forcing of lake ecosystems attending climate change events impact the thermal regime and cascade through the biochemical processes mediating food web function. Attempts to model outcomes of climatic variations have generated disparate projections of thermal structure and attendant responses by primary producers. The Great Lakes have, in rapid succession, experienced climatic 'bookend' years: the unusually warm 2012 season ('Big Heat') and the extreme cold of 2014 ('Big Chill'). These provide a unique opportunity to assess the impact of these 'bookend' years on the thermal regime. In 2012 and 2014, the Great Lakes Research Center at Michigan Tech led a collaborative effort to characterize the thermal regime of Lake Superior resulting from differences in annual meteorological forcing conditions. Impacts of these extreme climatic events were observed along temporal and spatial scales; e.g., an early onset (by 5 weeks) and duration (by >8 weeks) of thermal stratification in 2012, elevated maximum surface temperatures (by 6°C in 2012) and depth of the upper mixed layer (by >5 m in 2012). This characterization of the thermal regime for 'bookend' years offers insights regarding the potential response of the lake to long-term climate change. *Keywords: Environmental effects, Climate change, Lake Superior.*

GEARHART, T.A., EUCLIDE, P.T., KRAFT, J., and STOCKWELL, J.D., University of Vermont, Burlington, VT, 05401. **The effectiveness of mead acid as a biomarker for essential fatty acid deficiency in fish.**

Cyanobacteria blooms are increasing in frequency and magnitude and becoming a dominant source of primary production in some lakes. Cyanobacteria produce insufficient levels of essential fatty acids (EFA) for zooplankton growth. This effect may propagate up to zooplanktivorous fishes, potentially leading to EFA deficiencies (EFAD). To determine if and to what extent EFAD may impact wild fish populations, robust and broadly applicable biomarkers are necessary. We evaluate mead acid (C20:3), an ω-9 long-chain polyunsaturated fatty acid, as one such biomarker. Unlike ω-3 and ω-6 EFA, mead acid can be synthesized *de novo* by vertebrates and is a viable replacement for EFA in cell membranes. Because mead acid synthesis increases to replace low levels of EFA, it may be used to identify EFAD. To test this hypothesis, we compared the ratio of mead acid to EFA in yellow perch and zebrafish fed a diet deficient in EFA versus a control diet. We assessed the potential physiological impacts of EFAD by measuring metabolic efficiencies of the two diet groups. Results from this feeding study will be compared to ratios of mead acid to EFA found in yellow perch across a range of cyanobacteria densities in Lake Champlain during bloom and non-bloom periods. *Keywords: Bioindicators, Fatty acids, Yellow perch.*

GEFELL, D.[1], BANDA, J.A.[2], CHOY, S.J.[3], JORGENSON, Z.G.[4], MOORE, J.N.[5], ROE, A.[1], SECORD, A.[1], and TUCKER, W.[6], [1]USFWS New York Field Office, Cortland, NY; [2]USFWS Ohio Field Office, Columbus, OH; [3]USFWS Green Bay Field Office, Madison, WI; [4]USFWS Twin Cities Field Office, Bloomington, MN; [5]USFWS East Lansing Field Office, East Lansing, MI; [6]USFWS Bloomington Field Office, Bloomington, IN. **Screening Assessment of Relative Hazard to Fish from Emerging Contaminants at Great Lakes Sites.**

A screening ecological hazard assessment (EHA) was conducted to evaluate relative hazard in fish populations from exposure to contaminants of emerging concern (CECs). Project locations were distributed in and near Areas of Concern (AOCs) across the U.S.

Great Lakes basin. During 2010-2012, U.S. Fish and Wildlife Service (USFWS) offices, together with the U.S. Geological Survey (USGS) and other partners, coordinated a resident fish health investigation that evaluated morphological, histological, and biochemical endpoints in a limited set of fish species. This EHA augments biological effects information generated in the resident fish health investigation. The EHA's toxicity assessment is based on our ecotoxicological database compiled from peer-reviewed literature. Derivation of ecotoxicity screening values (SVs) from exposure-effects relationships is described for a variety of non-cancer endpoints, using effects data in numerous fish species. The SVs identify water concentration thresholds that bound our expectations about adverse effects in fish. Site-specific hazard was characterized by comparing toxicity SVs against co-located, measured water concentrations. Sampling sites and individual CECs were ranked for relative hazard, based on summed hazard scores. Implications for resource and waste management are discussed. *Keywords: Fish, Risk assessment, Great Lakes basin.*

GEORGE, E.M.[1], STOTT, W.[2], YOUNG, B.P.[1], CRABTREE, D.L.[3], KARBOSKI, C.T.[4], ROSEMAN, E.F.[2], and RUDSTAM, L.G.[1], [1]Cornell University, Ithaca, NY, 14850; [2]USGS Great Lakes Science Center, Ann Arbor, MI, 48105; [3]The Nature Conservancy of New York, Pulaski, NY, 13142; [4]USGS Lake Ontario Biological Station, Oswego, NY, 13126.

**Confirmation of Cisco Spawning in Chaumont Bay, Lake Ontario Using an Egg Pumping Device.**

Cisco *Coregonus artedii* are an important prey fish for many Great Lakes predators, including lake trout *Salvelinus namaycush*. Their numbers have declined drastically in the last century due to the impacts of invasive species such as sea lamprey *Petromyzon marinus* and alewife *Alosa pseudoharengus*, overfishing, and habitat degradation. Chaumont Bay, New York contains one of the last remaining spawning populations of cisco in Lake Ontario. In February and March 2014 we collected coregonine eggs from 30 locations within Chaumont Bay using an egg pumping device specially designed to retrieve eggs through the lake ice. Eggs were identified to species using genetic analysis. Cisco appear to rely heavily on rocky, shallow substrate during spawning, and egg distribution is closely associated with shoal areas in Chaumont Bay. The results from this study will be used to inform further investigations on the spawning behavior of cisco, as well as guide any future restoration efforts in Lake Ontario. *Keywords: Fish, Spawning, Lake Ontario, Cisco.*

GIBBONS, K.J. and BRIDGEMAN, T.B., University of Toledo, 2801 W. Bancroft, Toledo, OH, 43606. **The Effect of Temperature on Internal Loading of Phosphorus in the Western Basin of Lake Erie.**

The western basin of Lake Erie has been experiencing an increase in algal biomass. External loading of phosphorus has been used to forecast biomass of harmful algal blooms (HABs) with success. HAB forecasting does not take into account internal loading, which could be a significant source of phosphorus. Previous studies have shown periods of anoxia, which are known to happen intermittently in the western basin, cause phosphorus release from lake sediments. In this study, we examined the potential effect of temperature on internal loading of phosphorus under anoxic conditions. Sediment cores were collected during summer 2014 from 4 locations in the western basin of Lake Erie. Cores were incubated for 5 days in anoxic conditions under 3 different temperatures (10°C, 20°C, and 30°C). Phosphorus release rates varied greatly between temperature treatments and sites. The average phosphorus release rate for cores incubated at 20°C and 30°C was 2 and 14 times higher respectively, than cores incubated at 10°C. Release rates decreased as site distance from the Maumee River mouth increased. Extrapolating these fluxes for the entire western basin indicates that lake sediments could potentially contribute ~1000MT of dissolved phosphorus during five days of anoxia at 30°C. *Keywords: Phosphorus, Biogeochemistry, Cores.*

GILDOW, M.C., GEBREMARIAM, S.Y., and MARTIN, J.F., Ohio State University, Columbus, OH, 43210. **Evaluating Fertilizer Application Placement and Timing to Reduce Phosphorus Runoff to Lake Erie.**

Recent studies indicate that the intensifying eutrophication of Lake Erie results from increasing inputs of soluble reactive phosphorus (SRP), primarily as a result of agricultural runoff from the Maumee watershed. Recent government reports have recommended reducing springtime SRP loading from the Maumee River by 41% to reduce the intensity of harmful algal blooms, to be achieved by implementing recommended agricultural best management practices (BMPs). Fertilizer placement and improved timing of fertilizer application are two recommended BMPs that have not been previously examined on a watershed-scale in Ohio. Quantification of SRP reduction using fertilizer placement and improved timing throughout the Maumee watershed can be accomplished using the physically-based Soil and Water Assessment Tool (SWAT) modeling program to compare SRP output with a baseline model. Implementation of these recommended agricultural BMPs are modeled within SWAT both individually and in combination to determine the

effect on SRP reduction. Preliminary modeling indicates that watershed-wide adoption of fertilizer injection in the subsurface instead of broadcast application may reduce current SRP springtime loading from the Maumee River by as much as 45%. Analysis of these scenarios will provide further guidance on which BMPs have the greatest impact. *Keywords: Model studies, SWAT, Phosphorus, Best management practices, Watersheds, Nutrient management.*

GINN, B.K., Lake Simcoe Region Conservation Authority, 120 Bayview Parkway, Newmarket, ON, L3Y4X1. **Quaggas Rising: Shifting Benthic Dominance from Zebra to Quagga Mussels in Lake Simcoe (ON, Canada).**

Lake Simcoe is the largest inland lake in southern Ontario that, like Lake Champlain, can serve as a proxy for environmental studies on the Great Lakes. Since 2010, we have recorded a rapid decline in the population of zebra mussels (*Dreissena polymorpha*), an invasive species that since their arrival in 1995, has increased complexity in benthic habitats, shunted energy cycling toward the nearshore and benthos, and extirpated native mussels. As in some Great Lakes (Erie, Michigan, Ontario), the decline in zebra mussels has coincided with the expansion of its congener, the quagga mussel (*D. rostriformis bugensis*). Using annual monitoring of benthic macroinvertebrates, we have tracked the consequences of this change in the dominant, ecological engineering, species on other benthic taxa; as well as the implications of another invasive species, the Round Goby (*Neogobius melanostomus*), expanding through the ecosystem, and the effects these changes have on our strategy to restore this lake to an ecologically sustainable state. *Keywords: Dreissena, Quagga mussels, Benthos, Lake Simcoe, Zebra mussels.*

GLANCE, D., International Joint Commission, 2000 L Street, NW, Suite 615, Washington, DC, 20036. **A review of progress on protections, governance, and reflections on challenges and priorities.**

The International Joint Commission's 10-year review of its 2004 recommendations on the Protection of the Waters of Great Lakes report finds much has been done to address issues in the 2000 report, although further progress is necessary to secure the waters of the Great Lakes Basin. Issued in February of 2000, the report responded to a request by the Canadian and U.S. governments in 1999 to examine, report upon, and provide recommendations on Great Lakes water quantity matters including consumptive uses, diversions including withdrawals for export, the cumulative effects of existing and potential diversions and removals, and laws and policies related to these matters. Since this report was released,the Commission has conducted substantial investigations regarding water level

management of the Upper Great Lakes and the Lake Ontario-St. Lawrence River System. The session will discuss the Commission's current recommendations regarding the Protection of the Waters of the Great Lakes, highlight key Commission activities in water level and flow management, and discuss advances in Great Lakes governance while also reflecting upon data and science priorities to ensure the public and decision makers have the tools needed to inform decision making as it relates to the dynamic Great Lakes water system. *Keywords: Diversion, Environmental policy, Data acquisition.*

GLANCY, S.G. and MIHUC, T.B., SUNY Plattsburgh, Plattsburgh, NY, 12901.
**Comparing Zooplankton Communities of 52 Adirondack Lakes with Variable Fish Histories.**

The Adirondack Park holds more than 3000 lakes. Many of these have never been sampled for zooplankton. Knowledge of the patterns of zooplankton presence among Adirondack lakes has implications for fish stocking success, invasion vulnerability, and climate change. Greater knowledge will also contribute to health assessment of lakes throughout the region. During the summer of 2013, zooplankton and phytoplankton were sampled in 52 lakes in the northeastern Adirondack Park, along with a compilation of fish stocking records. Ordinations were used to evaluate presence, and density similarities. Lakes were selected using Generalized Random Tessellation Stratified, and then selected form that pool based on fish stocking history to evaluate the potential human impacts of unchecked fish stocking. Preliminary results show that larger lakes tend to have a greater number of species, which are a homogenized mixture of regionally present species while smaller more remote lakes tend to have fewer, and less common species, including cold stenotherms not found in larger lakes. Analysis also shows that while some larger species are ubiquitous to the region, *Leptodiaptomus minutus*, others are present on a more local or infrequent scale. *Keywords: Fish management, Zooplankton, Food chains.*

GOBIN, J.[1] and DUNLOP, E.S.[2], [1]Environmental & Life Sciences Graduate Program, Trent University, 1600 West Bank Dr., Peterborough, ON, K9J 7B8; [2]Ontario Ministry of Natural Resources and Forestry, 2140 East Bank Dr., Peterborough, ON, K9J 8N8. **Dreissenids may affect how size-selective mortality influences maturation in lake whitefish.**

Lake Huron's lake whitefish fishery employs two types of fishing gear that differ in the size of fish they target: trap nets capture all fish above a minimum size, and gillnets capture a range of mid-sized fish. Lake whitefish are also subject to size-selective predation by sea lamprey. Timing of maturation is a size-dependent trait that together with survivorship dictates an individual's lifetime reproductive output. We developed an individual-based eco-genetic model to examine the effects of various sources of size-selective mortality on the evolution of maturation in lake whitefish for both a pre-dreissenid and a post-dreissenid scenario. Both trap net and gillnet fisheries shifted the timing of maturation to younger ages and smaller sizes. These shifts were primarily due to increases in growth associated with declines in population biomass. How maturation evolved in response to different fishing gears varied for pre- and post-dreissenid scenarios. Minimum size limits, levels of fishing mortality, and lamprey predation also influenced the timing of maturation. Based on our findings, the establishment of dreissenids may have changed how the timing of maturation of lake whitefish populations responds to different sources of size-selective mortality, which could have implications for management. *Keywords: Lake whitefish, Life history studies, Lake Huron.*

GOGINENI, P., JANUSKA, B.M., MINNIEFIELD, C., and SIMOLIUNAS, S., Detroit River Remedial Action Council, 665 W. Warren Ave, Detroit, MI, 48201. **Chlorination of Drinking Water in the Detroit System.**

The Detroit water system uses chlorination without carbon filtration for disinfection of surface water. Responsible federal and state agencies permit chlorination for disinfection of drinking water, which some research indicates may result in toxic effects from chlorination by-products. Citizen groups advocated for at least twenty years, unsuccessfully, for use of safe alternative disinfection via ozone, ultraviolet light, or hypochlorite with carbon filtration. It is time for citizens to organize a scientific body to analyze chlorine by-products in drinking water and present their findings to the public and regulatory agencies. This endeavor is already underway. *Keywords: Detroit River, Drinking water, Organochlorine compounds.*

GOLNICK, P.C.[1], BRIDGEMAN, T.B.[1], CHAFFIN, J.D.[2], and QIAN, S.S.[1], [1]University of Toledo, 2801 W. Bancroft St., Toledo, OH, 43606; [2]F.T. Stone Laboratory, Ohio State University, P.O. Box 119, Put-In-Bay, OH, 43456. **A Statistical Comparison of Sampling and Analytical Methods Used by Lake Erie Research Institutions.**

Tracking eutrophication in Lake Erie requires thorough monitoring of chlorophyll a (chla) and total phosphorus (TP) concentrations involving many agencies and organizations. However, these institutions often use different sampling and/or analytical methods and measured chla and TP concentrations may not be comparable. This can make data set integration difficult. We compared sampling and analytical methods used by major laboratories in the western Lake Erie region: University of Toledo (UT), Ohio State's Aquatic Ecology Lab (AEL), Ohio EPA (OEPA), National Oceanographic and Atmospheric Administration (NOAA), US Geological Survey (USGS), National Center for Water Quality Research (NCWQR), and Ohio State's Stone Laboratory (SL). Linear regressions were used to compare the reported concentrations. Four different sampling methods that were employed produced very similar chla and TP concentrations (slopes=0.96-1.04, r-squared >0.98). Differences were found in analytical methods. One lab reported chla concentrations at least 2x lower (slope= 1.94, r-squared= 0.81) than all other institutions and another lab reported TP concentrations 2x times lower (slope= 2.01, r-squared= 0.97) than all other institutions. Variation for both TP and chla increased at higher concentrations for all institutions. *Keywords: Lake Erie, Comparison studies, Phosphorus.*

GORMAN, H.S.[1], NORMAN, E.S.[2], MORRISON, M.H.[1], and GAGNON, V.S.[1], [1]Michigan Technological University, 1400 Townsend Drive, Houghton, MI, 49931; [2]Northwest Indian College, 2522 Kwina Road, Bellingham, WA, 98226. **Fish Consumption Advisories, Societal Choices, and Systems of Governance.**

The question of when fish consumption advisories in the Great Lakes region will no longer be necessary is both a scientific question and a complex societal choice. Furthermore, it is a societal choice that is being made at many different scales, both within the basin and at the scale of international treaties and global governance. It is a global issue because the toxic compounds that give rise to fish consumption advisories do not recognize political borders once they are in circulation. This paper examines the processes currently in place for making choices about the governance of toxic substances, with special attention on the interaction between policy and science and the objectives being pursued at each scale. It characterize the extent to which the existing multi-scale, multi-jurisdictional system of governance and decision-making is even asking the question "When will the fish be safe to eat?" or establishing "safe fish" as a goal. This research is being conducted as part of multidisciplinary research project at Michigan Technological University titled "Managing Impacts of Global Transport of Atmosphere-Surface Exchangeable Pollutants (ASEPs) in the Context of Global Change." *Keywords: Assessments, Governance, Fish, Environmental policy.*

GORMAN, O.T., WEIDEL, B.C., and BUNNELL, D.B., USGS-Great Lakes Science Center, 2800 Lake Shore Dr E, Ashland, WI, 54806. **Great Lakes Prey Fish Populations: A Cross-Basin Overview of Status and Trends, 1978-2014.**

The assessment of Great Lakes prey fish stocks have been conducted annually since the 1970s. Although the surveys are conducted using bottom trawls, they differ among the lakes in the proportion of the lake covered, seasonal timing, trawl gear used, and the manner in which trawls are towed (across or along bottom contours). Because each assessment is unique, population indices were standardized to the highest value for a time series within each lake for the following prey species: Cisco (Coregonus artedi), Bloater (C. hoyi), Rainbow Smelt (Osmerus mordax), Alewife (Alosa pseudoharengus), and Round Goby (Neogobius melanostomus). There was basin-wide agreement in the trends of age-1 and older biomass for all prey species, with the highest concordance occurring for coregonids and Rainbow Smelt, and weaker concordance for Alewife. In general, trends in year-class strengths were less concordant across the basin and only coregonids showed statistical agreement across the upper Great Lakes. Although there was general basin-wide agreement in downward trends in prey fish biomass, factors likely driving these declines (top-down vs. bottom-up) appear to vary for each Lake. These cross-lake comparisons serve as a starting point for exploring differences in population dynamics of prey fishes across the Great Lakes basin. *Keywords: Fish populations, Fish community trends, Great Lakes basin, Fish management.*

GRAHAM, J.L. and STONE, M.L., U.S. Geological Survey, 4821 Quail Crest Place, Lawrence, KS, 66049. **Real-Time Estimation of Geosmin and Microcystin Occurrence, Cheney Reservoir, KS.**

Cheney Reservoir, a primary source-water supply for the city of Wichita, Kansas, experiences cyanobacterial blooms that cause drinking-water treatment concerns associated with geosmin and microcystin. Data were collected during 2001-2012 for developing reliable tools to estimate geosmin and microcystin occurrence. Model development related geosmin and microcystin to environmental variables measured in real-time (temperature, pH, specific conductance, turbidity, dissolved oxygen, chlorophyll, cyanobacteria, and light). A preliminary linear-regression model (R2=0.71, n=18) that estimated geosmin concentration met with some success, but was not robust over time. Logistic-regression models that estimated probabilities that geosmin (sensitivity=70%, n=127) and microcystin (sensitivity=89%, n=94) would exceed specified thresholds were more robust. The logistic models performed well under a range of environmental conditions, including some of the most extreme hydrologic events and cyanobacterial blooms observed during the 13-year study. Current models provide hourly probability estimates of geosmin and microcystin exceeding designated thresholds and are available on the internet at http://nrtwq.usgs.gov/ks/; these models will aid the City of Wichita in source-water management and drinking-water treatment decisions. *Keywords: Harmful algal blooms, Geosmin, Decision making, Microcystin, Drinking water.*

GRAY, D.K.[1], SHARMA, S.[2], READ, J.S.[3], O'REILLY, C.M.[4], SCHNEIDER, P.[5], LENTERS, J.D.[6], HOOK, S.[7], DONG, B.[8], GRIES, C.[9], HAMPTON, S.[10], and CONTRIBUTERS, G.L.T.[11], [1]Department of Biological and Environmental Sciences, California University of Pennsylvania, 250 University Avenue, California, PA, 15419; [2]Department of Biology, York University, 4700 Keele Street, Toronto, ON, M3J 1P3; [3]U.S. Geological Survey, Center for Integrated Data Analytics, 8505 Research Way, Middleton, WI, 53562; [4]Department of Geography-Geology, Illinois State University, 100 North University Street, Normal, IL, 61761; [5]NILU - Norwegian Institute for Air Research, PO Box 100, Kjeller, NORWAY; [6]LimnoTech, 501 Avis Drive, Ann Arbor, MI, 48108; [7]NASA Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, La Cañada Flintridge, CA, 91001; [8]University at Albany, State University of New York, 1400 Washington Avenue, Albany, NY, 12222; [9]Center for Limnology, University of Wisconsin-Madison, 680 North Park Street, Madison, WI, 53706; [10]Center for Environmental Research, Education and Outreach,, Albrook 202, Pullman, WA, 99164; [11]Global Lake Temperature Collaboration, City. **A Global Database of Lake Surface Temperatures from 1985-2009.**

Past studies have documented changes in lake surface temperatures associated with global climate change; however, it remains unclear if the magnitude of these changes is consistent among different regions, or if heterogeneity in the response of lake surface temperatures exists. In order to examine this question we assembled a global data set of surface water temperatures covering 291 lakes during the period 1985-2009. Temperature time series for 151 of the lakes were collected using in situ methods, while data for 154 were obtained using satellite-based methods (with 14 having both in situ and satellite data). We also assembled time series of data representing climatic drivers (e.g. air temperatures, solar radiation, and cloud cover) and geomorphometric characteristics (latitude, longitude, elevation, lake surface area, maximum depth, mean depth, and volume) that are thought to influence lake surface temperatures. Preliminary analyses suggest that many lakes are warming significantly across the globe and that climatic drivers and geomorphometric factors are important for understanding heterogeneity in the response of lake surface temperatures to climate change. *Keywords: Climatic data, Air-water interfaces, Global warming.*

GRAYSON, T.S.[1], HINCHEY, E.[2], and LIETZ, J.[3], [1]U.S. Environmental Protection Agency, 1200 Pennsylvania Ave, NW, Washington, DC, 20460; [2]U.S. Environmental

Protection Agency, 77 W. Jackson St., Chicago, IL, 60604; [3]U.S. Environmental Protection Agency, 6201 Congdon Blvd., Duluth, MN, 55804. **Development of a New Benthic Condition Tool for Use by the National Coastal Condition Assessment.**

The National Coastal Condition Assessment (NCCA), a US Environmental Protection Agency (USEPA) monitoring program, assesses the condition of the nation's estuaries and coastal waters. A probabilistic survey design and standardized indicators are utilized to determine condition at national and regional scales. Biological condition, a component of ecological condition, is assessed using benthic macroinvertebrate indices. Multi-metric indices, where available, are developed using different methods and applied to specific geographical regions (e.g., the Oligochaete Trophic Index in the Great Lakes). In the absence of a national index, these indices are combined to assess benthic condition nationally. Lack of a national benthic index prompted a recent effort by US EPA to develop a U.S. version of the Multivariate AMBI (M-AMBI) tool used in several European Union nations to assess ecological status. M-AMBI is based on measures of general stress tolerance, diversity and taxa richness. Current attention is on building this tool in marine waters, but desire exists to create a similar tool for application in nearshore Great Lakes environments. If adopted, M-AMBI will be used in future NCCAs. Specifics on the scientific underpinnings of M-AMBI, updates on the current development of a freshwater version of M-AMBI will be presented. *Keywords: Benthos, Index development, Monitoring, Assessments.*

GREEN, P.A., National Park Service, 800 E Lakeshore Dr, Houghton, MI, 49931. **Status of Rapid Response Tools for Ballast Vector.**

National Park Service (NPS), US Geological Survey and the Glosten Associates with support from US Maritime Administration developed a mobile ballast treatment system that can go on and off multiple ships to treat active ballast tanks. This rapid response tool arose from NPS' development of emergency ballast water treatment procedures. Proof of concept testing in 2013 documented its ability to effectively mix tanks so that both treatment and neutralization could occur. In 2014, two biological efficacy trials were conducted. First, testing of the treatment process occurred aboard the NPS vessel, Ranger III, but not the equipment due to ship constraints. The process met two out of three USCG ballast discharge standards for zooplankton and bacteria. Number of living phytoplankton were drastically reduced and living organisms after treatment were not viable. Second, efficacy trails were conducted this fall in brackish water aboard the vessel Golden Bear. Preliminary results are very positive and will be reported out at this meeting. Follow up actions to encourage implementation will be discussed. *Keywords: Ballast treatment, Rapid response, Great Lakes basin, Risk reduction.*

GRIFFITHS, R.W., Oregon State University, Corvallis, OR. **Effect of *Dreissena* on the Oligochaete Trophic Index (OTI).**

The OTI is used in littoral and profundal waters of lakes to assess organic enrichment conditions. The index is based on the abundance of oligochaete taxa and their tolerance to organic enrichment (e.g. Lauritsen et al. 1985). Although the specific calculation of OTI has varied among researchers, it is always an abundance-weighted measure of the community tolerance to organic enrichment, varying from 0-3. The invasion of the Great Lakes by zebra mussels in the late 1980s may have affected this trophic measure, thus impairing its use as a long-term measure of enrichment. Using oligochaete data from prior and after the invasion of zebra mussels into Lake St. Clair (LSC), I was able to test the effect of mussels on the OTI, since mussels initially occurred only in one part of the lake up to 1992. While sites in northwestern LSC that were free of mussels in 1990 all showed a net reduction in OTI (more oligotrophic) compared with the pre-mussel period, sites in southern LSC that were colonized by mussels in 1990 all showed a net increase in OTI (more eutrophic) compared with the pre-mussel period. The increased abundance of oligochaetes and shift in composition following mussel colonization consequently increased the value of OTI by 0.4 to 0.6 units. *Keywords: Bioindicators, Zebra mussels, Lake St. Clair.*

GRIMM, A.G.[1], BROOKS, C.N.[1], BINDER, T.R.[2], KRUEGER, C.C.[2], RILEY, S.C.[3], and SHUCHMAN, R.A.[1], [1]Michigan Technological University, Michigan Tech Research Institute, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [2]Department of Fisheries and Wildlife, Michigan State University, Hammond Bay Biological Station, 11188 Ray Rd., Millersburg, MI, 49759; [3]U.S. Geological Survey, Great Lakes Science Center, 1451 Green Rd., Ann Arbor, MI, 48105. **Assessment of Lake Trout spawning habitat in the Great Lakes using satellite remote sensing.**

The utility of satellite remote sensing for identifying spawning grounds actively used by lake trout *Salvelinus namaycush* was evaluated. The locations of spawning grounds were inferred based on behavioral observations of spawning trout, which have been reported to select clean cobble for spawning and sometimes to further clean the substrate before egg laying. Areas with these characteristics were classified in Pléiades multispectral satellite imagery collected before and after the beginning of the 2013 spawning season based on the brightness of bottom reflectance before the beginning of spawning and the change in brightness after spawning began. While the distribution of field data limited the assessment of the ability to distinguish among degrees of vegetation density and detect changes in vegetation density over time, a binomial regression model based on the above characteristics was reasonably accurate at predicting the locations of active spawning areas as confirmed by egg survey data. Combined with recent findings on the geological formations associated with lake trout spawning, vegetation mapping and change detection represents a new potential tool for locating spawning habitat. *Keywords: Remote sensing, Benthic flora, Lake trout.*

GROFF, C.G. and KASTER, J.L., University of Wisconsin Milwaukee School of Freshwater Sciences, 600 E. Greenfield Avenue, Milwaukee, WI, 53204. **Potential for Re-colonization by *Hexagenia* Mayflies in Green Bay, Lake Michigan.**

The Green Bay, Lake Michigan ecosystem is expected to be in a state of recovery from past degradation; however, mayflies of the genus *Hexagenia*, a well-known bioindicator of water quality, were extirpated in the 1950s and have yet to make a return. Both laboratory-based and *in situ* experiments are in progress -- including raising *Hexagenia* nymphs collected from the Mississippi River in sediment collected from Green Bay, and assessing differences in sediment properties between Green Bay and locations still harboring *Hexagenia* -- in an effort to determine their potential for re-introduction and re-colonization in Green Bay. *Hexagenia* serve important ecological roles associated with bioturbation and providing a high-quality food base for foraging fish; their renewed presence in Green Bay would likely prove beneficial for higher trophic levels and the enhancement of fisheries. The benthic macroinvertebrate community at large in Green Bay has remained relatively un-sampled since the late 1970s. Comparing our recently obtained data (2011-present) to several datasets from past decades may also reveal important changes in diversity, richness/evenness, and the appearance or disappearance of water quality indicator organisms. *Keywords: Benthos, Bioindicators, Green Bay.*

GRONEWOLD, A.D.[1], ANDERSON, E.J.[1], LOFGREN, B.M.[1], BLANKEN, P.D.[2], WANG, J.[1], SMITH, J.P.[3], HUNTER, T.[1], BELETSKY, D.[3], LANG, G.[1], and STOW, C.A.[1], [1]NOAA (Great Lakes Environmental Research Laboratory), Ann Arbor, MI; [2]University of Colorado at Boulder, Boulder, CO; [3]University of Michigan (CILER), Ann Arbor, MI.
**Impact of Regional Climate Perturbations on Lake Michigan's Heat Content.**

During the roughly 14-year period between the late 1990s and 2013, Lake Michigan was characterized by relatively high surface water temperatures, below-average ice cover, persistent below-average water levels and very high over-lake evaporation rates. While the beginning of this period represented a transition in the Lake's thermal and hydrologic regimes that coincided with one of the strongest El Nino events on record, the recent arctic polar vortex anomaly may have served as a catalyst for a similar shift, albeit one to a period with potentially lower surface water temperatures, lower evaporation rates, and higher water levels. Here, we explore historical impacts of the 1997-1998 El Nino and potential implications of the recent polar vortex anomaly on Lake Michigan's heat content with a particular emphasis on interrelationships between winter and fall conditions. More specifically, we look for an improved understanding of the extent to which the lake's winter conditions (including ice cover, surface temperature, and heat content) propagate into the lake's late fall conditions (including evaporation rates, heat content, and surface temperature) as well as how those relationships have changed during different 'cool' and 'warm' regimes. *Keywords: Hydrologic budget, Atmosphere-lake interaction, Lake Michigan.*

GUDIMOV, A., KIM, D.K., PERHAR, G., and ARHONDITSIS, G.B., University of Toronto, 1265 Military Trail, Toronto, ON, M1C1A4. **Integrating watershed modeling with socioeconomic values in the Great Lakes area.**

Lake Simcoe ecosystem integrity depends on the mitigation of non-point phosphorous sources. Tributary flows from adjacent watersheds represent a significant portion of the total loading (70-80 MT P/year), which can be controlled by the effective implementation of Best Management Practices in agriculture and storm water management. Building the foundation for a SWAT modeling exercise, our aim is to provide an integrated assessment of the environmental challenges and socioeconomic values in Lake Simcoe watershed. Using artificial neural network techniques, we classified 284 subwatersheds based on their soils characteristics, land use types, P export coefficients, and socio-economic parameters from the 2006 Census data. Our analyses renders support to the hypothesis that the expected shift from low to high density urban areas along with the concurrent urban sprawl from South to North may represent a major challenge for controlling tributary loading and consequently improving the tropic status of Lake Simcoe. Social media in Twitter and Google indicate different emotional bonding with the lake for residents of existing highly urbanized areas compared to low population areas, which may require special consideration when implementing programs of stewardship and forming general public acceptance of environmental policies. *Keywords: Land-use management, Climate change, Nutrient export, Economic evaluation, Hydrologic modeling, Urbanization.*

# H

HAHN, C.M.[1], IWANOWICZ, L.R.[2], BLAZER, V.S.[2], WALSH, H.L.[1], BRAHAM, R.P.[1], and MAZIK, P.M.[3], [1]West Virginia University, Wv Cooperative Fish and Wildlife Research Unit, Morgantown, WV, 26506; [2]US Geological Survey Leetown Science Center, 11649 Leetown Road, Kearneysville, WV, 25430; [3]US Geological Survey WV Cooperative Fish and Wildlife Research Unit, Morgantown, Wv, 26506. **Effects of Contaminants on Gene Expression Endpoints in Bass from Great Lakes Areas of Concern.**

A recent shift in environmental monitoring of the Great Lakes watershed includes the evaluation of a new group of compounds collectively referred to as contaminants of emerging concern (CECs). At Great Lakes Areas of Concern, both CECs and legacy contaminants are often present resulting in the exposure of aquatic organisms to complex chemical mixtures. In order to assess the cumulative impact of these chemical mixtures a suite of biological indicators from the molecular to the organismal level was evaluated in resident pelagic largemouth bass and smallmouth bass. Next generation sequencing technologies were used to identify biomarkers genes in these non-model species and gene expression analyses were conducted using the nCounter assay from Nanostring Technologies. Gene expression analyses were designed to complement histological assessments, plasma analysis of vitellogenin, estradiol and 11-keto-testosterone and water and sediment contaminants at each sampling location. Correlations between these biomarkers as well as seasonal and species variation of gene expression endpoints will be discussed. *Keywords: Bioindicators, Environmental contaminants, Genetics.*

HAHN, C.M.[1], IWANOWICZ, L.R.[2], CORNMAN, R.S.[3], and BLAZER, V.S.[2], [1]West Virginia University, Wv Cooperative Fish and Wildlife Research Unit, Morgantown, WV, 26506; [2]US Geological Survey Leetown Science Center, 11649 Leetown Road, Kearneysville, WV, 25430; [3]US Geological Survey Leetown Science Center, Ecosystems Mission Area, Kearneysville, WV, 25430. **First Hepadnavirus Isolated from Fishes: Evidence of Hepatitis B Virus Infection in White Sucker.**

A novel hepadnavirus has been identified in liver, skin and plasma samples from white sucker collected in the Great Lakes Region. Skin lesions of different morphological presentations and liver samples were collected from white sucker to establish a transcriptome. Total RNA was sequenced using an Illumina HiSeq 2000. BLASTX searches of assembled contigs indicated the presence of a Hepatitis B-like virus. Both viral DNA and RNA transcripts have been amplified and sequenced. Re-sequencing of the virus has

confirmed that the genome is circular and conforms to the prototypical codon organization utilizing three overlapping ORFs. The genome is approximately 3543bp and most similar to Duck Hepatitis B Virus. All seven viral proteins have been identified by similarity searches and percent amino acid identities range from 29 to 43%. Screening of liver and skin samples (n=20) for viral DNA was positive in 20% of individuals indicating that the virus is not present in all fish and, therefore, is not an endogenous viral relic. To date, Hepatitis B viruses have not been isolated from fishes. While it is unknown whether this virus is associated with pathology in the white sucker, in birds and mammals these viruses are typically associated with liver pathology including inflammation, necrosis, hemorrhage and hepatocellular carcinoma. *Keywords: Fish diseases, Viruses, White sucker.*

HALFYARD, E.A.[1], STEWART, T.J.[2], JOHNSON, T.B.[2], and FISK, A.T.[1], [1]GLIER - University of Windsor, 401 Sunset Ave, Windsor, ON, N9B 3P4; [2]Glenora Fisheries Station, OMNR, 41 Hatchery Lane, Picton, ON, K0K 2T0. **Evaluating Effects of Surgically Implanted Acoustic Transmitters in bloater, *Coregonus hoyi*.**

A bi-national effort is underway to restore deepwater cisco (bloater, *Coregonus hoyi*) to Lake Ontario after the species was extirpated by the 1950s through overfishing, predation, and competition with invasive fishes. A hatchery rearing program has been established with small numbers (16-20 thousand juvenile fish) stocked annually since 2012. With improvements to wild egg collections and significant progress in brood stock development, the planned target to stock 500,000 juveniles / yr may soon be possible. Paramount to this reintroduction program is an understanding the post-release behaviour and survival of bloater - questions that are amenable to study using acoustic telemetry. However, prior to a telemetry program, it is important to understand the risk to bloater subjected to tagging and the appropriateness of assuming that bloater behaviour, survival and movements are not affected by the presence of a transmitter. We have surgically implanted three different sized dummy tags in juvenile bloater (21-95g) and will report on their survival, growth, and tag retention over a 6 months period of observation. Results of our study will inform experimental design considerations for planned acoustic telemetry work on bloater and other small fishes in the Great Lakes basin. *Keywords: Fish behavior, Coregonus, Fish tagging, Acoustic telemetry, Survival.*

HALL, D.K.[1], LESHKEVICH, G.A.[2], NGHIEM, S.V.[3], STARR, C.A.[4], and DIGIROLAMO, N.E.[5], [1]Cryospheric Sciences Laboratory, NASA / Goddard Space Flight Center, Greenbelt, MD, 20771; [2]Great Lakes Environmental Research Laboratory, Ann

Arbor, MI, 48108; [3]3Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, 91109; [4]Global Science and Technology, Inc., Greenbelt, MD, 20770; [5]Science Systems and Applications, Inc., Lanham, MD, 20706. **Ice Growth and Decay on Lake Superior and Ice Type Classification: Winter of 2013 - 2014.**

The extensive ice cover over the Great Lakes in 2014 caused significant difficulties in shipping during the transition period from winter to spring. We have developed an animation of the growth and decay of ice cover on the Great Lakes during the winter of 2013-2014 when ice formed early (November 2013) and stayed late. The official ice-off date was 6 June 2014, with the maximum extent, 92.5 %, occurring on 6 March. During the satellite era, this is second only to the winter of 1978 - 1979 when the maximum ice extent was 94.7%. We also show a time series of images acquired in March of 2014 in which we combine RADARSAT-2 Synthetic Aperture Radar (SAR) ice-type classification maps with Moderate Resolution Imaging Spectroradiometer (MODIS)-derived ice surface temperature (IST) maps. We can refine our ability to distinguish ice from open water as a potential aid to winter navigation using RADARSAT-2 SAR and MODIS IST maps together. During an operational demonstration of the SAR ice-type classification algorithm, in-situ data for validation was collected on Lake Superior from the USCGC Mackinaw 20 March to 5 April. Lake Superior is thus the focus of the animation and ice classification. *Keywords: Lake Superior, Ice, Remote sensing.*

HAMED, A.A.[1], MOHAMMED, I.N.[1], ISLES, P.[1], RYNGE, M.[2], BUCINI, G.[1], TASI, Y.[1], and ZIA, A.[1], [1]University of Vermont, EPSCoR, 23 Mansfield Ave, Burlington, VT, 05405; [2]University of Southern California, Information Sciences Institute, 4676 Admiralty Way, Suite 1001, Marina del Rey, CA, 90292. **Measuring The Climate Change Impact on Water Quality Using a Weather Generator Pegasus Workflow.**

In continuation of the ongoing efforts to understanding the climate change impact on Lake Champlain basin, we present the current status: Our previous efforts have successfully linked human and natural system with climate-change and human drivers using Integrated Assessment Model, for basin management. Using Pegasus, a Scientific Workflow Management System, we were to integrate the following models: (1) Climate projections for daily precipitation and temperature are downscaled to a finer spatial resolution from global climate models (GCMs), (2) A Landuse transition agent-based model component (ILUTABM) that simulates heterogeneity in landuse decisions at parcel levels, (3) A Watershed Hydrology component to simulate the physical impact of climate and landuse using the Regional Hydro-Ecological Simulation System (RHESSys), (4) Coupled 3-D hydrodynamic and water quality model (EFDC-RCA). This workflow, however, lacks the study of direct impact of climate change on Lake Champlain and how this can in turn affect the landuse transition around the lake. Our current efforts have bridged this gap by incorporating a weather generator model that generates lake variables from the current climate data models. This tool, also known as (WG), is based on vector-autoregressive process, which has produced promising results for Lake Constance. *Keywords: Climate change, Pegasus Workflow Management System, Lake management, Scientific Workflows, Computer models.*

HAMILTON, D.P.[1], MCBRIDE, C.G.[1], LEHMANN, M.[1], BRUERE, A.[2], SCHOLES, P.[2], and MCINTOSH, J.[3], [1]University of Waikato, Hamilton, 3283, NEW ZEALAND; [2]Bay of Plenty Regional Council, Whakatane, 3158, NEW ZEALAND; [3]Lochmoigh Ltd, Whakatane, 3191, NEW ZEALAND. **Ecosystem modeling of two interconnected lakes: towards understanding of restoration processes.**

Two large lakes in the Bay of Plenty Region, New Zealand, have undergone major restoration strategies to combat eutrophication, guided by ecological models to understand critical control points. Lake Rotorua is polymictic and until recently underwent anoxia when stratified > 10 days. Alum dosing of inflows to this lake has been carried out for eight years. Understanding the critical control points where alum dosing has been effective in improving water quality has been aided by one- and three-dimensional modeling (DYRESM-CAEDYM and ELCOM-CAEDYM, respectively). The modeling has established a three-tier process by which alum dosing has been effective: (1) in removing bioavailable phosphorus (P) from inflows, (2) increasing flocculation of in-lake P and nitrogen (N), and (3) reducing anoxia-driven lake-bed releases of P. Lake Rotoiti stratifies for around ten months each year. DYRESM-CAEDYM and ELCOM-CAEDYM were used to forecast the effectiveness of diversion of the primary inflow to this lake from Rotorua. The forecasts have been validated with major improvements in water quality; reduction of cyanobacteria blooms and reduced duration of anoxia in bottom waters. *Keywords: Remediation, Ecosystem modeling, Eutrophication.*

HAMPEL, J.J.[1], MCCARTHY, M.J.[2], GARDNER, W.S.[2], LU, Z.[3], and NEWELL, S.E.[1], [1]Department of Earth and Environmental Sciences, Wright State University, 3640 Colonel Glenn Hwy, Dayton, OH, 45435; [2]University of Texas at Austin, Marine Science Institute, 750 Channelview Drive, Port Aransas, TX, 78373; [3]Nanjing Institute of Geography and Limnology, 73 East Beijing Road, Nanjing, 210008, CHINA. **Nitrification rates and the microbial community structure in hypereutrophic Lake Taihu, China.**

Lake Taihu, third largest lake in China, is a hypereutrophic lake experiencing seasonal, cyanobacterial harmful algal blooms (cyanoHABs). These non-N-fixing Microcystis blooms produce the toxin microcystin and have been linked to the increased input of the anthropogenic nitrogen loads. Microcystis spp. compete with ammonia-oxidizing organisms for ammonium in the lake, and this competition may alter the nitrification and, subsequently, denitrification rates. Studying the N-cycle is therefore crucial to understanding toxic blooms and eutrophication in Taihu basin. We measured total nitrification rates, along with ammonia oxidation and nitrite oxidation rates. Nitrification rates (up to 550±103 nM/hr) were high enough to account for the total of ammonium uptake outside of the bloom, but within the bloom, nitrification could only account for half of the total uptake. We also quantified abundance of amoA gene to examine the microbial community structure. *Keywords: Microcystis, Nitrification, Eutrophication, Lake Taihu, Nutrients.*

HAMSHAW, S.D., UNDERWOOD, K.L., RIZZO, D.M., and DEWOOLKAR, M., University of Vermont, 33 Colchester Ave, Burlington, VT, 05405. **Sediment Loading and Sources in the Mad River: Implications for sediment-bound nutrient management.**

Excessive sediment loading in the Lake Champlain basin is of growing concern due, in part, to associated nutrients and organic matter that act to impair surface waters. Accurately measuring sediment load and determining sources are important for monitoring the effects of climate change and river corridor modifications. The Mad River watershed, a headwater catchment in the Lake Champlain basin, was instrumented to monitor suspended sediment dynamics and partition fluvial sediments based on sources. Turbidity sensors and event-based sediment/nutrient sampling supported estimates of sediment loading and characterization of sediment and sediment-bound nutrient relationships. Surface and fluvial sediment samples were analyzed for several categories of tracers, including radionuclides, to determine the sources of suspended sediment discharged. Total sediment yields were used to inform the creation of sediment budgets. Comparison of sediment loads and sources at multiple locations and scales within the watershed provide insights into areas of high sediment loading and relationships to land-use and watershed characteristics. With relationships between sediments and nutrients such as phosphorus, these findings help inform surface water management efforts within the Lake Champlain basin to reduce excessive nutrient loading. *Keywords: Watersheds, Sediment load, Nutrients.*

HANNES, A.H.[1], HINTERBERGER, B.A.[1], RUBY, R.[1], and PÉREZ-FUENTETAJA, A.[2], [1]United States Army Corps of Engineers, Buffalo District, 1776 Niagara Street, Buffalo, NY, 14207; [2]SUNY Buffalo State, Great Lakes Center, 1300 Elmwood Avenue, Buffalo, NY, 14222. **Upbound Emerald Shiners - Locking Through to Lake Erie.**

The emerald shiner (*Notropis atherinoides*) is an important forage species in Great Lakes food webs. In eastern Lake Erie, these fish appear to migrate downstream into the upper Niagara River where they spawn before moving back into the lake. There is concern that anthropogenic modifications of the lake-river connection have increased water velocities and therefore reduced the ability for these fish to move back into the lake. The Black Rock Canal and Lock, a 3.8 mile long waterway running alongside the uppermost reach of the Niagara River (U.S. side), provides an opportunity for emerald shiners moving upstream to bypass the high velocity reach of the upper Niagara River. To investigate the canal and lock as an obstacle or opportunity for emerald shiner passage between the Niagara River and Lake Erie, seining was performed monthly to detect their presence throughout the canal and lock. Catch results suggest that yearling-and-older fish are utilizing the lock and canal, while young-of-year fish are abundant downstream of the lock and within the lock, however, they are absent within the canal. Enhancement of habitat conditions within the Black Rock Canal and other passage alternatives may facilitate emerald shiner movement into Lake Erie.
*Keywords: Fish populations, Niagara River, Lake Erie.*

<u>HANSON, Z.J.</u>[1], CHIU, C.[1], BOLSTER, D.T.[1], HAMLET, A.F.[1], JONES, S.E.[2], and ZWART, J.A.[2], [1]Department of Civil and Environmental Engineering and Earth Sciences, University of Notre Dame, Notre Dame, IN, 46556; [2]Department of Biological Sciences, University of Notre Dame, Notre Dame, IN, 46556. **Integrated Surface Water/Groundwater Modeling in the Midwest/Great Lakes Region.**

Surface water and groundwater models have typically been developed separately, and approaches for building coupled models at regional scales are needed to assess the effects of climate variability and change, land use change, biogeochemistry, and anthropogenic scenarios on water quantity and quality in areas like the Midwest that depend heavily on both surface and groundwater resources. Our current research efforts are focused on an area of interest in northern Wisconsin and Michigan with a high lake density. Coupled hydrology models will help quantify the groundwater and surface water inputs to small lakes that are an important control on the carbon cycle in these systems. We show preliminary results from the coupled surface water/groundwater hydrology model developed for this study. The model integrates groundwater recharge simulated by the macro-scale Variable Infiltration Capacity (VIC) hydrology model with the GFLOW analytic element groundwater model. The simplicity of this approach is intended to facilitate application of the model to relatively

large spatial scales (such as the entire Midwest region) in future work. *Keywords: Great Lakes basin, Model testing, Watersheds.*

HAPPEL, A.[1], RINCHARD, J.[2], and CZESNY, S.J.[1], [1]Lake Michigan Biological Station, Illinois Natural History Survey, University of Illinois, Zion, IL; [2]Dept. of Environmental Science and Biology, The College at Brockport - State University of New York, Brockport, NY. **Species specific fatty acid profiles across multiple different freshwater systems.**

Quantitative and qualitative estimates of trophic interactions provide valuable information on how food webs respond to perturbations. Recently, fatty acid signatures have been used to estimate dietary proportions of prey species for a variety of organisms in both wild and laboratory settings. Often these models must rely on the assumption that regardless of seasonal and spatial variation, fatty acid signatures allow discrimination among species. Whether this assumption holds over a variety of ecosystems has yet to be examined. To this end we investigated whether several fish species common to the Great Lakes maintain specific fatty acid signatures. First, variation in intra-specific fatty acid composition was assessed to establish whether among ecosystem differences existed in each species. Subsequently, a novel re-classification approach was utilized to evaluate whether fatty acid signatures allow accurate classification of species regardless of their sampling origin. High classification rates, even for samples of non-great lake systems indicate that qualitative fatty acid indicators (i.e., 16:1n-7 indicating benthic reliance) are transitive across freshwater bodies. Furthermore, our classification rates suggest that quantitative models may not need to be system and time specific. *Keywords: Fatty Acids, Food webs, Trophic ecology.*

HARBICHT, A.B.[1], ARDREN, W.R.[2], CASTRO-SANTOS, T.[3], and FRASER, D.J.[1], [1]Concordia University, 7141 Sherbrooke St. West, Montreal, QC, H4B 1R6; [2]U.S. Fish and Wildlife Service, 11 Lincoln St., Essex Junction, VT, 05452; [3]USGS-S.O. Conte Anadromous Fish Research Center, One Migratory Way, Turners Falls, MA, 01376. **Does Boosting Thiamine Levels of Adult Landlocked Atlantic Salmon Enhance Upstream Migration.**

Efforts to reintroduce landlocked Atlantic salmon (Salmo salar) in Lake Champlain are currently being hindered by the recent introduction of alewife (Alosa pseudoharengus) in 2003. Consuming alewife has decreased thiamine (vitamin B1) levels within salmon, potentially reducing migration performance due to impaired equilibrium and muscle weakness. In the fall of 2014, we used radio telemetry to quantify upstream migration performance of 24 adult salmon in the Boquet River at a steep cascade section immediately downstream of the Willsboro Dam. Half of these fish were injected with thiamine booster shots (150 nmol/g). All but one experimental fish continued upstream and held in a large pool just below the cascade for an average of 21 days. Two thiamine boosted and one non-boosted fish successfully migrated upstream of the cascade. To better characterize impacts of increasing thiamine levels on salmon migration performance, we are developing novel telemetry-based methods to quantify the extent, duration and frequency of attempts to climb the cascade for each fish. In early November many fish exhibited forced dispersal, resigning to spawn in sub-optimal locations below the cascade. Our results suggest this cascade presents a major challenge to salmon migration in the Boquet River. *Keywords: Fish tagging, Radio telemetry, Thiaminase, Salmon.*

HARRISON, J.H., University of Wisconsin Sea Grant, 600 E. Greenfield Avenue, Milwaukee, WI, 53204. **Assessing the Economic Cost of Water Quality Degradation at Lake Michigan Beaches.**

South Shore Beach in Milwaukee, Wisconsin historically has had degraded water quality and low visitor use rates. This urban beach is chronically closed due to elevated E. coli levels. Water quality advisories and closures range from 25% to nearly 50% of the swimming season, depending largely on the number of days of rainfall. Causes of pollution include localized runoff, regional sources such as stormwater discharges and combined sewer overflows, fecal waste from gulls and waterfowl, and limited water circulation due to breakwalls. Milwaukee County Parks, which manages South Shore Beach, estimated that improvements to water quality at South Shore Beach could cost anywhere from $1.6 to $5.6 million depending on the extent of improvements made. In order to compare the costs and benefits of investments in the beach, a study was conducted to assess the economic cost of water quality degradation at Wisconsin Lake Michigan beaches. The study employs travel cost and contingent valuation methods to compare urban and rural beaches, as well as beaches with poor and high water quality levels. Beach users and Milwaukee County residents were surveyed to determine their beach visitations rates and economic values they ascribe to Lake Michigan beaches. *Keywords: Economic evaluation, Environmental health, Lake Michigan.*

HARTIG, J.H., U.S. Fish and Wildlife Service, 9311 Groh Road, Grosse Ile, MI, 48138.
**Helping Develop the Next Generation of Conservationists Through Compelling Citizen Science.**

The Detroit River International Wildlife Refuge was established in 2001 as the only international one in North America and one of only a few truly urban ones. The goal of the Refuge is two-fold: to help restore and conserve continentally-significant fish and wildlife populations and their requisite habitats along the Detroit River and western Lake Erie; and to make nature part of everyday urban life to help develop the next generation of conservationists. To help develop the next generation of conservationists, a priority has been placed on compelling citizen science. Examples include: Detroit River Hawk Watch, marsh bird monitoring, Christmas Bird Counts, common tern habitat restoration, and soft shoreline engineering. The value and benefits of this work include: developing a personal connection to the places citizens work and study; gaining an understanding of environmental and natural resource problems, challenges, and needs; learning about scientific methods and how science contributes to management; becoming involved in environmental and natural resource management decisions; building the capacity of governments, nongovernmental organizations, and other stakeholder groups to fulfill their environmental and natural resource missions; and improving scientific literacy and developing a stewardship ethic.
*Keywords: Citizen science, Monitoring, Ecosystem health.*

HEBERT, C.[1], POPP, B.[2], FERNIE, K.[3], KA'APU-LYONS, C.[2], RATTNER, B.[4], and WALLSGROVE, N.[2], [1]Environment Canada, 1125 Colonel By Drive, Ottawa, ON, K1A 0H3; [2]University of Hawaii, Honolulu, HI; [3]Environment Canada, Burlington, ON; [4]United States Geological Survey, Beltsville, MD. **Ground-truthing Amino Acid-specific δ15N Analysis in Birds: Results from Lab and Field Studies.**

Top predator aquatic birds integrate lower food web processes making them useful indicators of ecosystem state. Such species have been used for decades in research programs. Core goals of these programs include understanding the environmental fate of contaminants and detecting environmental change through alterations in ecological processes, e.g. food web disruption by exotic species. Addressing these goals requires methods, such as stable isotope analysis, to assess pathways of energy, nutrient, and contaminant flow. In the past, most nitrogen isotopic studies of birds have been based upon the analysis of bulk tissues. However, spatial and temporal comparison of $\delta^{15}N$ values may not be appropriate because of potential differences/changes in $\delta^{15}N$ values at the base of the food web. Amino acid compound-specific nitrogen isotope analysis (AA-CSIA) may provide the means to address this issue by generating $\delta^{15}N$ baseline and trophic position estimates from the same sample. Here, we describe AA-CSIA results stemming from avian laboratory and field studies. These results demonstrate the utility of this approach for environmental research. To illustrate this, we provide an example of how baseline correction of $\delta^{15}N$ data is useful when interpreting contaminant data. *Keywords: Stable isotopes, Isotope studies, Avian ecology.*

HEEREN, A.[1], TOMAN, E.[1], WILSON, R.[1], BURNETT, E.[1], and MARTIN, J.F.[2], [1]School of Environment and Natural Resources-The Ohio State University, 2021 Coffey Rd., Columbus, OH, 43201; [2]Department of Food, Agricultural and Biological Engineering-The Ohio State University, 590 Woody Hayes Ave, Columbus, OH, 43201. **Applying Social Science Research in Addressing Lake Erie's Algal Blooms.**

Lake Erie is the most productive of the Great Lakes. Algal blooms, caused by non-source point nutrient and sediment run-off, pose a severe threat to both human health and the multi-million dollar sport fishing economy. Experts have proposed numerous agricultural practices designed to reduce nutrient and sediment run-off. However, substantial uncertainty remains regarding the effectiveness and social acceptability of such practices. It is not clear how those in the general public, or those in the agricultural community, perceive the problem, or whether they will support certain policies to mitigate the blooms. Social science offers multiple methodologies to examine how the public perceives water quality problems as well as ways to predict how proposed policies and practices would be received. Here, we present a number of qualitative and quantitative social science research methods that we have used to examine how the public perceives algal blooms and related environmental issues affecting Lake Erie, such as climate change. Using focus groups, interviews, surveys and choice-experiments, we examine how different groups (such as urban and rural residents, or those living near or far from the lake) view algal blooms as well as their support for policies addressing the blooms. *Keywords: Algae, Environmental policy, Harmful algal blooms.*

HELLWEGER, F.L. and FREDRICK, N.D., Northeastern University, 360 Huntington Ave, Boston, MA, 02115. **Time to Add More Biology to Ecosystem Models? Agent-based Modeling of Anabaena-nitrogen Interaction.**

The current ecosystem modeling approach has proven useful to support management, but real systems continue to surprise us highlighting the need to for further advancements. Operational water quality models (e.g. WASP) were originally developed in the 1970s and significant advances have been made in terms of physics (e.g. 3-D hydrodynamics), land-side integration (e.g. watershed models) and forecasting and uncertainty analysis. Less change has occurred in the biology and most models still use a highly simplified approach (e.g. Monod growth kinetics). At the same time the biological sciences are advancing the knowledge of microbes at a fascinating rate. We have to continue to explore integrating this knowledge into our ecosystem models. We present an example of this for the cyanobacteria Anabaena. The agent-based model simulates individual cells, each with a number of genes (e.g. nirA) that are expressed and yield transcript and protein levels and interact to take up and metabolize N. The model dynamically simulates filaments with individual cells, which respond to combined N deprivation by differentiating heterocysts that fix atmospheric N and pass it on to adjacent vegetative cells. The model is constrained with observations from 30+ published papers and used to simulate the population dynamics at the ecosystem scale. *Keywords: Cyanophyta, Ecosystem modeling, Gages.*

HENQUINET, J.W.[1] and GREEN, P.A.[2], [1]Henquinet Consulting, LLC, Houghton, MI; [2]Isle Royale National Park, National Park Service, Houghton, MI. **Rapid Response for Invasive Species in Ballast Water: Policy and Practicality.**

Vessel ballast water discharge regulations that mandate installation of ballast water treatment systems (BWTS) are many years away from full implementation. There is a need for rapid response interventions to prevent AIS in the interim and in the future should a ship's ballast present a high risk due to BWTS failure or other reason. The current U.S. regulatory approach to ballast water management is largely silent on rapid response even though it is common in other aspects of shipping and invasive species management. This presentation assesses this regulatory gap and potential solutions. *Keywords: Ballast, Environmental policy, Invasive species.*

HENSLER, S.R.[1], BOWEN, A.[2], STADIG, E.R.[1], OLDS, C.[2], KEPPNER, S.[3], SANDERS, S.[3], DRAKE, D.[3], HALTNER, R.[3], HIMES, H.[3], and SCHLOESSER, J.[4], [1]U.S. Fish & Wildlife Service, 7806 Gale Road, Waterford, MI, 48327; [2]U.S. Fish & Wildlife Service, 480 West Fletcher Street, Alpena, MI, 49707; [3]U.S. Fish & Wildlife Service, 1101 Casey Road, Basom, NY, 14013; [4]U.S. Fish & Wildlife Service, 2800 Lake Shore Drive East, Ashland, WI, 54806. **Vector-based strategy for early detection of non-native aquatic species in Lake Erie.**

In response to decades of invasions by non-native species and prompted by Great Lakes Restoration Initiative funding, the U. S. Fish & Wildlife Service is developing and implementing an early detection monitoring program for non-native aquatic species in Lake Erie as well as the other Laurentian Great Lakes. The goal of this program is to detect species while they are rare, potentially allowing initiation of management or policy efforts to stop new species from becoming invasive. Focus taxa include fishes, amphipods, and bivalves. Using vector- and species-based risk assessments as well as direct measures of relative risk for potential vectors of introduction, transparent procedures were developed to select sampling sites where new species would likely first appear in Lake Erie. A suite of sampling gears is being used to collect a variety of organisms during various life stages. Rarefaction is performed to estimate species detection probability, and molecular techniques are used to improve organism detection and identification. The USFWS early detection monitoring program is designed to be flexible and responsive to new non-native species threats. *Keywords: Risks, Invasive species, Biological invasions.*

HETHERINGTON, A.L.[1], ZHAO, A.S.[2], HUNN, J.M.[1], SCHNEIDER, R.S.[1], RUDSTAM, L.G.[1], HIPSEY, M.R.[3], and BRUCE, L.C.[3], [1]Cornell University, Ithaca, NY, 14853; [2]The Japan Exchange and Teaching Program, Nagahama, 529-0412, JAPAN; [3]University of Western Australia, Crawley, WA, 6009, AUSTRALIA. **Comparison of Zebra and Quagga Mussel Clearance Rates across Annual Lake Temperatures.**

Invasive zebra, *Dreissena polymorpha*, and quagga, *Dreissena rostriformis bugensis*, mussels impact the structure and function of freshwaters globally by filter feeding, thereby increasing water clarity. Since quagga mussels are replacing zebra mussels in several lake ecosystems, total mussel filtration as well as seasonal patterns of filtering may have changed. Through replicated, laboratory microcosm experiments, we measured clearance rates of zebra and quagga mussels over a range of temperatures from 2-30°C using *Chlamydomonas reinhardii* as the food source. Temperature dependence of clearance rates was similar for the two mussel species peaking at 18°C for zebra mussels and 20°C for quagga mussels. Zebra and quagga mussels actively fed from 4-30°C, but not at 2°C. Clearance rates of zebra mussels exceeded those of quagga mussels at most temperatures. Based on these results, replacement of zebra by quagga mussels would not result in any change in the seasonal pattern of filtration and would lower lake-wide mussel filtration rates unless the replacement also includes an increase in mussel biomass. These results were included in a mussel module for the open source, 1D lake water quality model, GLM-FABM-AED, to predict changes in mussel lake-wide clearance rates as affected by abundance and distribution. *Keywords: Dreissena, Filtration, Temperature.*

HILL, N.D.[1], GEARHART, T.A.[2], STOCKWELL, J.D.[2], KRAFT, J.[2], and GOFF, P.[1], [1]Vermont Commons School, 75 Green Mountain Drive, South Burlington, VT, 05403; [2]University of Vermont, Burlington, VT, 05401. **Seasonal Effects of Cyanobacteria on Fatty Acid Composition of Perch in Lake Champlain.**

Cyanobacteria are low in essential fatty acids (EFAs). Zooplankton fed diets of cyanobacteria experience decreased EFAs, leading to decreased growth and reproduction. Hypotheses have been proposed to suggest this disruption in the transfer of EFAs may propagate up to fish. If true, fish in systems with cyanobacteria blooms may experience seasonal decreases in their EFA content, which may impact both the health of the fish and the benefits of fish consumption by humans. We tested the hypothesis that there is seasonality in the EFA levels in fish occupying waters prone to cyanobacteria blooms. We measured EFA levels in muscle tissue of Lake Champlain white perch (*Morone americana*) and yellow perch (*Perca flavescens*) purchased from a local fish vendor in both summer and winter. If we find a decrease in EFA concentration in the summer treatment, this would suggest that cyanobacteria blooms may affect the human health benefits of eating fish. *Keywords: Human health, Fish, Fatty acids, Cyanophyta.*

HILLIS, E.H.[1], XENOPOULOS, M.A.[2], and HAFFNER, G.D.[1], [1]Great Lakes Institute for Environmental Research, University of Windsor, Windsor, ON; [2]Trent University, Peterborough, ON. **Factors regulating primary production in Lake Erie.**

Historically, phosphorus has been considered the major nutrient limiting primary production in lakes. In response to increasing eutrophication in Lake Erie during the 1960s, models relating primary production to total phosphorus loadings (TP) and chlorophyll *a* concentrations (chl *a*) (Vollenweider et al. 1974) were used to establish target TP loadings. However, in a study from 2000-2001 in the western basin, annual primary production was not related to TP and chl *a* as predicted by these earlier models (Fitzpatrick et al. 2007). To look at primary production on a larger spatial scale, nearshore and offshore sites in all three basins of Lake Erie were sampled monthly from May to October of 2014. At each site, TP, nitrate, chl *a*, phytoplankton biomass, light penetration, and water quality parameters were measured. Primary production was measured using the *in situ* uptake of $^{14}C$. Despite a low overall average TP of 15.9 $\mu g\ L^{-1}$ and an average chl *a* of 2.9 $mg\ m^{-3}$ (versus 5.5 $mg\ m^{-3}$ in 1970), the range in primary production (~ 5 - 50 $mg\ C\ m^{-3}\ h^{-1}$) was similar to that in 1970. This suggests that regulation of primary production in Lake Erie is complex and not solely based on phosphorus or chl *a* concentrations. *Keywords: Nutrients, Primary production, Carbon cycle, Lake Erie.*

HINCHEY, E.[1], BOLGRIEN, D.W.[2], KELLY, J.R.[2], HORVATIN, P.J.[1], ANGRADI, T.R.[2], COTTER, A.M.[2], YURISTA, P.M.[2], SCHAROLD, J.[2], LIETZ, J.[2], BARTSCH, W.M.[2], GIANCARLO, M.B.[1], NETTESHEIM, T.[1], SINGLETON, N.[1], NORD, M.[1], GRAYSON,

T.S.[3], ELLISON, R.[1], and BRACKETT, M.L.[1], [1]U.S. EPA Great Lakes National Program Office, 77 W. Jackson Blvd G17-J, Chicago, IL, 60604; [2]U.S. EPA Office of Research and Development Mid-Continent Ecology Division, 6201 Congdon Blvd, Duluth, MN, 55804; [3]U.S. EPA Office of Water, 1200 Pennslyvania Ave, NW, Washington, DC, 20460.
**Connecting the Lakes - Completing their Assessment: Huron-Erie Corridor NCCA Pilot Study.**

The Huron-Erie Corridor (HEC), comprised of the St. Clair River, Lake St. Clair, and Detroit River, is the ecologically and economically significant connecting channel between Lake Huron and Lake Erie. In 2014, U.S. EPA conducted a pilot assessment of ecological conditions in the HEC. The pilot demonstrated the feasibility of assessing the HEC for inclusion in the 2015 U.S. EPA Office of Water National Coastal Condition Assessment (NCCA) and will establish baseline/temporal information. The NCCA provides statistically valid regional and national estimates of the condition of U.S. coastal waters and the Great Lakes. In our pilot study, 63 stations were sampled for water quality, sediment quality, and benthic community composition to provide information on spatial variability of conditions throughout the corridor. Results will be analyzed with respect to landscape characteristics of adjacent watersheds. In future years, NCCA pilot assessments of the St. Marys and Niagara rivers are planned. The combined corridor water quality data and landscape characterization form a demonstration and validation of a comprehensive assessment of the Great Lakes and their connecting channels. Results also will contribute to a coastal observing system that may be applied to all connecting corridors of the Great Lakes. *Keywords: Monitoring, Connecting channels, Assessments, Detroit River, Coasts, Lake St. Clair.*

HIRIART-BAER, V.P. and MILNE, J.E., Environment Canada, Burlington, ON. **Why Now? Understanding the Reasons Hamilton Harbour is Letting Go of Sediment Phosphorus.**

Hamilton Harbour, designated as an Area of Concern (AOC) in 1985 by the International Joint Commission (IJC), has been systematically monitored since 1987 in response to its Remedial Action Plan (RAP). In this study, we present the long-term water quality record (1987 to 2012) of Hamilton Harbour focusing on the temporal changes in the hypolimnetic environment. During the summer period, Hamilton Harbour has consistently, over the last 25 years, gone anoxic with intermittent increases in oxygen following Lake Ontario water intrusions. Only over the last decade, however, has this translated into an accumulation of soluble reactive phosphorus (SRP) and an increasing trend is seasonal average hypolimnetic SRP concentrations. In 2014, we began sampling for additional water

quality parameters as well as surface sediment to attempt to understand the seasonal changes in water chemistry in the hypolimnion of the harbour. Here we present preliminary results on hypolimnetic water and sediment chemistry in relation to anoxia and SRP concentrations in the hypolimnion. These results are placed in the context of the recent history of Hamilton Harbour and changes to its industrial loads. *Keywords: Sediment load, Phosphorus, Oxygen.*

HLADYNIUK, R. and LONGSTAFFE, F.J., The University of Western Ontario, 1151 Richmond Street, London, ON, N6A5B7. **Anthropocene Changes in Organic Matter Accumulation in Lake Ontario.**

We have analyzed organic carbon (%OC) and total nitrogen (%TN) abundances in benthos cores from the Niagara (west), Mississauga (central) and Rochester (east) basins across Lake Ontario in order to assess how primary productivity and/or terrestrial inputs of organic matter (OM) have changed in response to natural and anthropogenic stressors since 1750 (A.D.). Pb-210 dating (Niagara basin) and previous work were used to acquire age-depth models. From 1750 to 1920, all three basins record similar OC (~2%) and TN (~0.3%) abundances. Beginning in 1920, an increase in OC (to ~4%) and TN (to ~0.6%) occurs in the Niagara and Mississauga basins. The increase in OC and TN begins much later (~1985) in the Rochester basin. This difference likely reflects basin-specific, proximity-related, responses to source inputs from the Niagara River and industrialization/urbanization in the western half of Lake Ontario. By 2008, however, sediments from all three basins have similar (and high) OC and TN contents; the processes responsible for OM accumulation now impart a common signal across Lake Ontario. Carbon, nitrogen and oxygen isotope analysis of OM and authigenic carbonate are in progress to elucidate the OM sources and the role of lake thermal structure on OM accumulation. *Keywords: Lake Ontario, Paleolimnology, Organic carbon, Stable isotopes, Climate change, Anthropocene.*

HLEVCA, B.[1], WELLS, M.G.[1], COOKE, S.J.[2], MIDWOOD, J.D.[2], and DOKA, S.E.[3], [1]University of Toronto Scarborough, 1265 Military Trail, Toronto, On, M1C 1A4; [2]Carleton University, 1125 Colonel By Drive, Ottawa, ON, K1S 5B6; [3]Fisheries and Oceans Canada, 867 Lakeshore Road, Burlington,, ON, L7S 1A1. **Water-level fluctuations drive exchange in shallow embayments of the Toronto Waterfront.**

We analyze the exchange between shallow embayments of the Toronto Harbour and Lake Ontario. Toronto Harbour has a surface area of 18 km² and a mean depth of 10 m, and contains many shallow artificial embayment created to support fish habitat. The exchange between these embayments and the lake is driven primarily driven by oscillations in the water level that have a 1-hour period. The embayments are generally much warmer than the lake and provide important warm water fish habitat. However the lateral temperature gradients appear to be of secondary importance in driving the exchange currents through the channels. The thermal regime of the embayments is a strong function of the residence time of water - with rapidly flushed bays being in general cooler than bays with longer residence times. We use a combination of analysis of observational data and three-dimensional simulations to determine the hydrodynamic characteristics of the lake-harbour system. The influence of geometry on hydrodynamics and thermal regimes are further studied using numerical simulation scenarios, and we discuss the design implications for successful creation of fish habitat.

*Keywords:*Littoral zone; hydrodynamics; Lake Ontario; internal waves. *Keywords: Lake Ontario, Computer models, Toronto Harbour, Coastal wetlands, Hydrodynamics.*

HLINA, B.L.[1], MUHAMETSAFINA, A.[1], BIRCEANU, O.[1], JUBAR, A.[2], SLAGHT, K.S.[3], SLADE, J.W.[2], and WILKIE, M.P.[1], [1]Wilfrid Laurier University, 75 University Avenue West, Waterloo, ON, N2J 1C6; [2]Ludington Biological Station-US-Fish and Wildlife Service, 229 South Jebavy Drive, Ludington, MI, 49431; [3]Hammond Bay Biological Station-US Geological Survey, 11188 Ray Rd. Millersburg, MI 49759, Millersburg, MI, 49759. **The seasonal differences in the TFM tolerance and TFM detoxification capacity in larval sea lamprey.**

The lampricide, 3-trifluoromethyl-4-nitrophenol (TFM), is the primary control method used to manage sea lamprey in the Great Lakes and Lake Champlain. This chemical is applied to streams and rivers infested with larval sea lampreys, but our recent work has indicated that their tolerance to TFM is 2-3 times greater in late summer compared to spring. The goal of this study was test the hypothesis that the capacity of larval sea lampreys to detoxify TFM was greater in later summer compared to spring. To test this hypothesis, larval sea lamprey were collected in April, June, August, and October and subjected to TFM toxicity tests by exposing the larvae to a range of TFM concentrations (0.5-5 mg $L^{-1}$). Whole body TFM concentrations and its metabolite, TFM- glucuronide, were determined using solid phase extraction and high pressure liquid chromatography. Whole body TFM concentrations averaged between 60-70 nmol $g^{-1}$ wet weight, but only traces of TFM-glucuronide were detected, and neither varied with season. These data suggest changes in the

capacity of larval sea lampreys to detoxify TFM via glucuronidation do not explain seasonal differences in their tolerance to TFM. *Keywords: Biotransformation, Sea lamprey, Lampricides.*

HO, J.C.[1], MICHALAK, A.M.[2], STUMPF, R.P.[3], and BRIDGEMAN, T.B.[4], [1]Stanford University, Stanford, CA; [2]Carnegie Institution for Science, Stanford, CA; [3]University of Toledo, Toledo, OH; [4]NOAA National Centers for Coastal Ocean Science, Silver Spring, MD. **28-year History of Blooms in Lake Erie Shows Foreshadowing of Increasing Susceptibility to Blooms.**

Although summer algal blooms in western Lake Erie have occurred periodically for the past few decades, the paucity of data on historical blooms has become a barrier to deeper understanding of the factors controlling bloom occurrence. Previous efforts to understand long-term trends in Lake Erie blooms have been limited by the inherent constraints of in-situ sampling and/or the lack of historical data from modern satellite sensors, resulting in a patchy historical record characterized by uncertainty and inconsistency. In this work, we use LANDSAT to generate spatially explicit maps of blooms since 1984 to create the first long-term, self-consistent data set on algal blooms in western Lake Erie. We do this by testing LANDSAT algorithms on coherence with in-situ Microcystis biovolume and remotely-sensed cyanobacteria data for 2002-2011 and then using the best algorithm to hindcast blooms since 1984. The bloom history shows trends in interannual variability with time, presenting new evidence supporting previously hypothesized trends in bloom size and occurrence, including data on a bloom reported in 1998. *Keywords: Lake Erie, Remote sensing, Harmful algal blooms.*

HOFFMAN, J.C., PETERSON, G.S., COTTER, A.M., SIERSZEN, M.E., TREBITZ, A.S., and KELLY, J.R., US EPA Mid-Continent Ecology Division, 6201 Congdon Blvd, Duluth, MN, 55804. **Energy and Nutrient Flows Connecting Coastal Wetland Food Webs to Land and Lake.**

Both landscape character and hydrologic forces (principally, tributary discharge and seiches) can influence utilization of externally-derived energy and nutrients in coastal wetland food webs. We quantified the contribution of internal vs external energy and nutrients among wetlands with varying population density and along a gradient of river and lake water. We used carbon and nitrogen stable isotope analysis to identify internal and external material supporting fish larvae somatic growth in three coastal river-wetland complexes in Lake Superior. We found that fish growth was largely supported by internal energy sources (generally 60% to 90%), including phytoplankton, benthic periphyton, and aquatic vegetation. With respect to nutrients, a multivariate model that included both population density and NH4+ explained most of the variation in larval fish δ15N values. Near effluent sources, contribution of land-based nutrients to the food web supported up to 50% of fish production. We conclude that watershed-based nitrogen has a negative effect on utilization of watershed-based energy sources in coastal wetland food webs, whereas lake-based nutrients and energy are likely positive correlated, in part because these subsidies are delivered to coastal wetlands by organism movement rather than by physical exchanges. *Keywords: Fish, Stable isotopes, Wetlands.*

HOLDA, T.J.[1], RUDSTAM, L.G.[1], SULLIVAN, P.J.[2], WATKINS, J.M.[1], WALSH, M.G.[3], CONNERTON, M.J.[4], and HOLDEN, J.P.[5], [1]Cornell Biological Field Station, Bridgeport, NY; [2]Cornell University Department of Natural Resources, Ithaca, NY; [3]USGS Lake Ontario Biological Station, Oswego, NY; [4]NY DEC Lake Ontario Unit, Cape Vincent, NY; [5]OMNR Glenora Fisheries Station, Prince Edward, ON. **Dual-Frequency Acoustics for Mysis diluviana.**

Mysid "shrimps" (Mysis diluviana) form an integral part of the Great Lakes food web both as zooplankton predators and as an important prey species for forage fish in all of the Great Lakes except Lake Erie. Monitoring mysid abundance and spatial ecology contributes useful information about offshore food web interactions. High-frequency fisheries acoustics have been used to detect mysids and estimate their abundance in the Great Lakes using the standard fisheries frequency of 120 kHz. Adding a higher frequency (430 kHz) may allow separation of different size classes, and this frequency is increasingly used for zooplankton. 120 kHz and 430 kHz acoustic data were collected across Lake Ontario in 2013, along with vertical net hauls. We used these data with nets to estimate acoustic relationships for both frequencies and compare with theoretical scattering models. Net and acoustic estimates of biomass compare very well (0.36 g dw m-2). Estimates of acoustic properties compare well with prior studies. Our goal is to use differences in 120 kHz and 430 kHz acoustics to reveal horizontal patterns of adult and juvenile mysid distributions. *Keywords: Lake Ontario, Zooplankton, Acoustics.*

HOLDEN, J.P.[1], CONNERTON, M.J.[2], SCHANER, T.[1], RUDSTAM, L.G.[3], and FAIRBANKS, A.[2], [1]Ontario Ministry of Natural Resources and Forestry, 41 Hatchery Lane, Picton, ON, K0K 2T0; [2]New York State Department of Environmental Conservation, 541 East Broadway, Cape Vincent, NY, 13618; [3]Cornell University, 310 Fernow Hall, Ithaca,

NY, 14850. **Comparing Upward and Down-looking Hydroacoustics for Abundance Estimates of Alewife in Lake Ontario.**

The abundance and biomass of alewife and rainbow smelt in Lake Ontario are assessed annually by spring bottom trawling surveys but is limited to the New York portion of Lake Ontario. A midsummer hydroacoustic survey complements these data by using sonar to provide a lake-wide estimate of preyfish biomass. The hydroacoustic survey has been traditionally conducted at night with sonar transducers aimed downward from the water surface. The "down-looking" acoustic survey technique however does not sample the shallow surface layer due to transducer depth and nearfield interference. A Biosonics SUB DTX, acoustic system mounted inside a "towfish" with the transducer oriented toward the surface was towed away from the boat at depths greater than 40m to provide acoustic estimates of alewife near the surface. Concurrent hydroacoustic data and vertical gillnetting suggests that at times a large proportion of alewife may be distributed within the top 6m of water depth. Up-looking acoustic data were used to derive a conversion factor to adjust alewife abundance and biomass estimates from the down-looking survey. *Keywords: Lake Ontario, Alewife, Hydroacoustics.*

HOLETON, C.[1], HOWELL, E.T.[2], SHERMAN, R.K.[1], MCPHAIL, L.[1], CHIANDET, A.S.[1], HUGHSON, R.[1], and BENOIT, N.[2], [1]Severn Sound Environmental Association, 67 Fourth St., Midland, ON, L4R 3S9; [2]Ontario Ministry of the Environment and Climate Change, 125 Resources Road, Toronto, ON, M9P 3V6. **Peeling the Onion: a Multi-Scale Approach to Understanding Variability in the Nearshore.**

A novel approach was used to explore spatial variability in factors that have the potential to shape the nearshore nutrient regime. The approach was applied to the eastern Georgian Bay (GB) coast, an area with exceptional diversity of natural features and large contrasts in land use. Comprised of inlets, embayments, and archipelagos, the coastline presents a complex layering of factors that can drive variability in nearshore productivity. The comparatively rich conditions in many of the sheltered embayments contrast sharply with areas exposed to mixing with the oligotrophic waters of GB. These contrasts are superimposed on large regional differences among watersheds. Spatial analyses of key factors such as watershed and coastline characteristics, and basin or shoreline morphology were used to explore questions about variability in nearshore water quality: which factors have a strong influence, when, and at what scale? The analyses cover themes including tributary inputs, exposure to mixing with offshore water, stratification patterns and coastal development. The process derived metrics to describe the gradients associated with factors at regional to local scales. The relationships between the metrics and nearshore water quality will inform strategies for monitoring that can adequately capture variability at appropriate scales. *Keywords: Nutrients, Georgian Bay, Coastal ecosystems, Nearshore, Spatial analysis.*

HOLIFIELD, R.[1], WILLIAMS, K.C.[1], and MCCOY, C.[2], [1]University of Wisconsin-Milwaukee, Milwaukee, WI, 53201; [2]Illinois-Indiana Sea Grant, Chicago, IL, 60604.
**Environmental governance in the Great Lakes: Geographic factors of stakeholder participation in AOCs.**

One of the hallmarks of the shift towards environmental governance is the emphasis on stakeholder participation. Proponents argue that stakeholder participation can make plans, decisions, and actions to address environmental problems both more legitimate and effective. However, stakeholder participation in governance varies significantly across different sites, and research has only begun to investigate the causes of this variation. This paper presents findings from an ongoing study of the geographic factors that influence stakeholder participation in the governance of Great Lakes Areas of Concern (AOC), 43 toxic "hotspots" designated by the 1987 amendments to the Great Lakes Water Quality Agreement. The study, which focuses on the 27 US or bi-national AOCs, examines two dimensions of the governance of AOCs: the structure of governance in the remedial action plan process and the degree to which program coordinators and advisory council leaders attribute challenges with stakeholder participation in AOCs to such geographic factors as territorial and ecological complexity, areal extent, and location. Our hypothesis is that such geographic factors affect the success of participation in similar ways as well-documented factors such as levels of funding and community awareness and the presence of established governance networks. *Keywords: Areas of Concern, Environmental governance, Stakeholder participation.*

HOLMLUND, E.[1] and MODLEY, M.D.[2], [1]Paul Smiths College, 7833 New York 30, Paul Smiths, NY, 12970; [2]Lake Champlain Basin Program, 54 West Shore Rd, Grand Isle, VT, 05458. **AIS: Regional Spread Prevention Program Design in the Adirondack Park.**

This session describes the process by which a consortium of agencies, municipalities, property owners, an institute at a college, and the environmental community use vector data to design a coordinated, landscape-scale spread ANS spread prevention intervention. Boat launch steward data collected over four years provides the quantitative basis for the prioritization of particular waterways in terms of their roles either as spread hubs or linkage waterways. Boat launch steward managers performed a 13-part analysis of user traffic data to characterize the sub-network connections apparent in a 23-lake system of waterways across the Adirondack region. Collaborators used this analysis in a widely distributed white paper articulating recommendations for data-supported placement of regional spread prevention assets. This session reports on the process of deliberation by regional stakeholders working toward consensus on a park-wide, coordinated, spread prevention program. *Keywords: Partnership, Management, Regional, Invasive species, Spatial analysis.*

HOLSEN, T.M.[1], KRABBENHOFT, D.P.[2], ZHOU, H.[1], JOHNSON, T.A.[1], and CRIMMINS, B.S.[1], [1]Clarkson University, Potsdam, NY, 13699; [2]U.S. Geological Survey, Middleton, WI, 53562. **Mercury in Great Lakes Fish: Are Global Mercury Inputs Affecting the Great Lakes Ecosystem?**

Lake Trout and walleye total mercury (HgT) concentrations are measured yearly as part of the Great Lakes Fish Monitoring and Surveillance Program. Previous analyses of concentration trends were inconsistent. An updated trends analysis indicates that at most locations, HgT concentrations are decreasing with the exceptions of the shallow site in LM and the deep site in LH which showed increasing Hg concentrations. Apparent increasing trends at these two locations are likely the result of older fish present in the size class collected as well as possible localized deposition. These results in conjunction with significant reductions in water column Hg; decreases in Hg(0) concentrations in air over the lakes over the past 7-10 years, and declining trends in Hg wet deposition at most locations near the Great Lakes over the past 10 years suggest that environmental regulations enacted by U.S. and Canada are having positive effects in the Great Lakes ecosystem and that increasing global anthropogenic emissions are not overwhelming regional controls and significantly impacting mercury concentrations in the Great Lakes. Analysis of stable Hg isotope results, which is a new tool in Hg research that can help discern differing Hg sources, pathways and processes, will also be presented. *Keywords: Lake trout, Toxic substances, Mercury.*

HONDORP, D.[1], BOASE, J.[2], CHIOTTI, J.[2], THOMAS, M.V.[3], WILLS, T.[3], MOHR, L.[4], and KRUEGER, C.C.[5], [1]USGS, Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105; [2]US Fish and Wildlife Service, Alpena FWCO Waterford Sub-station, 7806 Gale Rd., Waterford, MI, 48327; [3]Michigan DNR, Lake St. Clair Fisheries Research Station, 33135 S. River Road, Harrison Township, MI, 48045; [4]Ontario MNR, Lake Huron Management Unit, 1450 Seventh Ave., East, Owen Sound, ON, N4K 2Z1; [5]Michigan State University, Center for Systems Integration and Sustainability, 1405 South Harrison Road, 115 Manly

Miles Building, East Lansing, MI, 48823-5243. **Habitat use and migration patterns of lake sturgeon in the Detroit-St. Clair river system.**

This presentation summarizes results from an ongoing project using acoustic telemetry to help fishery managers quantify the habitat use, geographic organization, and migration patterns of lake sturgeon (Acipenser fulvescens) populations that spawn in the Detroit-St. Clair river system. To address these objectives, lake sturgeon were captured, implanted with acoustic transmitters with a 10-year battery life, and then released back into the environment. Since spring 2012, movements of tagged individuals have been tracked on strategically located lines of acoustic receivers. Results to date have shown that sturgeon habitat use varies by release location. Lake sturgeon released into the Detroit R. tended to remain in the Detroit R. or move up into Lake St. Clair, whereas lake sturgeon released into the lower St. Clair R. either remained in the St. Clair R. or moved down into Lake St. Clair. Lake sturgeon released into the upper St. Clair R. spread out to occupy Lake Huron, the St. Clair R., and Lake St. Clair. Significant mixing of release groups occurs in Lake St. Clair. The high incidence of resident (non-migratory) individuals in the Detroit-St. Clair river population was a surprise. *Keywords: Acoustics, Habitats, Management.*

HOST, G.E.[1], BROWN, T.N.[1], KOVALENKO, K.E.[1], MEYSEMBOURG, P.[1], CIBOROWSKI, J.J.H.[2], and JOHNSON, L.B.[1], [1]University of Minnesota Duluth, 5013 Mil, Duluth, MN, 55811; [2]University of Windsor, 401 Sunset Ave, Windsor, ON, ON N9B 3P4.
**An interactive map of environmental stress for watersheds of the Great Lakes basin.**

Our ability to manage and restore Great Lakes ecosystems depends on the availability of scientifically-defensible means of describing the suite of anthropogenic stressors impacting the system and the presence of reliable indicators of condition that allow us to prioritize restoration areas and assess the effects of climate and land-use change. We have developed an on-line map utility that characterizes the degree of agricultural and urbanization for watersheds of the US and Canadian Great Lakes basin. These landscape-scale stressor maps can be used to classify watersheds as reference or degraded based on biotic thresholds, or to place them along a continuum of anthropogenic stress. The map utility also allows site-level biological indicators to be superimposed on the stressor gradient. The deviation between observed data and predicted stress can be used to determine if a site is more degraded than expected based on watershed characteristics, or if remediation techniques or BMPs are having beneficial impacts on site condition. *Keywords: Great Lakes basin, GIS, Urbanization, Indicators, Coastal wetlands.*

HOWELL, E.T., Ontario Ministry of the Environment and Climate Change, 125 Resources Road, Toronto, ON, M9P 3V6. **Nearshore Gradients over Three Contrasting Regions of the Great Lakes.**

Strong water quality gradients characterize the nearshore of north-central Lake Erie (NCLE), southeastern Lake Huron (SELH) and northwestern Lake Ontario (NWLO), however, they differ among regions. Water quality at tributary mouths tends to exhibit the strongest variability with adjacent land-use and geology being the principal drivers. Alongshore circulation drives the interactions of land with the lake over the coastline, but this manifests itself in different ways. In NWLO mixing of runoff from urbanized shoreline results in a heterogeneous pattern of water quality whereas the erodible shoreline of the NCLE results in rivers of turbidity over the coastline. Onshore circulation episodically affects water quality in NCLE and NWLO. Upwelling of clear, low-nutrient water in NWLO flushes the nearshore. In NCLE the upwelled water may be hypoxic resulting in reduced oxygen and elevated nutrients. Water transparency varies among regions. Wide photic zones in SELH and NWLO support copious benthic algae. Dreissenid mussels are abundant in the nearshore of NWLO, but sparse in SELH and seemingly less of a driving factor. This presentation will explore contrasting feature among three regions of the Great Lakes with the aim of arguing that characterization of the nearshore be mindful of varying and unique features among regions. *Keywords: Coastal ecosystems, Coastal processes, Regional analysis.*

HRYCIK, A.R., ALMEIDA, L.Z., and HÖÖK, T.O., Purdue Dept. of Forestry and Natural Resources, 195 Marsteller Street, West Lafayette, IN, 47907. **Determining an ecologically-relevant definition of hypoxia.**

Hypoxia is increasing in the Great Lakes and worldwide, in part due to anthropogenically-exacerbated nutrient loading to aquatic systems. Hypoxia is most commonly defined as 2 mg/L of dissolved oxygen, which is primarily based upon mortality studies. However, definitions vary among journal articles and regulatory agencies, and there is considerable evidence that higher dissolved oxygen levels can negatively affect aquatic organisms. To establish a more ecologically-relevant definition of hypoxia, we performed a meta-analysis on studies that test the effects of dissolved oxygen on fish growth and consumption across a range of species. Our results reveal consistent, significant effects of oxygen on growth and consumption at levels as high as 5 mg/L. In addition, we found that age, habitat, and temperature helped to predict fish response to dissolved oxygen. Our results suggest that aquatic food webs may be affected by oxygen levels at higher concentrations than previously thought, either through movement of aquatic organisms out of hypoxic areas, or through biomass effects if fish remain in low-oxygen areas despite declining growth and consumption. These findings indicate that we may need to reassess water quality and habitat management in areas with high nutrient loading, such as Lake Erie, to include non-lethal effects on fish. *Keywords: Oxygen, Nutrients, Food chains.*

HU, H.[1], WANG, J.[2], FUJISAKI-MANOME, A.[1], and BAI, X.[1], [1]The University of Michigan, Ann Arbor, Mi, 48108; [2]NOAA/GLERL, 4840 S. State Rd, Ann Arbor, Mi, 48108. **Simulation of Lake Erie ice and thermodynamics.**

A Great Lakes Ice-circulation Model (GLIM) with a 2-km resolution grid was applied to Lake Erie under hourly high-frequency atmospheric forcing derived from meteorological measurements. The GLIM reasonably well reproduces the seasonal cycles of ice concentration, thickness, velocity, and other variables in the 2003/04 ice season in comparison with satellite measurements. Furthermore, some important features in ice dynamics and thermodynamics are revealed. Month-to-month change in categories of ice thickness and ice speed is reproduced using available historical ice drifting measurements, indicating that the GLIM reasonably well capture the lake ice histogram due to the usage of multiple category process in dynamics. The simulated ice velocity speeds compares well with some important features of the observed ice drifts. *Keywords: Ice, Hydrodynamics, Lake Erie.*

HUANG, C.[1], XUE, P.[2], PAL, J.[1], and LENTERS, J.D.[3], [1]Great Lakes Research Center, Dept. Civil&Environmental Engineering, Michigan Tech, 1400 Townsend Dr., Houghton, MI, 49931; [2]Dept. Civil&Environmental Engineering, Loyola Marymount University, 1 LMU Drive, Los Angeles, CA, 90045; [3]LimnoTech, 501 Avis Dr., Ann Arbor, MI, 48108.
**Estimation of the Surface Heat and Water Budgets of the Great Lakes Using a Regional Climate Model.**

The Great Lakes and surrounding region are particularly sensitive to climate change. Observational records provide abundant evidence that the Great Lakes water balance is highly vulnerable to and strongly impacted by climate change, with wide-ranging consequences for society and ecosystems. In this study, we couple a regional climate model with a hydrodynamic model of the Great Lakes to resolve the complex interactions between the lake and atmosphere. Simulations of present and future climate are carried out over the Great Lakes region and validated with observational data. Water and heat budgets are estimated and compared between present and projected future climates. *Keywords: Atmosphere-lake interaction, Climate change, Hydrodynamic model.*

HUBERT, T., USGS, 2630 Fanta Reed Rd., LaCrosse, WI, 45602. **An Introduction to Integrated Pest Management.**

Integrated pest management (IPM), sometimes referred to as integrated pest control, has been practiced for several centuries. As a formal concept in agricultural practice, it was in the late 1950s that IPM evolved from casual practice to a cohesive strategy for managing pests. An IPM program generally consists of four main components: biological control, chemical control, physical control, and social/cultural control. These four main components will be discussed along with the advantages and disadvantages of each, and examples of each type of control will be presented. The factors that need to be considered when developing an IPM program, the incorporation of the various IPM techniques into the program, and the implementation of the program will be discussed. An example of a successful integrated pest management program will be provided. *Keywords: Invasive species, Dreissena, Management.*

HUCKINS, C.J.[1], MATTHYS, A.M.[1], OGREN, S.A.[2], DANHOFF, B.[1], CHIMNER, R.[5], NICHOLAS, G.[3], and AHO, R.[4], [1]Michigan Technological University, 1400 Townsend Drive, Houghton, MI, 49931; [2]Little River Band of Ottawa Indians, 159 Brick Yard Rd, Manistee, MI, 49660; [3]Houghton Keweenaw Conservation District, 600 East Lakeshore Drive, Houghton, MI, 49931; [4]USDA Natural Resources Conservation Service, 711 W. Lakeshore, Houghton, MI, 49931; [5]MTU Forest Resources and Env. Sci, 1400 Townsend Dr., Houghton, MI, 49931. **Fish and Invertebrate Response to Stamp Sand Deposits and Stabilization in a Lake Superior Tributary.**

Extensive historical mining residue was deposited along streams and lakes of the Keweenaw Peninsula in the Western Upper Peninsula of Michigan. These deposits are a significant source of fine and course sediment aggradation and copper-rich water pollution. With funding from the Great Lakes Restoration Initiative, the Hills Creek Stamp Sand Stabilization project stabilized and vegetated riparian stamp sand aggradations. The goal of the project was to reduce copper concentrations in runoff and groundwater into this Lake Superior tributary and benefit the riverine biological system and fisheries. We monitored fish and macroinvertebrates within five reaches before and after restoration, spanning upstream and downstream of the restoration reach. Longitudinal variation in the abundance and species composition of fish and macroinvertebrates, and patterns of the indices of biotic integrity within the river correspond to the distribution of stamp sand deposits along the river suggesting negative effects on stream biota. Temporal variation in these metrics also appears to be associated with stabilization of the restored (and stabilized) stamp sand aggradation site. These results suggest that historical mining legacies continue to impact

ecosystems today and that these effects may be mitigated by successful restoration activities. *Keywords: Remediation, Fish, Sediments, Macroinvertebrates, Biomonitoring, Streams.*

HUNTER, T.[1], CLITES, A.[1], BOLINGER, R.A.[2], and GRONEWOLD, A.D.[1], [1]NOAA (Great Lakes Environmental Research Laboratory), Ann Arbor, MI; [2]UCAR, Ann Arbor, MI. **A historical monthly hydrometeorological database for the Great Lakes.**

Seasonal projections of the Great Lakes water budget and water levels depend not only on accurate projections of regional meteorological and climate conditions, but also on a robust historical record of the components of the Great Lakes water budget. Here, we explore the development and application of the NOAA Great Lakes historical monthly hydrometeorological database, as well as its use in regional operational water level forecasting models. In addition to describing the individual components of the historical database, we discuss ongoing advances in improving estimates of those components in light of ongoing transitions in the state-of-the art in both modeling systems, and monitoring infrastructure technology. *Keywords: Model studies, Hydrologic budget, Great Lakes basin.*

HUNTER, T.[1], SMITH, J.P.[2], QIAN, S.S.[3], and GRONEWOLD, A.D.[1], [1]NOAA (Great Lakes Environmental Research Laboratory), Ann Arbor, MI; [2]CILER (University of Michigan and NOAA-GLERL), Ann Arbor, MI; [3]University of Toledo, Toledo, OH.
**Improving the historical record of the Great Lakes water budget.**

Historical estimates of the Great Lakes water budget are generally comprised of a combination of long-term records (dating back several decades) developed from relatively conventional models and data aggregation methods, as well as shorter-term records and data sets (in many cases dating back less than a decade) based on state-of-the-art models and monitoring technology. As such, developing a robust historical record of the entire Great Lakes water budget across both the United States and Canada that dates back to the early 1900s requires an explicit quantification of uncertainty based on the full set of readily-available model output and monitoring data. Here, we appraise the current state of water budget estimates from both long-term historical records as well as from relatively new monitoring infrastructure, and propose relatively novel uncertainty quantification protocols for simultaneously accommodating multiple sources of information. Our goal is to ultimately develop a robust historical record suitable not only for understanding historical changes in the Great Lakes water budget, but also for supporting regional water resource management planning decisions that depend on an understanding of those changes. *Keywords: Decision making, Hydrologic cycle, Great Lakes basin.*

HUTTON, M.A.[1], COLLINGSWORTH, P.[2], HÖÖK, T.O.[1], and LESHT, B.M.[3], [1]Purdue University, West Lafayette, In, 47907; [2]U.S. Environmental Protection Agency-Great Lakes National Programming Office, Chicago, IL, 60604; [3]University of Illinois-Chicago, Chicago, IL, 60607. **Nearshore Primary Production in Lake Michigan: Analysis of Trends Using Remote Sensing Techniques.**

Invasion of Dreissenid mussels have altered nutrient dynamics and phytoplankton assemblages across the Great Lakes. By filtering primary producers and sequestering nutrients in the nearshore zone, Dreissenid mussels disrupted the transport of nutrients and contributed to decreases in chlorophyll *a* concentrations in offshore areas (>30m in depth). However, coincident responses in chlorophyll *a* concentrations in nearshore habitats may not mirror these offshore patterns. A recent algorithm has estimated monthly chlorophyll *a* concentration throughout Lake Michigan from 1998-2013 using images captured by the SeaWiFS and MODIS satellites. This new algorithm also includes very nearshore areas (< 30m). Estimated chlorophyll *a* concentrations were compared across specific bathymetric contours along a nearshore to offshore gradient. To better understand large temporal and spatial changes, concentrations were averaged for seasonal variation and for five different regions around Lake Michigan. While chlorophyll *a* concentrations clearly decreased in offshore areas, concentrations in nearshore areas did not decline during the study period and may have increased slightly. *Keywords: Phytoplankton, Nearshore, Satellite technology, Lake Michigan.*

HWANG, K. and CHANDLER, D.G., Syracuse University, Link Hall, Syracuse, NY, 13244. **Hydrogeomorphic classification of the natural and restored wetlands in St. Lawrence Valley.**

Evaluation of wetland restoration needs to be carefully conducted because the ecosystem components respond with different degree of sensitivity to its landform. Since landscape features, such as topography, land use and flow regime, promote ecosystem species, geomorphology needs to be considered as one of the main drivers for sustaining wetland ecology. In order to define wetland ecosystem functions and services, regional classification of a wetland should be accompanied. In this study, natural and restored wetlands in St. Lawrence Valley are classified by the hydrogeomorphic approach and their hydrologic characteristics over the classes are investigated. The wetland ecosystems distributed over large area are broadly classified in terms of geomorphic setting, water source, and hydrodynamics and then hierarchically specified into regional subclasses to determine unique features. Wetland hydrology for each subclass is also characterized for functional assessment using hydraulic gradient between surface water within the system and

adjacent upland groundwater. The regional wetland classification and functional assessment will provide useful tools to make a proper restoration plan. *Keywords: Wetlands, Hydrogeomorphology, Hydrodynamics.*

# I

IACARELLA, J.C. and RICCIARDI, A., Redpath Museum, McGill University, 859 Sherbrooke Street West, Montreal, QC, H3A 0C4. **Calcium Limits Growth and Predatory Response of Round Gobies.**

Ecological impacts of nonnative species are mediated by environmental conditions. The invasive Round Goby *Neogobius melanostomus* is brackish water adapted with high predatory and competitive impacts on native communities. We test the hypothesis that both growth and predatory impacts of the Round Goby are reduced in low dissolved calcium (Ca) waters in which they can establish. We evaluated the functional response (FR) - relationship between predation rate and prey supply - of the Round Goby on amphipods at high (35mg/L) and low (12mg/L) Ca after 36 days of acclimation in either condition. Round Gobies in high Ca ate more food during the acclimation period and gained more body mass after acclimation and FR experiments in high Ca than fish in only low Ca conditions. FRs revealed that Round Gobies at high Ca levels for both acclimation and FR experiments had the highest predatory impact, whereas fish in all other treatment combinations had similarly low predation rates. In addition, non-acclimated Round Gobies had a higher FR on mayfly nymphs at high Ca than fish at low Ca levels. Our results indicate that nonnative species may have stronger impacts in abiotic conditions that are more physiological optimal. Identifying other key physico-chemical factors that influence impacts of invaders may aid management efforts. *Keywords: Invasive species, Functional response, Round goby, Predation.*

IGRAS, J.D.[1], CREED, I.F.[2], and CORMIER, R.[3], [1]Western University Social Science, 1151 Richmond St,, London, ON, N6A K73; [2]Western University Science, 1151 Richmond St., London, ON, N6A K73; [3]Institute for Coastal Research, Human Dimensions in Coastal Areas, Max-Planck-Straße 1, Geesthacht, 21502, GERMANY. **Managing cumulative ecosystem risk in Lake Erie from nutrient stressors in the Grand River Watershed.**

The Great Lakes Water Quality Agreement has played a significant role in the management of nutrient contributing stressors within the Great Lakes basin. However, recent and recurrent nuisance algal blooms pose an increased risk to human health and aquatic ecosystem services in Lake Erie. This presents a unique opportunity to evaluate the current regulatory framework from an integrated science and management perspective. In this study we apply an Ecosystem Risk Management framework along with Bow-tie risk assessment and Bayesian network analysis (BNA) methodologies to identify areas for enhancement within current regulatory measures managing nutrient contributing stressors and their consequences in the Grand River watershed. The Bow-tie approach provides a simple, qualitative way of assessing risk while considering the regulatory control measures around it. Nested in the Bow-tie; BNA quantitatively models cause and effect relationships of different management decisions and ecosystem responses and will depend on the Soil and Water Assessment Tool, as well as a review of the literature and expert elicitation for indicator dynamics and network design. This research aims to identify and improve vulnerabilities in the current regulatory framework and provide an enhanced science-policy integrated approach to environmental management. *Keywords: Environmental policy, Grand River Watershed, Eutrophication, Nutrients.*

ISLES, P.[1], VERHAMME, E.M.[2], and SCHROTH, A.[3], [1]RSENR, University of Vermont, 3 College St., Burlington, VT, 05401; [2]LimnoTech, 501 Avis Avenue, Ann Arbor, MI, 48108; [3]Dept. of Geology, University of Vermont, 180 Colchester Ave., Burlington, VT, 05405.

**Validation of a coupled hydrodynamic and water quality model of Missisquoi Bay, Lake Champlain using.**

Water quality models have usually been calibrated to monitoring data taken at weekly or bi-weekly intervals and single depths. While such models often capture seasonal trends in nutrients and phytoplankton, they may fail to accurately represent processes operating at short temporal scales (daily to hourly), which may be particularly important in shallow systems where the development of transient thermal stratification mediates both light available to phytoplankton and internal nutrient loading. In this study, a 3-D coupled hydrodynamic and water quality model was implemented for Missisquoi Bay, Lake Champlain. The hydrodynamic model (Environmental Fluid Dynamics Code, EFDC) was calibrated using vertical temperature profile data from several stations as well as an array of Acoustic Doppler Current Profilers. The water quality model (Row Column Aesop; RCA) was driven using daily estimates of tributary nutrient loads and was calibrated using high-frequency measurements of water column biological and geochemical parameters from a single site, in addition to episodic measurements at several sites within the bay and time-series sediment core data. Particular attention was given to the model representation of

vertical temperature and oxygen gradients and their role in driving sediment nutrient release. *Keywords: Harmful algal blooms, Lake Champlain, Model studies, Eutrophication.*

# J

JACKSON, J.A., Greater Lakes: Reconnecting the Great Lakes Water Cycle, 17 Major Street, Kitchener, ON, N2H 4R1. **Reconnecting the Great Lakes Water Cycle through Water Conservation & Green Infrastructure.**

In our Greater Lakes: Reconnecting the Great Lakes Water Cycle project, we have examined the environmental and financial impacts of our water supply, sewage, and stormwater management systems in six municipalities in the Great Lakes basin (3 Canadian & 3 U.S.) as examples from which we can learn lessons and approaches for municipalities throughout the Great Lakes basin. Our society has fractured the natural water system through our focus on heavily engineered big-pipe systems that move water unnaturally over great distances. Our project is now focused on exploring two types of restoration actions: 1) Taking an integrated water management approach where we make decisions on water supply, use, and sewage and stormwater management as part of one system, rather than being separate systems, & 2) Focussing on both water use conservation/efficiency programs and green-infrastructure projects because these approaches address human water needs in ways that are more linked to the natural water system. This presentation will focus on the lessons that we have learned throughout this three-year project. The author, John Jackson, is the project manager for this Great Lakes Commission project. It is funded by the Great Lakes Protection Fund. *Keywords: Decision making, Green infrastructure, Management, Water conservation, Hydrologic cycle.*

JACKWOOD, R.W., DWYER, D.F., and EGAN, K.J., University of Toledo, 2801 W. Bancroft St., Toledo, OH, 43606. **Restoration Projects to Reduce Phosphorus Loadings into Lake Erie: From Concept to Implementation.**

Maumee Bay State Park (MBSP) issues swim advisories for Lake Erie beaches during the recreational season (May to September) due to high levels of algal toxins associated with harmful algal blooms (HABs) and *E. coli*. The Wolf Creek watershed, which enters Lake Erie within MBSP, is a proximal source for bacteria and a contributor of phosphorus. Funding obtained through the Great Lakes Restoration Initiative was used to create a tiered wetland and a riparian sedimentation zone within Wolf Creek to reduce loadings of phosphorus, sediment and bacteria entering the lake. Reductions for these three parameters since August 2014 for the sedimentation zone alone were 50% for phosphorus and sediment, and 75% for *E. coli*; the wetland has only recently come online. The project was initiated to demonstrate new approaches to address beneficial use impairments (BUIs) within the Maumee River Area of Concern (AOC) and similar locations. Identification of sites to implement similar projects within the Maumee AOC includes an economic analysis that will be addressed within the context of data obtained during monitoring of the Wolf Creek projects. *Keywords: Phosphorus, Restoration, Wetlands, Water quality.*

JENSEN, E.S., Great Lakes Commission, Ann Arbor, MI, 48104. **Protecting the Great Lakes from Internet Sales of AIS.**

Intentional and unintentional releases of live organisms that are bought and sold for use in aquariums, nurseries, water gardens, aquaculture, and as live bait make up a complex vector for invasive species--organisms in trade--that can adversely affect the Great Lakes. Internet commerce facilitates this trade in live organisms, providing consumers, hobbyists and others on-demand access to distribution networks worldwide. While research has shown that restricted plants and animals are available online; little is currently being done to address this pathway as a way to prevent the import, trade or release of potentially invasive species into the Great Lakes environment. The Great Lakes Commission is working to support invasive species management efforts by developing web-crawling software to assess the availability of invasive species via Internet sales, identify sellers, and develop and implement targeted management activities. This project is providing information on the Internet marketplace, developing management tools, and presenting options for additional action to effectively prevent aquatic invasive species introductions via this pathway. *Keywords: Invasive species.*

JETOO, S. and KRANTZBERG, G., McMaster University, 1280 Main St West, Hamilton, ON, l8s4l8. **Eutrophication Governance: Comparison of the Great Lakes and the Chesapeake Bay.**

The Laurentian Great Lakes has a history of eutrophication success and failure. During the 1960s to the early 1990s Lake Erie went from being declared 'dead' with high nutrient levels to successful nutrient reduction starting in the 70s right through to the 90s and a concomitant revitalized ecosystem. Actions to reduce Phosphorous input into the lake such as the banning of phosphorous in detergents and upgrade of sewage treatment plants proved very effective. However, the problem has resurfaced and in 2011, Lake Erie had the largest recorded algal bloom in history. The problem is no longer a simple issue of point sources; it is now a non point pollution issue compounded with other stressors such as climate change and aquatic invasive species. What governance mechanisms would be useful to restore the ecological resilience of Lake Erie? This question is examined by comparing and contrasting eutrophication governance in Chesapeake Bay, one of the largest estuaries in North America and a water body also plagued by stressors from non point source pollution such as agriculture, with that of the Great Lakes. *Keywords: Eutrophication, Governance, Lake Erie, Adaptive capacity, Policy making, Chesapeake Bay.*

JOHNS, C.M.[1] and FRIEDMAN, K.B.[2], [1]Ryerson University, 350 Victoria Street, Toronto, ON, M5B2K3; [2]SUNY U Buffalo, Buffalo, NY. **Institutional Capacity and Governance Networks in the Great Lakes Region.**

This paper and presentation outlines the value of using network theory from public policy and public administration and social network analysis methods to analyze transboundary and domestic governance networks in the Great Lakes region. It focuses on the value of analyzing networks of public administrators, non-government and private sector actors as contributors to transboundary and binational governance and institutional capacity in the region. The paper presents some preliminary findings from a social network analysis survey at the regional scale and outlines the potential and challenges of using this approach to analyze and compare networks as indicators of governance capacity across jurisdictions and policy domains. *Keywords: Environmental policy, Regional analysis.*

JOHNS, M.[1], JONES, H.[1], BRUXER, J.[2], JAREMA, C.[3], and GRONEWOLD, A.D.[4], [1]University of Michigan, Ann Arbor, MI; [2]Environment Canada, Cornwall, ON; [3]US Army Corps of Engineers, Detroit, MI; [4]NOAA (Great Lakes Environmental Research Laboratory), Ann Arbor, MI. **Quantifying uncertainty in St. Marys River flow estimates.**

Lake Superior's regulated outflow through the St. Marys River represents a significant component of the Great Lakes water budget. A robust understanding of both historical and future projected flows through the St. Marys River is necessary for improved water level forecasting and management planning. Control of St. Marys River flows involves a combination of individual flow structures including domestic water intakes, transportation locks, hydroelectric facilities, and a 16-gate control structure at the head of the St. Marys Rapids known as the Compensating Works. Flow through the Compensating Works represents a particularly unique source of uncertainty St. Marys River flow estimates because of the unique hydrodynamic and physical characteristics of the river at this location, the variable settings of the 16 gates within the works, and the protocols that govern international coordination of those gate settings. Here, we explore alternative approaches to quantifying parameters of the equations that relate gate settings to theoretical flow rates, compare model results to observations, and put forward recommendations for future operational water budget and water level modeling protocols for the federal agencies responsible for regulating flows through the St. Marys River and, ultimately, the water levels of Lake Superior. *Keywords: Hydrologic budget, St. Marys River, Water level.*

JOHNSON, K. and RIOS MENDOZA, L.M., University of Wisconsin Superior, Belknap and Catlin, Superior, WI, 54880. **Are we Breathing Plastics?**

Today, plastic dominates our society. Everything from mobile phones to food is packaged in plastic. As a result, plastic pollution has dominated the news lately. In 2013 plastic particulates were found in Concentrated MOTRIN® Infants' Drops Original Berry Flavor ½ fl. Oz. bottles. Recently, the Minnesota Department of Agriculture has proposed a plan for gypsy moth management that includes dispensing mating disruption pheromones by sandwiching them between plastic flakes and aerially distributing them. These news stories along with the obvious prevalence of plastic in day-to-day lives prompted the question: Is there plastic in the air we breathe? To answer this question, air samples were taken using vacuum filtration in multiple locations. These locations were both indoors and out on the University of Wisconsin - Superior campus. The results have shown plastic fibers in every sample location, including Wisconsin Point, the off campus control location. The fibers range in size between 10 to 7500 micrometers and are primarily blue, red and white in color. *Keywords: Air contamination, Environmental health, Microplastic fibers, Environmental contaminants, Microplastics.*

JOHNSON, L.B.[1], ALLAN, J.D.[2], DANZ, N.[3], UZARSKI, D.G.[4], and CAI, M.[1], [1]University of Minnesota Duluth, Natural Resources Research Institute, 5013 Miller Trunk Highway, Duluth, Mi, 55811; [2]University of Michigan, Ann Arbor, MI; [3]University of Wisconsin Superior, Superior, WI; [4]Central Michigan University, Mt Pleasant, MI; [5]University of Windsor, Windsor, On. **Uses and interpretation of human disturbance gradients for condition assessment in Great Lakes coast.**

The Laurentian Great Lakes and its basin are impacted by multiple stressors that range from chronic to pulse in their temporal dimension and local to regional in the spatial dimension. Successful restoration across a region requires comprehensive data capable of depicting stress types and sources, permitting evaluation, planning, and execution. Two

projects (Great Lakes Environmental Indicators "GLEI" and Great Lake Environmental Assessment Map "GLEAM") have characterized human activities across the Basin. The Coastal Wetland Monitoring Program developed a disturbance gradient to represent localized sources of stress including water quality and landscape data. These stress gradients each have appropriate uses for predicting stress and evaluating ecological responses. We will discuss characteristics of each gradient, examine concordance in areas of overlap, and discuss appropriate uses. Preliminary results show strong concordance between watershed and localized stressors closest to shore, with lower levels of concordance at the outer fringes of wetlands. *Keywords: Coastal ecosystems, Disturbance gradient, Watersheds, Regional analysis.*

JOHNSON, L.T.[1], SLAWECKI, T.A.D.[2], and ROERDINK, A.R.[1], [1]Heidelberg University, 310 East Market St., Tiffin, OH, 44883; [2]LimnoTech, 501 Avis Drive, Ann Arbor, MI, 48108. **The Heidelberg Tributary Loading Program: Sharing Forty Years of Data Online.**

As a part of the Heidelberg Tributary Loading Program (HTLP), the National Center for Water Quality Research (NCWQR) has been collecting samples for nutrient and sediment analysis 1-3 times a day, year round for up to 40 years. Samples are currently collected from 16 tributaries throughout Ohio and Michigan, but the longest-term data have been collected from the major external inputs to Lake Erie: the Sandusky, Maumee, Cuyahoga, and Raisin rivers. To date, over 100,000 samples have been collected from these rivers and their subwatersheds. Although HTLP data are posted on the NCWQR website, to expand accessibility we have partnered with the Great Lakes Observing System (GLOS) and LimnoTech to provide HTLP's Lake Erie tributary data on GLOS for download and visualization, updated quarterly. Because the Maumee River is the largest external input to Lake Erie and current seasonal western Lake Erie harmful algal bloom (HAB) forecasts are based on spring Maumee River phosphorus loads, we developed an expedited process to provide weekly data from the Maumee River from March through August. In addition to being available for download, these data can be visualized on GLOS using a new online tool that facilitates tracking spring loads from the Maumee River and comparisons with past years as well as other Lake Erie tributaries. *Keywords: Observing systems, Lake Erie, Water quality.*

JOHNSON, R.A.[1], KUHANECK, B.O.[1], MAYER, C.M.[1], AREND, K.K.[2], WEIMER, E.J.[3], and ROSS, J.E.[4], [1]University of Toledo, Department of Environmental Sciences and Lake Erie Center, 2901 Bancroft, Toledo, Oh, 43606; [2]Ohio Department of Natural Resources, Division of Wildlife, 305 East Shoreline Drive, Sandusky, OH, 44870; [3]Ohio DNR, Division of Wildlife, Old Woman Creek National Estuarine Research Reserve, 2514 Cleveland Road East, Huron, OH, 44839; [4]U.S. Fish and Wildlife Service, Ashland Fish and Wildlife Cooperative Unit, 2800 Shoreline Dr. East, Ashland, WI, 54806. **Altered Lake Erie Shorelines: Impacts of Vegetation and Armor Type on the Near-shore Fish Community.**

The near-shore zone of large lakes influences ecosystem function and is often impacted by human activity. Most of Ohio's Lake Erie shoreline has been altered, likely affecting the near-shore fish community. Previous work showed that the effect of armoring on the number of fish species in the near-shore zone depended on background habitat type, whereas the presence of shoreline vegetation was consistently associated with higher numbers of fish species. Our goal in this study was to determine if specific types of armoring structures or vegetation differentially affected fish diversity in the near-shore zone. We focused on vegetation growing above the waterline because landowners often remove these plants. We saw that sites with riprap had more species of fish than sites with concrete slabs or metal plates. In contrast, we saw little difference in the number of fish species based on dominant type of shoreline vegetation (small plants, shrubs, mixed vegetation including trees), although shorelines without vegetation tended to have fewer fish species. While changes to armored structures can be very costly, allowing shoreline vegetation to colonize armored areas may be a cost effective way to promote habitat that results in higher fish diversity in the near-shore. *Keywords: Fish, Vegetation, Coastal ecosystems.*

JOLY, A., Accès Fleuve / Comité ZIP Ville-Marie, 981, rue Pierre-Dupuy, Longueuil, QC, J4K 1A1. **Acces fleuve: a web based app to promote river access.**

Accès Fleuve (www.acces-fleuve.org) is a web-based map application that was developed during the 2013 Ecohack Montreal with the help of concerned citizens. It allows the user to have a geolocalised access point to the St. Lawrence river along with a list of possible activities for each site. These activities not only include water-based activities such as swimming, surfing, kayaking and sailing; but also more family oriented activities like picnicking, nature interpretation and cycling. Each site's data also present the municipal infrastructures such as benches, marinas, toilets, etc. In early 2015, a reporting application will be added to the site so citizens can send information regarding shoreline quality and other pertinent elements (presence of erosion or waste, add or remove activities, update infrastructure). When users start to send in data, they will be compiled so that a clear picture of Montreal's shoreline can be defined. These data will allow us to better orient volunteer cleanup crews or city workers to problem areas and to better manage shoreline restoration projects. In time, the water quality data from the city of Montreal will be added for each site in relation to the nearest sampling station. A mobile version of the app is also in the works (Summer 2015). *Keywords: St. Lawrence River, Public participation, Citizen science.*

JOUNG, D.J., GILES, C.D., XU, Y., ISLES, P., GEARHART, T.A., and SCHROTH, A., EPSCoR, University of Vermont, 23 Mansfield ave, Burlington, vt, 05401. **VARIATIONS OF SEDIMENTRAY PHOSPHROUS AND TRACE METAL INPUTS IN A EUTROPHIC BAY of LAKE CHAMPLAIN.**

To understand the spatial and temporal dynamics of internal loading, nutrients (N and P) and metals (Al, Ca, Fe, Mn) were studied in waters and sediments collected bi-weekly (April-October, 2014) from a shallow eutrophic bay in Lake Champlain (USA). Vertical stratification of temperature and dissolved oxygen were observed in July to mid-August 2014 when most of sedimentary P and metal changes occurred, suggesting that water column stability and associated redox conditions were the primary driver of internal loading. Ongoing analysis of water column P and metals concentrations revealed a seasonally increasing trend through October 2014 with minor fluctuations. At the same time, sedimentary P and metals showed opposite trend relative to their water column distributions, indicating that internal loading was the source of water column P and metals. Additional analyses demonstrate that multiple pools of sediment-derived P may be important sources of this macronutrient to the overlying water column at different times of the year, and that riverine nutrient sources also have intermittent impacts on bloom and P dynamics. *Keywords: Phosphorus, Sediments, Eutrophication.*

JUNEAU, K.J.[1], HUCKINS, C.J.[1], MARCARELLI, A.M.[1], CHIMNER, R.[1], BROOKS, C.N.[2], XUE, P.[3], and MEADOWS, G.[3], [1]Michigan Technological University, 1400 Townsend Drive, Houghton, Mi, 49930; [2]Michigan Tech Research Institute, 3600 Green Ct., Ann Arbor, MI, 48105; [3]Great Lakes Research Center, 1400 Townsend Drive, Houghton, MI, 49931. **Ecological Response to Eurasian Watermilfoil Management in a Lake Superior Coastal Waterway.**

Eurasian watermilfoil (*Myriophyllum spicatum*, EWM), is a prolific invasive plant in North America. Populations of EWM have recently been established in coastal waterways of the Upper Great Lakes, where cold water temperatures and intense circulation patterns present a unique management challenge. Management of EWM is further complicated by its ability to hybridize with native northern watermilfoil (*M. sibiricum*) producing a community of watermilfoil with varying resistance and susceptibility to management activities. The goal of our study is to conduct a multi-faceted control program to identify the best management practices for arresting the growth and spread of EWM and its hybrids in the Upper Great Lakes via a multi-year treatment and monitoring program in the Keweenaw Waterway, Michigan. Year 1 studies of herbicide treatments show a significant decrease in EWM biomass 6 weeks after herbicide treatment, but an increase in dominance by watermilfoil hybrids. There were no changes in total biomass of non-target macrophytes or phytoplankton after treatment. In year 2, we will explore the efficacy and logistics of supplementing herbicide-based approaches with non-chemical control measures to improve management of EWM and its hybrids, with the ultimate goal of creating more cost- and time-effective treatment option. *Keywords: Management, Eurasian watermilfoil, Invasive species, Biological invasions.*

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KAMMIN, L.K., RILEY, A., GULLEY, A., HALLESY, T., and KNOWLES, E., Illinois-Indiana Sea Grant, 1101 W. Peabody Dr., Urbana, IL, 61801. **PPCPs in Great Lakes States & Beyond: Illinois-Indiana Sea Grant's Approach to Pollution Prevention.**

Illinois-Indiana Sea Grant (IISG) works to increase and share knowledge about pharmaceutical and personal care products (PPCPs) in the environment. IISG seeks practical solutions for the management and disposal of PPCPs. Our education and outreach efforts focus on sources, fate, and potential impacts of PPCPs on human, animal, and environmental health. IISG uses a multipronged approach to reducing the load of PPCPs reaching Lake Michigan and other waterways within the Great Lakes Basin: 1) funded research, 2) education and outreach programs, 3) engagement through social media, 4) partnerships, and 5) hosting the Sea Grant National PPCP working group. Working with other organizations, IISG strives to use the latest science on emerging contaminants to empower people to solve problems in sustainable ways. *Keywords: Great Lakes Restoration Initiative (GLRI), Environmental contaminants, Outreach.*

KANE, D.D.[1], LUDSIN, S.A.[2], BRILAND, R.B.[2], CULVER, D.A.[2], FITZPATRICK, M.[3], ROZON, R.[3], NIBLOCK, H.[3], and MUNAWAR, M.[3], [1]Defiance College, 701 N. Clinton St., Defiance, OH, 43512; [2]The Ohio State University, Columbus, OH, 43212; [3]Department of Fisheries and Oceans Canada, Burlington, ON, L7S 1A1. **Ten Years Gone: Continued Degradation of Plankton Communities in Lakes Erie and Ontario.**

The Planktonic Index of Biotic Integrity (P-IBI) was developed during the turn of the 21st century as a tool to assess lake ecosystem health. Herein, we use data from two long-term monitoring programs to demonstrate that in the last decade regions of both lakes Erie and Ontario have become more eutrophic, as gauged by their plankton communities. We calculated Planktonic Index of Biotic Integrity (P-IBI) values for the western and central basins of Lake Erie during 2003-2013 and compared them to P-IBI values from periods of heightened eutrophy (1970) and the recovery from eutrophy (1995-2002). As expected, P-IBI scores in the range of eutrophy have predominated in both the western and central basins during 2003-2013, suggesting that Lake Erie has indeed become more eutrophic. This decline in P-IBI scores (and hence ecosystem health) has been more evident in the western basin relative to the central basin. In Lake Ontario, during the past decade both the Bay of Quinte and Hamilton Harbour have typically been characterized as eutrophic, with some years of hyper-eutrophic conditions. Degradation of plankton communities in these systems will continue without reductions in non-point source nutrient pollution. *Keywords: Bay of Quinte, Lake Erie, Eutrophication, Hamilton Harbour, Bioindicators, Plankton.*

KANG, G.[1], LESHKEVICH, G.A.[2], and MASON, D.M.[2], [1]Michigan State University Department of Civil and Environmental Engineering, 1449 Engineering Research Ct., East Lansing, MI, 48824; [2]NOAA Great Lakes Environmental Research Laboratory, 4840 South State Road, Ann Arbor, MI, 48108. **Identifying and Quantifying Coastal Upwellings in Lake Michigan using satellite SST data.**

Costal upwelling events play an important role in ocean and large lake ecosystems, since they transport the cooler and usually nutrient-rich water to the surface layer boosting phytoplankton growth and thus fishery production. However, depending on different locations, an in situ instrument might not capture an upwelling event because the limited spatial area it covers is usually not large enough to produce the temperature profile needed for upwelling analysis. High spatial resolution remote sensing thermal infrared data provide the opportunity to capture the large-scale water surface temperature change. In our study, daily cloud-free surface water temperature (GLSEA) charts derived from the Advanced Very High Resolution Radiometer (AVHRR) surface water temperature data are used to monitor upwelling events' spatial variability and horizontal distribution. By revisiting and restructuring a semi-automated upwelling detection method, this research focuses on Lake Michigan as a case study and uses a 19-year (1995-2003) GLSEA database to identify, quantify and locate upwelling events and attempts to define a costal upwelling season for

Lake Michigan. With slight modification, the upwelling detection method could be used on the other Great Lakes. *Keywords: Remote sensing, Upwelling, Lake Michigan, Satellite technology.*

KARATAYEV, A.Y.[1], BURLAKOVA, L.E.[2], and MEHLER, K.[2], [1]Buffalo State The State University of New York, 1300 Elmwood Avenue, Buffalo, NY, 14222; [2]Research Foundation of The State University of New York, 1300 Elmwood Avenue, Buffalo, NY, 14222. **Long-Term Dynamics of *Dreissena* spp. in Lake Erie: Insights for Population Boom and Bust.**

In 2014 in collaboration with the U.S. EPA we collected over 340 samples from over 110 sites, including historical stations sampled since 1992, using both traditional techniques (ponar grabs, SCUBA diving) and over 320 video images to estimate the density and distribution of dreissenids in Lake Erie. Dreissenid densities are highest in the eastern basin and lowest in the central, where they are limited by hypoxia. Quagga mussels were found at all depths and in all basins, while zebra mussels were common only in the western basin. In the western basin *Dreissena* spp. were much smaller than in the eastern basin. Comparison of our results with the previous data show that among the most important intrinsic and extrinsic drivers of dreissenid distribution in Lake Erie are time since the initial invasion, lake basin morphometry, depth, oxygen content, substrate type, and interspecific competition. Geographic sample bias as well as differences in sampling methods used by different authors may introduce another challenge in understanding of the long-term dynamics of these ecosystem engineers. *Keywords: Exotic species, Lake Erie, Dreissena.*

KASHIAN, D.R.[1], RAM, J.L.[2], BOEGEHOLD, A.G.[1], ALAME, K.I.[1], and JOHNSON, N.S.[3], [1]Wayne State University, Department of Biological Sciences, Detroit, MI, 48202; [2]Wayne State University, Department of Physiology, Detriot, MI, 48201; [3]USGS, Great Lakes Science Center, Hammond Bay Biological Station, Millersburg, MI, 49759.
**Cyanobacteria limits dreissenid sperm mobility and fertilization success.**

Interactions between phytoplankton and mussel species are largely unknown and likely complex. Moreover, increased frequencies of toxic cyanobacteria blooms (e.g. *Microcystis aeruginosa*) in the Great Lakes since the invasion of zebra and quagga mussels (Dreissena) may influence mussel reproduction. Spawning in dreissenids is stimulated by an abundance of nutritious green algae; yet it is unknown if toxic cyanobacteria such as *Microcystis* can inhibit reproduction. Although a biocide (Zequanox®) has been recently discovered to control dreissenids, a multifaceted management program combining several control methods to attack dreissenids is preferred. *Microcystis* was tested for its effects on dreissenid reproduction in mussels collected from the Detroit River, MI. Spawning assays were run against a known spawning inducer while fertilization was tested by mixing female and male gametes. Although *Microcystis* did not influence spawning, sperm motility and fertilization were significantly reduced compared to controls ($p<0.05$). If the chemical compound that disrupts mussel reproduction is different from the agent that is toxic to other organisms, a chemical tool for reducing dreissenid reproduction might be derived from cyanobacteria to be used in tandem with other biocides. *Keywords: Control systems, Dreissena, Microcystis.*

KEELER, K.M.[1], ROSEMAN, E.F.[2], DEBRUYNE, R.L.[2], FISCHER, J.L.[1], and PRITT, J.J.[3], [1]Cooperative Ecosystem Studies Unit-Michigan State University, 13 Natural Resources, East Lansing, MI, 48824; [2]USGS-Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105; [3]Inland Fisheries Research Unit-Ohio Division of Wildlife, 10517 Canal Road, Hebron, OH, 43025. **Rolling Down the St. Clair-Detroit Rivers: Analyzing Spatial Movement of Copepods to Coregonines.**

Increased reproduction of native fishes resulting from improved water quality and habitat restoration within the St. Clair-Detroit River System (SCDRS) has prompted extensive studies into species utilization of habitats within this important corridor connecting Lake Huron to Lake Erie. Not only has the system been identified as vital habitat for adult fish, but also for larval fish due to restored spawning and nursery habitat. Furthermore, studies on zooplankton community dynamics and their use as food by fishes have revealed the complexity of relationships between trophic levels. Herein, we present our methodology on larval fish and zooplankton sampling, current profiling, and diet studies, in order to investigate the relationships of species in the lower trophic levels incorporating zooplankton to larval fish, how they were interconnected, and what this information demonstrates about the foodweb of a system in transition. *Keywords: St. Clair River, Detroit River, ADCP, Coregonids, Zooplankton.*

KELLEY, J.G.W.[1], ANDERSON, E.J.[2], CHEN, Y.[1], LANG, G.[2], and XU, J.[3], [1]NOAA/National Ocean Service/CSDL, 1315 East-West Highway, Silver Spring, MD, 20910; [2]NOAA/Great Lakes Environmental Research Laboratory, 4840 S State Road, Ann Arbor, MI, 48108; [3]NOAA/National Ocean Service/CO-OPS, 1305 East West Highway, Silver Spring, MD, 20910. **Upgrade of NOAA/NOS' Lake Erie Operational Forecast System to FVCOM: Skill Assessment.**

The Great Lakes Operational Forecast System (GLOFS) uses real-time weather observations and weather forecasts to produce forecast guidance of water temperatures, currents, and levels. GLOFS was originally developed by The Ohio State University and NOAA's Great Lakes Environmental Research Laboratory (GLERL) and was migrated into NOAA/National Ocean Service's 24 x 7 operations in 2005. NOS and GLERL are working together to upgrade GLOFS, starting with the Lake Erie Operational Forecast System (LEOFS), to provide improved forecast guidance to users. The upgrade uses FVCOM instead of POM as its core ocean circulation model. The FVCOM-based LEOFS has been evaluated by comparing hindcasts for 2005 and 2006 against surface water level and water temperature observations and vertical temperature data from IFYLE 2005 moored thermistors. In addition, hindcasts were compared to observations and nowcasts from the operational POM-based LEOFS during 2014. Preliminary comparisons indicate that the new LEOFS version has improved predictions of the vertical water temperature structure of the lake. At the surface, the mean algebraic error (MAE) and RMSE for hourly water level hindcasts from the new LEOFS were about -4 and 8 cm, respectively. The MAE and RMSE for surface temperatures were less than 1 and 1.3°C, respectively. *Keywords: Lake Erie, Real-time forecasts, Atmosphere-lake interaction, FVCOM, Hydrodynamic model, Circulation models.*

KELLOGG, W.A. and SAMANTA, A., Levin College of Urban Affairs, Cleveland State University, 2121 Euclid Avenue, Cleveland, OH, 44115. **The Patterns of Effective Watershed Collaborations: Form, Function, and Transformation.**

Governance for multi-jurisdictional water policy and implementation occurs through policy networks--a social-ecological system consisting of nodes and connections either between people or organizations as they work together to respond to ecological conditions. Understanding the structural qualities of networks (frequency, centrality, density of connections) as these shape policy actions may identify practices to improve function of collaborations in terms of relationships, decisions, flow of resources, flow of knowledge, and communication patterns. The paper presents results from a two-year study of networked governance in the Chagrin River watershed in northeast Ohio. We conducted interviews with stakeholders identified through snowball and cross-sector sampling, reviewed 15 years of plans and policy statements, and constructed a social network analysis using UCINET software. The overall effectiveness of the network was assessed in terms of tangible outcomes (mobilization of funding resources, development of plans and policies, implementation practices, etc.) and the capacity for collaboration (sharing knowledge, innovation, and trust). The study found among other aspects, that the evolution of network macro structure to support changing goals and activities of the collaborators enabled a high level of performance. *Keywords: Policy making, Watersheds, Governance, Networks.*

KERFOOT, W.C.[1], HOBMEIER, M.M.[1], YOUSEF, F.[1], LAFRANCOIS, B.M.[2], MAKI, R.P.[3], and HIRSCH, J.K.[4], [1]Department of Biological Sciences, Great Lakes Research Center, Michigan Technological University, 1400 Townsend Drive, Houghton, MI, 49931; [2]National Park Service, 2800 Lake Shore Drive East, Ashland, WI; [3]Voyageurs National Park, 415 S Pokegama Avenue, Grand Rapids, MN; [4]Minnesota Department of Natural Resources, 500 Lafayette Road Box 25, St. Paul, MN. **"Blind-sided": How Bythotrephes Alters Microcrustacean Communities, Biomass And Secondary Production.**

The spiny cladoceran (*Bythotrephes longimanus*) is an invasive, predaceous zooplankter expanding from Great Lakes coastal waters to inland lakes within a northern latitudinal band. In a large, boundary-water lake complex (Voyageurs National Park), we use two independent comparisons, a 2-year spatial and a 12-year temporal, to quantify seasonal impacts on food webs, biomass, and secondary production. Bythotrephes alters seasonal biomass patterns, severely depressing microcrustaceans (cladocerans and cyclopoids) during summer and early fall, when the predator is most abundant. The resistant cladoceran Holopedium is favored in spatial comparisons. Over the 12-year span, there is a major loss of microcrustacean biomass (40-60% reduction), an even greater impact on secondary production (67% reduction), and a community shift towards calanoid copepods. Secondary production declines come from from biomass losses plus the longer generation times of calanoid copepods (slower turnover). Many cladoceran species seem unaware of Bythotrephes' presence and do not deploy naturally induced defenses. Because Voyageurs is a large interconnected system, largely uncompromised by multiple stressors (phosphate abatement, mussels, severe fish alterations), our results shed light on changes in Laurentian Great Lakes communities. *Keywords: Bythotrephes cederstroemii, Invasive species, Food chains.*

KIM, D.K.[1], RAMIN, M.[1], MUGALINGAM, S.[2], GEATER, K.[3], MORLEY, A.[4], and ARHONDITSIS, G.B.[1], [1]University of Toronto, 1265 Military Trail, Toronto, ON, M1C1A4; [2]Lower Trent Conservation, 714 Murray Street, Trenton, ON, K8V 5P4; [3]Environment Canada, 4905 Dufferin St., Toronto, ON, M3H 5T4; [4]Ontario Ministry of the Environment & Climate Change, 1259 Gardiners Rd, Kingston, ON, K7M 8S5. **Coupling public perception and watershed modeling with the water quality criteria setting process.**

We present a modeling analysis of the management practices that could lead to significant reduction of phosphorus export from the Bay of Quinte watershed and an evaluation of the overall uncertainty associated with the assessment of the Beneficial Use Impairment "Eutrophication and Undesirable Algae". Our work highlights the internal recycling as one of the key drivers of phosphorus dynamics in the Bay. The flow from the Trent River is the predominant driver of the upper Bay dynamics until the main stem of the middle area, but the sediments in the same segment release a significant amount of phosphorus and the corresponding fluxes are likely amplified by the macrophyte and dreissenid activity. A major undertaking of this research is to engage public, local stakeholders, variety of government, private sector, community participants and policy makers that are involved with the Bay of Quinte RAP. Our research uses expert elicitation and public input to identify the water quality criteria that effectively balance between environmental concerns and socioeconomic values. The public survey was conducted throughout the summers of 2013 and 2014. We completed a total of 1430 surveys of local residents and tourists. Our next goal is to develop a novel policy analysis tools that will effectively guide the delisting decisions in the area. *Keywords: Biogeochemistry, Adaptive management, Urban watersheds, Bayesian analysis, Water quality, Land-use management.*

KINDREE, M.M. and MANDRAK, N.E., University of Toronto, Toronto. **Effect of Sampling Gear on the Index of Biotic Integrity in the Huron-Erie Corridor.**

In 1987, the International Joint Commission identified the St. Clair and Detroit rivers as Areas of Concern (AOC) in response to ongoing losses of critical fish and wildlife habitat. Implementation of remedial action plans required aquatic monitoring of these areas using the Index of Biotic Integrity (IBI) as an indicator of ecosystem health. The IBI has traditionally been calculated for AOCs based on fish community sampling using boat electrofishing; however, site conditions in the Huron-Erie corridor are characterized by relatively high water velocity and depth, which may lead to reduced capture efficiency when boat electrofishing techniques are employed. This may lead to biases in species captures (and associated IBI scores) relative to other sites in the Great Lakes basin. This project examines the influence of sampling gear type on IBI scores based on statistical comparisons of paired fish community data collected using boat electrofishing and benthic trawling conducted in 2011 to 2014. In addition to testing the effect of gear type, the influence of IBI calculation method (Hamilton 1989, Minns et al.1994, Edwards et al. 2006) will also be examined. Results of this study will provide guidance on the development of long-term monitoring protocols in the Huron-Erie Corridor. *Keywords: Huron-Erie Corridor, Ecosystem health, Index of Biotic Integrity.*

KING, A.T.[1], SCHWEITZER, S.A.[1], COWEN, E.A.[1], and RUEDA, F.J.[2], [1]Cornell University, DeFrees Hydraulics Laboratory, School of Civil and Environmental Engineering, Ithaca, NY, 14853; [2]Universidad de Granada, Instituto del Agua y Dpto. Ingeniería Civil, Granada, SPAIN. **3D Modeling of Hydrodynamics and Residence Time on Cayuga Lake's Southern Shelf.**

Cayuga Lake is long (65km), narrow (3km), and deep (130m max). A shallow shelf (<6m deep) extends 2km north from the south end. Concern about phosphorous and sediment loading has initiated an effort to understand the physical processes that control water residence time (WRT) on the south shelf. Sources include two major tributaries dominated by erosion and agricultural loading, two wastewater treatment plants, and a deep lake cooling facility. Shelf hydrodynamics are controlled by point sources and wind-induced circulation, modulated by stratification and the earth's rotation. To investigate how these phenomena determine shelf WRT, we incorporated a near-field point source model based on CORMIX into the 3D hydrodynamic model Si3D. This tool is calibrated using field temperature transects and remote flyover images, and validated using field data from deep water temperature strings, shelf temperature data, velocity data, and monitoring from herbicide treatments. Simulations based on observed forcing are used to characterize shelf WRT, and simulations based on hypothetical forcing are used to investigate the relative importance and interaction of different hydrodynamic processes. *Keywords: Hydrodynamic model, Residence time, Point source.*

KIRETA, A.R.[1], SAROS, J.E.[1], and REAVIE, E.D.[2], [1]Climate Change Institute, University of Maine, Orono, ME, 04669; [2]Natural Resources Research Institute, University of Minnesota Duluth, Duluth, MN, 55811. **Climate Change and Great Lakes Water Quality: Response to Past and Present Warming.**

Water quality and biological changes have been occurring in all of the Great Lakes in the past decades, but the specific role of warming as a driver of these rapid alterations is largely unknown. For the past 200 years, anthropogenic activities have been degrading and restoring the water quality in the Great Lakes, making it difficult to isolate the effects of climate shifts on recent water quality changes. Thus, we are looking at a previous period of warming, the Medieval Climate Anomaly (MCA, 950-1250 CE), to understand how warming has and is impacting water quality. We are comparing diatom algae from modern monitoring

data with fossilized diatoms from Erie and Superior sediment cores. Our goals are to decipher the effects of current warming on community structure changes and to understand how warming manifests these changes in lakes with different nutrient dynamics. This research will provide information about the timing, extent, and resilience of the prevailing water quality to previous warming as well as provide an estimated trajectory for future climate changes. *Keywords: Climate change, Water quality, Diatoms.*

KLUMP, J.V.[1], LABUHN, S.L.[1], KOOPMANS, D.[1], WAPLES, J.T.[1], BRAVO, H.[1], HAMIDI, S.[1], and ZORN, M.[2], [1]University of Wisconsin-Milwaukee, 600 E. Greenfield Ave., Milwaukee, St, 53204; [2]University of Wisconsin-Green Bay, 2420 Nicolet Dr, Green Bay, WI, 54311-7001. **The Biogeochemistry of Sediment-Water Interactions in a Seasonally Hypoxic Embayment.**

Green Bay, Lake Michigan has a long history of excessive nutrient enrichment, hypereutrophication and summertime hypoxia. Because of its morphology and restricted water mass exchange with Lake Michigan, the bay is very efficient in trapping much of its primary production within the bay and processing this organic rich material within a tightly coupled benthic-pelagic system. Estuarine-like circulation, sediment resuspension , and thermal stratification combined with nutrient and carbon remineralization processes and sediment oxygen demand all interact to produce frequent and persistent summertime bottom water hypoxia. Using a variety of methods including, water mass tracers, particle tracers, and estimates of benthic metabolism, we are attempting to develop a biogeochemical model of the onset and duration of hypoxia in the bay, and how changes in climate might alter current conditions. *Keywords: Biogeochemistry, Hypoxia, Green Bay, Sediments.*

KLYMUS, K.E., MARSHALL, N.T., and STEPIEN, C.A., University of Toledo, Lake Erie Center, 6200 Bayshore Dr., Oregon, OH, 43616. **Developing Genetic Assays To Detect Aquatic Invasive Invertebrate Species From Environmental Samples.**

Environmental DNA (eDNA) surveys are being integrated into management plans for the early detection of aquatic invasive species. The technique involves the amplification of species DNA from shed epithelial cells, or in the case of microscopic organisms, the entirety of the organism, found in water samples. Advances in DNA sequencing technology now allow for the high throughput analysis of samples as well as the ability to identify DNA from multiple species in a community. We are designing several high throughput genetic assays that aim to detect over 60 invasive, or potentially invasive, invertebrate species in the Laurentian Great Lakes. We place emphasis on primer design and testing in order to avoid

non-target species amplification and amplification bias. We also are employing internal standards to ultimately provide relative quantitation of species DNA in samples as well as determine the assays' limits of detection. We present data on our latest assays that focus on invasive bivalve and gastropod species using mtDNA markers. *Keywords: Mollusks, Environmental DNA, Genetics, Invasive species.*

KNACK, I.M.[1], SHEN, H.T.[1], HUANG, F.[1], and KOLERSKI, T.[2], [1]Clarkson University, 8 Clarkson Ave, Potsdam, NY, 13699-5710; [2]Gdansk University of Technology, Gabriela Narutowicza 11/12, 80-233, Gdansk, POLAND. **Numerical Model Studies of Ice Effects on the Great Lakes Connecting Channels.**

The presence of ice can have a significant effect on the hydraulics of rivers and can impact wintertime navigation, power generation, and aquatic ecology. Each of the Great Lakes connecting channels has a history of significant ice events. To the extent possible, the flow in the connecting channels is regulated during the wintertime to reduce the negative impacts of these ice events. The result of numerical model studies investigating the effects of ice on wintertime operation of the Great Lakes connecting channels is presented. A two-dimensional coupled hydro-thermal-ice dynamics model was used for the studies. The results show that numerical modeling can be a useful tool for wintertime flow regulation and operation of hydropower projects on the Great Lakes Connecting Channels. *Keywords: Hydrodynamic model, St. Lawrence River, Ice, St. Marys River, Niagara River, St. Clair River.*

KOCH, K.R.[1], KNEE, K.[2], ADAMS, B.[2], GALVARINO, C.[3], SLAWECKI, T.A.D.[1], and PAIGE, K.R.[4], [1]LimnoTech, 501 Avis St., Ann Arbor, MI, 48108; [2]RPS ASA, 55 Village Square Dr., South Kingstown, RI, 02879; [3]Second Creek Consulting, LLC, P.O. Box 50960, Columbia, SC, 29250; [4]Great Lakes Observing System (GLOS), 328 So. State St., Ann Arbor, MI, 48104. **GEO-Great Lakes: Gathering Momentum.**

GEO Great Lakes (GEO-GL) (as part of GEOSS) supports data collaboration efforts between the United States and Canada in the Great Lakes Region. Representatives work to make bi-national datasets discoverable (easy to find), transparent (easy to understand) and interoperable (easy to use). These needs are met through application of internationally accepted standards that ensure that the data are accurate, consistent and verified. This presentation will focus on the three recent projects: 1) the Evaporation Network which will publicize high-frequency over-lake evaporation measurements. The goal of this effort is to improve understanding of lake level fluctuations and accuracy of weather forecasts. 2) The Lake Simcoe, ON pilot project which is a bi-national effort between GEO-

GL and Conservation Ontario. The goal of this project is to incorporate water quality and streamflow monitoring data and metadata into the GLOS Data Portal, thus making it readily accessible for stakeholder use. 3) Use of GeoNetwork categorization capabilities to populate the underlying BaseX database using metadown (collecting ISO 19119/19139 compliant metadata) for our next revision of the GLOS Data Portal. The use of existing metadata categorization will provide better capabilities for search and the ability to offer customization of content for users. *Keywords: Data storage and retrieval, Metadata, Observing systems, Data collaboration, Data acquisition.*

KORNECKI, K.M.[1], KATZ, M.E.[1], MCCARTHY, F.M.G.[2], SCHALLER, M.F.[1], and STAGER, J.C.[3], [1]Rensselaer Polytechnic Institute, Troy, NY; [2]Brock University, St. Catherines, ON; [3]Paul Smith's College, Paul Smiths, NY. **Multi-proxy Reconstruction of Anthropogenic Impact in Lake George, NY.**

Lake George, NY is a headwater lake with Class AA-Special water quality rating, surrounded by forever-wild forest, and is a valuable tourist revenue source. Lake monitoring reveals increasing anthropogenic impact over at least 30 years. RPI, IBM, and FUND for Lake George recently formed a partnership, called The Jefferson Project at Lake George (JP), to study water quality and recovery efforts in the lake. In conjunction with JP, we conducted a multi-proxy pilot study using microfossil assemblages (thecamoebians, ostracodes, diatoms) and stable isotopes (O, C) in 9 short cores and 10 Ekman grab samples to reconstruct anthropogenic influence on the lake (e.g., salt-loading, phosphatization, eutrophication, temperature) from information archived in lake sediments. We characterize modern assemblages using coretops and Ekman samples, and link modern biotic variability to water quality data from Darrin Fresh Water Institute. Pollen data constrain downcore sediment ages (Riddick et al. this session). Increases in phosphorous-tolerant difflugid strains of thecamoebians reveal eutrophication lakewide, but are most distinct and occur earliest in populous areas. Our future work will apply our multi-proxy strategy to longer cores to determine the pristine state of the lake before anthropogenic impact. *Keywords: Water quality, Paleolimnology, Bioindicators.*

KORNIS, M.S.[1], WEBSTER, J.L.[1], LANE, A.A.[1], PANKOW, K.W.[1], MANN, K.A.[1], EGGOLD, B.T.[2], LEGLER, N.D.[3], BREIDERT, B.[4], CLARAMUNT, R.M.[5], CLAPP, D.F.[5], CLEVENGER, J.A.[5], FIELDER, D.G.[6], ROBILLARD, S.R.[7], and BRONTE, C.R.[1], [1]U.S. Fish and Wildlife Service, Great Lakes Fish Tag and Recovery Laboratory, 2661 Scott Tower Drive, New Franken, WI, 54229; [2]Wisconsin Department of Natural Resources, Fisheries Management/Water Division, 600 E. Greenfield Ave, Milwaukee, WI, 53204; [3]Wisconsin Department of Natural Resources, Fisheries Management/Water Division, 110 S. Neenah Ave, Sturgeon Bay, WI, 54235; [4]Indiana Department of Natural Resources, Division of Fish and Wildlife, 100 W. Water St, Michigan City, IN, 46360; [5]Michigan Department of Natural Resources, Charlevoix Fisheries Research Station, 96 Grant Street, Charlevoix, MI, 49720; [6]Michigan Department of Natural Resources, Alpena Fisheries Research Station, 160 E. Fletcher, Alpena, MI, 49707; [7]Illinois Department of Natural Resources, Lake Michigan Program, 9511 Harrison St, Des Plaines, IL, 60016. **Movements, Reproduction, and Fishery Contributions of Chinook Salmon in Lakes Michigan and Huron.**

Millions of salmonines are annually stocked in the Great Lakes to support and diversify sport fisheries, restore native fish populations, and control invasive fishes. In 2011 the Great Lakes Mass Marking Program, in partnership with the states, began coded-wire tagging and adipose-fin clipping all Chinook salmon stocked into Lakes Michigan and Huron to better understand movement patterns, contribution of stocked fish to fisheries, and levels of natural reproduction. Data and tag recoveries from a network of field personnel helped describe movement patterns of stocked Chinook salmon from various ages, year classes, and seasons. Fish have been recovered up to 520 km away from their stocking location (ave. = 140 km), but move closer to stocking locations as they mature. Early findings suggest greater fishery contributions (i.e., recoveries per number stocked) from Chinook salmon stocked along the western shore of Lake Michigan, and also indicate Chinooks are more likely to move from Lake Huron into Lake Michigan, although there is some reciprocal movement. We also describe levels of natural reproduction for Chinook salmon in various districts (ave. 59.8% in L. Michigan and 55.4% in L. Huron). Our preliminary results show that coordinated basin-wide, muti-agency tagging efforts enhance understanding of Great Lakes fisheries. *Keywords: Salmon, Lake Michigan, Spatial analysis, Lake Huron, Fisheries.*

KOROSOV, A.[1], POZDNYAKOV, D.[2], SHUCHMAN, R.A.[3], SAYERS, M.J.[3], and SAWTELL, R.[3], [1]Nansen Environmental and Remote Sensing Centre, Bergen, NORWAY; [2]Nansen International Environmental and Remote Sensing Centre, St, Petersburg, RUSSIA; [3]Michigan Tech Research Institute, Ann Arbor, MI. **Bio-optical Retrieval Algorithm for the Optically Shallow Waters of the Great Lakes.**

With the exception of a few areas, Lake Michigan is an oligotrophic clear water body. It is predominantly in the nearshore where ecology-relevant processes unfold due to natural and anthropogenic forcing. However, the bottom influence is strong enough to contaminate

satellite observed signal, thus impeding the remote sensing of water quality parameters within the coastal zone. A new approach based on a radiative transfer model, a specific hydro-optical model and multivariate optimization has been developed to produce a tool for operational satellite retrievals of water quality parameters in optically shallow areas. The algorithm retrieves concentrations of the Color Producing Agents (CPAs), chlorophyll, suspended matter, and CDOM in coastal waters with varying bottom types. The sensitivity of the new approach was tested for hydro-optical conditions in Lake Michigan. MODIS data acquisitions were synchronized with in situ radiometric measurements, as well as identification of bottom type and depth. Retrievals of remote sensing reflectance and CPA concentrations within the ranges of depth where bottom reflectance is detectable compared will with in situ observations. Application of the developed operational tool has convincingly shown its advantage over the OC4 performance in optically shallow waters at all control stations. *Keywords: Remote sensing, Satellite technology, Water quality.*

KOSIARA, J.M., SCHOEN, L.S., COOPER, M.J., STUDENT, J.J., and UZARSKI, D.G., Central Michigan University, Barrie Wilkes Vice President, Mount Pleasant, MI, 48859.
**Patterns in trace element concentrations of nearshore and wetland waters in northern Lake Huron.**

Analysis of otolith microchemistry, which relies on distinct trace element concentrations among habitats, may be useful in assessing fish movement between wetland and nearshore habitats. We explored spatial patterns in trace element concentrations of nearshore and wetland water in the Les Cheneaux Islands of Lake Huron to inform otolith microchemistry-based assessments of fish movement. Water samples collected from 16 wetlands and 3 nearshore areas were analyzed via ICP-MS. Principal component analysis revealed patterns in trace element concentrations among wetlands and between wetland and nearshore habitats. Wetlands with greater wave energy were more similar to nearshore sites in the ordination. Within wetlands, water collected from bulrush dominated areas (at the pelagic edge of wetlands) were associated with nearshore samples while water from cattail dominated areas (closer to shore) appeared to have unique trace element signatures. These results suggest hydrology and pelagic mixing are important drivers of trace element concentrations. Elemental concentrations from cattail dominated areas are likely influenced by groundwater whereas bulrush dominated areas are exposed to mixing with nearshore water. Moving forward, higher resolution sampling will be employed to further assess patterns within and between sites. *Keywords: Coastal wetlands.*

KOSMENKO, N.J.[1], JOHNSON, T.B.[2], DROUILLARD, K.G.[1], and SEMENIUK, C.[1], [1]Great Lakes Institute for Environmental Research, 2990 Riverside Drive West, Windsor, ON, N9C 1A2; [2]Glenora Fisheries Station, OMNR, 41 Hatchery Lane, R.R. #4, Picton, ON, K0K 2T0. **Correlating fish traits with metabolic rates to assess trophic impact of AIS.**

The effects of aquatic invasive species (AIS) on biodiversity, productivity, and ecosystem services cost North Americans billions of dollars annually and alter the quality and opportunities associated with previously derived benefits. Although a priori predictions could provide insight into the level of prevention or control required, making these predictions is often difficult. Currently, much of AIS management occurs after the fact, which is expensive and time-consuming. Metabolic rates of fish may provide insight into the magnitude of trophic impacts, and correlations between these rates and life history traits could provide a cost-effective way to identify relative trophic impact of introduced fish. We used published literature to summarise metabolic rates and life history traits for freshwater fish, then described relationships between fish traits and routine metabolic rates. Next, the above relationships were used to generate a predictive model that can be applied to discriminate between high- and low-trophic impact AIS, and the model was subsequently validated and applied to fish species of concern. The ability to predict trophic impact from analysis of easily-attainable traits will aid management decisions regarding newly arrived or anticipated species, allowing managers to apply efforts in the most efficient manner.
*Keywords: Bioenergetics, Invasive species, Fish.*

KOVALENKO, K.E.[1], JOHNSON, L.B.[1], CIBOROWSKI, J.J.H.[2], and BRADY, V.J.[1], [1]Natural Resources Research Institute, Duluth, MN; [2]University of Windsor, Windsor.
**Macroinvertebrate Metrics: Confounding Effects and Consistency Across Time.**

Macroinvertebrate metrics are an essential tool in freshwater biomonitoring. Yet, many well-known stream metrics do not perform well as indicators of stress in lakes. Great Lakes present additional challenges to metric development by virtue of strong geographic gradients, diversity of coastal ecosystem types and changing lake levels. We attempt to untangle the relationships among metrics and watershed stressors while accounting for potential confounding factors using hierarchical partitioning, Random Forests and spatially explicit approaches. The selection of metrics includes newly proposed, as well as existing macroinvertebrate metrics, many of which are used in Indices of Biotic Integrity. We use data from the two stages of the Great Lakes Environmental Indicators project which sampled coastal wetlands across all five Laurentian Great Lakes and the full gradient of anthropogenic stress in 2001-2003 and 2011-2013. This temporal resample allows us to test

metric reliability across time. Implications of these patterns for metric utility are discussed. *Keywords: Coastal wetlands, Indicators, Macroinvertebrates.*

KREIS, JR., R.G.[1], MURPHY, E.W.[2], ZHANG, X.[3], RYGWELSKI, K.R.[1], WARREN, G.J.[2], HORVATIN, P.J.[1], MELENDEZ, W.[4], HOLSEN, T.M.[5], and PAGANO, J.J.[6], [1]USEPA, ORD, NHEERL-MED-LLRFB, 9311 Groh Rd., Grosse Ile, Mi, 48138; [2]USEPA Great Lakes National Program Office, 77 W. Jackson Blvd., Chicago, IL, 60604; [3]Z-Tech / ICF Corporation, Grosse Ile, MI; [4]Computer Sciences Corporation, Grosse Ile, Mi; [5]Clarkson University, Potsdam, NY; [6]SUNY Oswego, Oswego, NY. **Lake Michigan Lake Trout PCB Model Forecast Post Audit.**

Scenario forecasts for total PCBs in Lake Michigan (LM) lake trout were conducted using the linked LM2-Toxics and LM Food Chain models, supported by a suite of additional LM models. Efforts were conducted under the Lake Michigan Mass Balance Study and the post audit represents the period 1995-2013, since the conclusion of the study. Forecasts of 5 to 6-year old lake trout from Sturgeon Bay and Saugatuck, representing two LM regions, indicated that total PCB concentrations will continue to decrease and the Sports Fish Advisory Task Force's goal for unrestricted consumption could be achieved in coming years, during the mid-2030s. Compared to PCB data for lake trout from the Great Lakes Fish Monitoring Program, the model forecasts and data exhibit good agreement, suggest that the model forecasts are reasonable, and that concentrations should continue to decline. Results are consistent with long-term decreases in other media and together indicate a considerable weight of evidence for continued decreases and improvements in the ecosystem from various actions. These are subject to assumptions and we will present some information on issues that may accelerate or exacerbate the anticipated future. This abstract does not necessarily reflect EPA policy. *Keywords: Environmental contaminants, Great Lakes Restoration Initiative (GLRI), Fish.*

KRIEGER, J.R. and DIANA, J.S., University of Michigan, School of Natural Resources and Environment, 440 Church St., Ann Arbor, MI, 48109. **Habitat Utilization and Influences on Dispersal of Age 0-2 Lake Sturgeon in the St. Clair River, MI.**

The identification and protection of nursery habitat utilized by post-drift larval and age 0-to-2 lake sturgeon has been designated as a top priority in the Great Lakes Basin. In the Great Lakes Connecting Channels, most studies have focused on adult and juvenile (>300mm) lake sturgeon, with relatively little attention being given to earlier life-stages, resulting in a gap in knowledge of lake sturgeon-environmental connectivity through their early life history development. This study examined the influence of both abiotic and biotic influences on the distribution of larval and age 0-to-2 lake sturgeon in the St. Clair River System. Larvae were found to reside in the ~4-5 km stretch of the river between their spawning point of origin and the river mouth, for a period of 2-3 weeks and were found in greater abundance in smaller, low-flow velocity, secondary channels, suggesting that larvae may not just passively drift downstream but are actively selecting preferred sites. Georeferenced habitat information on substrate, invertebrate composition, river flow, and depth collected in this system was also used to construct a lake sturgeon habitat suitability index in a GIS to produce spatially explicit models, predicting the location and abundance of suitable YOY and juvenile life stage specific habitat in the St. Clair River. *Keywords: St. Clair River, Habitat Suitability Modeling, Fish behavior, Lake Sturgeon, Habitats.*

KRUMWIEDE, B.[1], MARCY, D.[2], BETZHOLD, L.[1], BROOKS, W.[1], and STIRRATT, H.[2], [1]The Baldwin Group at NOAA Office for Coastal Management, 2234 South Hobson Avenue, Charleston, SC, 29405; [2]NOAA Office for Coastal Management, 2234 South Hobson Avenue, Charleston, SC, 29405. **Visualizing the Impacts of Changing Water Levels in the U.S. Great Lakes: NOAA's Lake Level Viewer.**

The Lake Level Viewer provides a web-based interface that allows users to easily visualize the impacts of changing water levels along the coastal margin of the U.S. Great Lakes, as well as aid in coastal management efforts by understanding what areas will be impacted. To populate this tool, developers created a seamless topographic-bathymetric data set at a spatial resolution of 3 meters for areas collected by airborne LiDAR. This presentation will focus on the development of the background topographic-bathymetric data used in the Lake Level Viewer, data hosting and accessibility, connection to the Great Lakes Water Level Dashboard, as well as a demonstration of the tool and improvements that are anticipated in the next release. The National Oceanic and Atmospheric Administration's Office for Coastal Management officially released the first version of the Lake Level Viewer in the fall of 2014. *Keywords: Water level fluctuations, GIS, Great Lakes Restoration Initiative (GLRI).*

KUCZYNSKI, A.[1], AUER, M.T.[1], and CHAPRA, S.C.[2], [1]Civil and Environmental Engineering, Michigan Technological University, Great Lakes Research Cent, 1400 Townsend Drive, Dow Bldg. 870, Houghton, MI, 49931; [2]Civil and Environmental Engineering, Tufts University, Anderson Hall, Medford, MA, 02155. **Phosphorus Management and *Cladophora* in the Eastern Basin of Lake Erie.**

Nuisance growth of *Cladophora* is an Environmental Response Indicator (ERI) manifested in the level and frequency of beach fouling. The Great Lakes Water Quality Protocol of 2012 mandates that Substance Objectives be set for phosphorus (P) as prelude to the establishment of revised P loads and attendant remediation of nuisance conditions. Here, we define nuisance conditions and apply the Great Lakes *Cladophora* Model (GLCM) in proposing a Substance Objective for soluble reactive phosphorus (SRP) with respect to the *Cladophora* ERI. The SRP Substance Objective is then expressed in terms of total phosphorus (TP; empirical relationship) and the corresponding TP load is calculated. The GLCM is further applied to establish the relationship between SRP and stored P in *Cladophora*, with the latter recommended as a means of monitoring system response to management. The P loads so derived correspond to whole-lake nutrient levels. Nearshore conditions, however, are also influenced by local P sources. An example case for eastern Lake Erie illustrating the management challenges presented by interaction between nearshore and offshore waters is provided. *Keywords: Cladophora, Phosphorus, Management.*

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LAFONTAINE, J., GRGICAK-MANNION, A., and DROUILLARD, K.G., GLIER, University of Windsor, 401 Sunset Ave, Windsor, On, N9B3P4. **Contaminant patterns in Huron-Erie Corridor sediments using the Getis-Ord geospatial statistic.**

Sediment Samples from the Huron-Erie Corridor (HEC) (St. Clair River, Lake St. Clair and Detroit River) were collected using a random-stratified approach in a 2013-2014 survey to evaluate sediment chemistry and benthic invertebrate communities. The results are compared and contrasted with a similar study conducted in 2009. The sediment chemistry analyses consisting of grain size, TOC, total mercury, trace metals, PCBs, PAHs and OCs. At the corridor scale there were distinct differences noted in the distribution of organic and metal contaminants. Mercury concentrations were enriched throughout Canadian portions of the St Clair River and Lake St. Clair whereas organic contaminants tended to be enriched in nearshore U.S. waters of the Detroit River. A Geographic Information System (GIS) was used to map and assess information while the Getis-Ord geospatial statistic tool was used to characterize regional zones of high and low contamination for selected contaminants. Temporal analyses showed no distinct changes in sediment chemistry with time for most contaminants within the Detroit River. Total Hg levels in the Huron-Erie corridor averaged $0.33\pm0.064$ in 2004 and $0.23\pm0.047$ in 2013/14 and were not significantly different ($p>0.1$; t-test) with time. *Keywords: Mercury, Sediment quality, PCBs.*

LAMAY, M.A.[1], MIHUC, T.B.[1], SCHULTZ, R.E.[2], and STOCKWELL, J.D.[3], [1]SUNY Plattsburgh, Lake Champlain Research Institute, 101 Broad Street, Plattsburgh, NY, 12901; [2]SUNY Plattsburgh, Center for Earth and Environmental Science, 101 Broad Street, Plattsburgh, NY, 12901; [3]University of Vermont, Rubenstein Ecosystem Science Laboratory, 3 College Street, Burlington, VT, 05401. **Zooplankton Diel Vertical Migration in a Lake Invaded by *Bythotrephes longimanus*.**

Zooplankton diel vertical migration was analyzed in Lake George, NY, a system within the Lake Champlain Basin containing the invasive *Bythotrephes longimanus* (spiny water flea) and compared to zooplankton migration in the non-invaded Lake Champlain. Vertical tows were conducted using 153-µm- and 250-µm-mesh closing nets at discrete 5-m increments to assess zooplankton vertical structure at one 50-m site in each lake. Discrete day and night sampling rounds were conducted monthly from June 2013 to September 2013. Results suggest differences in zooplankton vertical structure between the two lakes, with species residing deeper in Lake George than in Lake Champlain, likely as a result of the greater transparency in Lake George. Migration amplitudes in Lake George decreased as *Bythotrephes* densities increased over the sampling period, with many species remaining at depth in the metalimnion and hypolimnion even at night. In Lake George, *Bythotrephes* may drive some species into deeper strata and discourage nocturnal migration to the epilimnion for certain species that display typical migration behavior in Lake Champlain. With the introduction of *Bythotrephes* into Lake Champlain in 2014, comparative data between the two sites provide an essential reference for future study. *Keywords: Zooplankton, Diel vertical migration, Bythotrephes longimanus.*

LAMBERT, R.S.[1], DEPINTO, J.V.[1], and AUER, M.T.[2], [1]LimnoTech, 501 Avis Drive, Ann Arbor, MI, 48108; [2]Great Lakes Research Center, Michigan Technological Unversity, Houghton, MI, 49931. **Managing Great Lakes Eutrophication on the Basis of Bioavailable Phosphorus.**

Phosphorus loading limits were established for the five Laurentian Great Lakes with the 1978 amendment of the Great Lakes Water Quality Agreement (GLWQA). All of these limits were based on the total phosphorus loads, and regulators continue to manage based on total phosphorus, ignoring the key role of soluble reactive P, and the bioavailability of dissolved organic, and particulate P. The 2012 update to the GLWQA calls for new phosphorus loads to be set for the Great Lakes, and for the bioavailability of these loads to be accounted for when they are calculated. Here methods for quantifying the bioavailability of loads are discussed. Chemical and algal assay technologies are available that may be used

to quantify the bioavailability of the three analytical defined forms: particulate (PP), dissolved organic (DOP) and soluble reactive (SRP) phosphorus. These methods provide an approach for quantifying and managing loads to the lakes on the basis of bioavailable P. Results from assays performed on samples collected at several locations on the Great Lakes are discussed. On average, 36% of the particulate P, 67% of the DOP and 100% of the SRP was determined to be bioavailable. *Keywords: Phosphorus, Bioavailablity, Algae, Harmful algal blooms.*

LANDON, M.E.[1], MURPHY, E.W.[2], AMOS, M.M.[1], and SCHOFIELD, J.A.[1], [1]CSC, 6361 Walker Lane Suite 300, Alexandria, VA, 22310; [2]U.S. EPA Great Lakes National Program Office, 77 West Jackson Boulevard, Chicago, IL, 60622. **Addressing the Impact of Ecosystem Changes in a Long-term Monitoring Program.**

Long-term monitoring programs are critical for providing extensive data sets & identifying trends. However, ecosystems, technologies & methods are dynamic & responding to changes requires careful planning, coordination & evaluation efforts. GLNPO's Great Lakes Fish Monitoring & Surveillance Program monitors fish contaminant concentration trends & has been in existence for 40+ years. Adapting the program to change must be done without negatively impacting current procedures, data reliability, schedules, etc. Yet, shifts in the ecosystem & the development of an innovative fish aging method have led to the consideration of using this method in the GLFMSP. Age is a critical piece of information when assessing contaminant levels & fish homogenized together should be of similar ages for improved data interpretation. However, obtaining accurate ages prior to homogenization is challenging. The new method enables age determination prior to processing & analysis thus allowing fish to be sorted into appropriate age classes. This presentation 1)identifies the problem, 2)discusses development & evaluation of procedures & 3)discusses considerations for formal implementation. We will highlight close collaboration among partners, challenges & lessons learned in hopes that other long-term monitoring programs can benefit from our experience. *Keywords: Fish, Age data, Monitoring, Environmental contaminants.*

LANG, J., SNYDER, R., PÉREZ-FUENTETAJA, A., CLAPSADL, M.D., COCHRAN, J., and OSBORNE, C., Biology Department, SUNY Buffalo State, 1300 Elmwood Ave., Buffalo, NY, 14222. **Morphometric Differentiation in Lake and River Populations of the Emerald Shiner.**

Understanding mechanisms that account for phenotypic variation has been of interest to biologists since the advent of Darwin's theory of evolution by natural selection. It is now understood that adaptive divergence is a key driving force of intraspecific differentiation. Further, differences in habitat have been shown to drive adaptive divergence in fish. For instance, fish inhabiting faster flowing water generally exhibit more fusiform bodies than their lake counterparts. Similarly, the partitioning of benthic and pelagic morphs generally results in smaller heads with the latter. This study will assess morphological differences between populations of the emerald shiner (*Notropis atherinoides*) inhabiting the Niagara River, Lake Erie, and Lake Ontario using geometric shape analysis. It is expected that emerald shiners inhabiting the two lakes will have more robust bodies, smaller heads and will feed primarily on pelagic prey. Conversely, river shiners are more likely to feed on benthic prey and have more fusiform bodies with larger heads. Since the emerald shiner is a key component of the food web in the Niagara River and throughout the Great Lakes, understanding factors that influence its morphology and adaptation to local conditions is important to inform future management decisions that may impact this species. *Keywords: Comparison studies, Fish populations, Niagara River.*

LANGEN, T.A.[1], BENSON, C.E.[2], and CARBERRY, B.C.[1], [1]Clarkson University, Box 5805, Potsdam, NY, 13699; [2]Lincoln Memorial University, 6965 Cumberland Gap Parkway, Harrogate, TN, 37752. **Success of Wetland Restorations for Conserving Species: Restoration Method, Landscape, Size, or Age?**

In the St. Lawrence River Valley and Lake Ontario lowlands of northeastern New York, we conducted biotic surveys for species of greatest conservation need and wetland - associated biodiversity, including frogs, birds, turtles, fish, and plants, at 50 wetland restoration projects done as public-private partnerships by the National Resources Conservation Service, U.S. Fish and Wildlife Service, and Ducks Unlimited. In this talk, we report on what attributes predict whether or not a wetland restoration will support wetland-associated biodiversity: the method of restoration (excavated pothole, dike), landscape context (surrounding land cover and land use, hydrological connectivity), size of the restoration, and age of the restoration. We conclude that each of these factors is associated with some patterns of species occupancy. Our research is indicating best practices on where to restore wetlands and how to restore them to provide habitat for species of conservation concern and other wetland-associated species. *Keywords: Wetlands, Habitat restoration, Bioindicators, Conservation, Management, St. Lawrence River.*

LANTZ, S.R., US Fish and Wildlife Service, Marquette Biological Station 3090 Wright St, Marquette, MI, 49855. **Alternative (Next Generation) Lampricides.**

Lampricides have been an effective and essential tool in the control of invasive sea lampreys (*Petromyzon marinus*) throughout the Great Lakes for over 50 years and in Lake Champlain for over 20 years. This long history is attributable to lampricide selectivity and low environmental persistence as well as a lack of sea lamprey resistance in the field. At the same time, 50+ years of chemical innovation has yielded numerous chemical functionalities that have not been explored for lampricidal activity. Data mining of the low-throughput lampricide screening data from the 1950s indicates that other chemical classes have lampricidal activity. Furthermore, the advent of high-throughput chemical screening technologies allows cost-effective research into specific chemical and toxicological questions. A great potential exists for the development of new lampricides with an array of benefits including but not limited to: higher sea lamprey toxicity (less chemical used), lower toxicity to nontarget species (decreased potential for nontarget mortality) or alternative mechanisms of action (useful in delaying lampricide resistance). Current lampricides are 'green' in many ways, but can we make 'greener' lampricides? *Keywords: Green chemistry, Lampricides, Invasive species, Pesticides, Sea lamprey.*

LAURENT, K.L.[1], CREED, I.F.[1], CORMIER, R.[2], and FRIEDMAN, K.B.[3], [1]Western University, Canada, 1151 Richmond Street, London, ON, N6A 5B7; [2]EcoRisk Management Inc., Ammon, NB; [3]University at Buffalo School of Architecture and Planning, Regional Institute, SUNY at Buffalo, Buffalo, NY. **A systems approach to policy analysis for risk management in the Great Lakes Basin.**

Despite a century of treaties and agreements, the Great Lakes-St. Lawrence River basin continues to show signs of deterioration as new challenges face these waters, such as pernicious algal blooms in Lake Erie. The 2012 Great Lakes Water Quality Agreement (GLWQA) commits Canada and the United States to develop Substance Objectives by 2016 for Lake Erie's phosphorus content and loading, followed by the development of phosphorus reduction strategies and domestic action plans by 2018; the expectation is that the 2012 GLWQA will be implemented within existing legislation and programs. In this study, we have applied the International Organization for Standardization (ISO) 31000:2009 Risk Management framework and its bowtie methodology, which combine the state of scientific knowledge with existing legislation and programs, to: (1) identify opportunities for enhancement as aspired by the 2012 GLWQA, and (2) facilitate implementation of these mechanisms to avoid future risks to the integrity of the Great Lakes ecosystem. We show how this method can streamline and energize current efforts to develop and implement measures to reduce Lake Erie and Ontario nutrient loads and algal blooms, and enhance the efficiency of the analysis of these measures, all within the current regulatory frameworks for the Great Lakes. *Keywords: Great Lakes basin, Policy, Water quality, Risk management, Nutrients.*

LAWRENCE, P.L., University of Toledo, Dept of Geogrraphy and Planning, Toledo, OH, 43606. **2014 Toledo Drinking Water Crisis: Community, Planning, Policy Issues and Responses.**

The Toledo drinking water crisis in August 2014 reflected a complex series of events and issues related to Lake Erie HABs and the health impacts, including weather, sediments, nutrients,lake environmental conditions, runoff, river and stream hydrology, water treatment procedures and infrastructure, water quality monitoring, in additional to a range of community based planning and policy aspects. This paper will provide a review of those aspects and their role leading up to the event and subsequent discussions and efforts to resolve the factors at play and to address future efforts aimed at solving key contributing factors. The focus will include examining watershed management and planning issues and practices within the Maumee River watershed, community local decision-making and engagement, improved policies and planning tools, need for improved education and public awareness, incentives to address land use management, cooperative and coordinated efforts between public agencies, the private sector, and citizens, and raising the importance of Lake Erie HABs and their impact on environmental conditions and potential human health through drinking water more broadly with society, especially in the Toledo area but also within the Lake Erie basin and Great Lakes where communities and populations are at continued and increased risk. *Keywords: Environmental policy, Harmful algal blooms, Lake Erie.*

LEDUC-LAPIERRE, M., Great Lakes Commission, South Industrial highway, Ann Arbor, Mi, 48104. **Beneficial Use of Dredged Material in the Great Lakes.**

Maritime transportation on the Great Lakes system is an important economic driver, delivering needed products and commodities and producing jobs for the region. Commercial navigation requires continued dredging of harbors, ports, marinas, and shipping channels. Each year, dredging in the Great Lakes produces 2-3 million cubic yards of sediment. Placement of dredged material in open water and in confined disposal facilities are some of the traditional methods of managing these sediments. But there is an increasing awareness that clean dredged material can and should be managed as a sustainable resource and marketed as a commodity with value. Recognizing that value, and identifying ways to maximize it, is the concept behind "beneficial use" as an environmentally sound, practical and sustainable approach to dredged material management. Projects like habitat creation in

Wisconsin and Minnesota, and brownfield restoration in Ohio are some examples of innovative use of dredged material management. *Keywords: Great Lakes basin, Dredging, Beneficial Use.*

LEGER, W.P.[1] and LEE, D.H.[2], [1]Environment Canada, 867 Lakeshore Road, Burlington, ON, L7S 1A1; [2]Great Lakes Environmental Research Laboratory, NOAA, 4840 South State Rd., Ann Arbor, MI, 48108. **The Evolution and Implementation of an Adaptive Management Approach to Great Lakes Water Levels.**

Over the past 50 years, the International Joint Commission (IJC) has conducted numerous comprehensive Great Lakes studies, driven by the impacts of extreme low or high water levels. The fact that there has been such a series of studies suggests that the impacts of extreme water levels continues to be an issue faced by the Great Lakes-St. Lawrence River community. It also suggests that the current approach of conducting a study every time there are extremes (on a roughly multi-decadal cycle) may not be the most efficient and effective way of addressing the problem. The most recent IJC studies on the regulation plans for managing Great Lakes water levels, including the International Upper Great Lakes Study and the Lake Ontario-St. Lawrence River Study, concluded that adaptive management is the best way to address uncertainties including those associated with climate change. Recently, the IJC established a new Great Lakes-St. Lawrence River Adaptive Management (GLAM) Committee to support the three Great Lakes Boards of Control with the on-going review and evaluation of regulation plans. This presentation will examine the evolution of adaptive management in the Great Lakes-St. Lawrence River basin with an emphasis on the genesis and significance of the new GLAM Committee. *Keywords: Water level, Adaptive Management, Great Lakes basin, Climate change.*

LEGEZA, M.[1], SINGER, J.[1], MANLEY, P.[2], and MANLEY, T.O.[2], [1]SUNY - Buffalo State, 1300 Elmwood Avenue, Buffalo, NY, 14222; [2]Middlebury College, 14 Old Chapel Road, Middlebury, VT, 05753. **Evaluation of Changes in Channel Geometry Following Environmental Dredging in the Buffalo River.**

The Buffalo River is an urbanized watershed and a designated Great Lakes Area of Concern. The Buffalo River is a federal navigation channel that the U.S. Army Corps of Engineers (USACE) maintains to a navigational channel depth of 6.7 m below mean lake level by dredging every 2-3 years. To remove some of the most contaminated sediments, a large scale sediment removal project was conducted between 2011 and 2014. This environmental dredging project involved the removal of more than one million cubic yards

of sediment from both within and outside the navigation channel, significantly modifying the river's cross-sectional profile. To quantify the volume of sediment removed from selected portions of the river, USACE collected pre- & post-dredging bathymetric data along closely-spaced bank-to-bank transects. These digital data sets were used to draw cross-sections of the river between Hamburg Street and the Concrete Central Elevators. Documentation of changes in channel width and depth (cross-sectional area) were obtained by comparing the cross-sections before and after dredging. These findings are augmented by side-scan sonar records collected annually over the same period. By comparing pre- & post-dredging side-scan sonar records for sections of the river, it is seen that the sedimentary furrows quickly reform following dredging. *Keywords: Bottom currents, Sediments, Lake Erie.*

LEKKI, J.[1], LIOU, L.C.[1], TOKARS, R.[1], ANDERSON, R.[1], LESHKEVICH, G.A.[2], RUBERG, S.A.[2], ORTIZ, J.D.[3], SHUCHMAN, R.A.[4], BECKER, R.H.[5], and BENKO, T.[6], [1]NASA Glenn Research Center, 21000 Brookpark Rd., Cleveland, OH, 44050; [2]NOAA GLERL, Ann Arbor, MI; [3]Kent State University, Kent, OH; [4]Michigan Technology Research Institute, Ann Arbor, MI; [5]University of Toledo, Toledo, OH; [6]OhioView, Kirtland, OH. **Airborne Hyperspectral remote sensing of Harmful Algal Blooms in western Lake Erie.**

A coordinated airborne and ground campaign to obtain hyperspectral remote sensing data of Harmful Algal blooms (HABs) and wetlands was conducted in western Lake Erie during August and September 2014. During this campaign, coincident airborne hyperspectral data, water sampling and ground based optical measurements were obtained on numerous dates with significantly varying conditions. A description of the breadth of data obtained, initial results and discussion of efforts to streamline HAB condition monitoring results will be presented. *Keywords: Harmful algal blooms, Remote sensing, Great Lakes basin.*

LENAKER, P.L.[1], CORSI, S.R.[1], BORCHARDT, M.A.[2], SPENCER, S.K.[2], BALDWIN, A.K.[1], and LUTZ, M.A.[1], [1]U.S. Geological Survey, 8505 Research Way, Middleton, WI, 53562; [2]U.S. Department of Agriculture, 2615 Yellowstone Dr., Marshfield, WI, 54449.
**Hydrologic, Land Use and Seasonal Patterns of Waterborne Pathogens in Great Lakes Tributaries.**

Great Lakes tributaries deliver waterborne pathogens from a host of sources. In this GLRI study, eight Great Lakes tributaries with various land use classifications were studied from 2011 to 2013. To characterize waterborne pathogens and assess hydrologic variability, land use and seasonality, 290 samples were collected in all seasons during low-flow (101) and runoff event (189) periods. Twenty-two pathogens were measured, including eight human-specific viruses, four pathogenic bacteria, two protozoa, and eight bovine-specific viruses. Among all samples, human viruses occurred in 17%, bovine viruses 18% and bacteria 1.4%; no protozoa were detected. Overall, mean concentrations for the sum of all human, bovine viruses and bacteria were 4.9, 25.6 and 0.16 genomic copies/L, respectively. Urban watersheds had the highest human virus occurrence (34%), while agricultural watersheds, where dairy farming was most prevalent, had the highest bovine virus occurrence (51%). Hydrologic variability had an effect on human and bovine virus concentration and occurrence; however, results varied across the eight tributaries. Human virus concentrations were highest during summer runoff events, but occurrence was greater during winter and spring low-flow conditions. Bovine virus concentrations and occurrence were highest during winter events. *Keywords: Tributaries, Waterborne pathogens, Great Lakes Restoration Initiative (GLRI), Human-specific viruses, Environmental contaminants, Bovine-specific viruses.*

LENTERS, J.D.[1], READ, J.S.[2], SHARMA, S.[3], O'REILLY, C.M.[4], HAMPTON, S.[5], GRAY, D.K.[6], MCINTYRE, P.B.[7], HOOK, S.J.[8], SCHNEIDER, P.[9], and GLTC-CONTRIBUTORS, I.[10], [1]LimnoTech, Ann Arbor, MI; [2]USGS, Middleton, WI; [3]York University, Toronto, ON; [4]Illinois State University, Normal, IL; [5]Washington State University, Pullman, WA; [6]California University of Pennsylvania, California, PA; [7]University of Wisconsin-Madison, Madison, WI; [8]NASA Jet Propulsion Laboratory, Pasadena, CA; [9]Norwegian Institute for Air Research, Kjeller, NORWAY; [10]Global Lake Temperature Collaboration, Ann Arbor, MI. **Global Records of Lake Surface Temperature Reveal a Century of Warming.**

Recent studies have shown significant warming of inland water bodies throughout the world. To better understand the patterns, mechanisms, and ecological implications of global lake warming, an initiative known as the "Global Lake Temperature Collaboration" (GLTC) was started in 2010, with the objective of compiling and analyzing lake temperature data from numerous in situ and satellite-based records dating back at least 20-30 years. The GLTC project has now assembled data from over 300 lakes, with some in situ records dating back more than 100 years. Here, we present an analysis of the long-term warming trends, interdecadal variability, and a direct comparison between in situ and remotely sensed summer lake surface temperatures from 1895-2009. The results show consistent trends of lake surface warming across most but not all sites. A few "hotspots" of warming are identified around the globe, including the Laurentian Great Lakes. Some lakes with especially long records show accelerated warming in the most recent two to three decades. Almost half

of the world's lake surfaces are warming at rates in excess of 0.5 °C per decade during the period 1985-2009, and a few even exceed 1.0 °C per decade. *Keywords: Climate change, Water temperature, Global warming, Air-water interfaces.*

LEON, L.F.[1], YERUBANDI, R.[1], BOCANIOV, S.A.[2], and MCCRIMMON, C.[1], [1]Environment Canada - WSTD, Burlington, On, L7R 4A6; [2]Graham Sustainability Institute - U of Michigan, Ann Arbor, MI. **On the simulation of algal blooms in Lake Erie / Modeling Phytoplankton Events.**

Lake Erie exhibits large algal blooms caused by a combination of favoring weather conditions and excessive nutrient loadings into the lake. Tributary nutrient loadings have the potential to enhance algal growth, which is also enhanced by physical processes in the lake. The external forcing drivers (timing of the hydrological discharges and meteorology) are assumed to play a major role in the extent and intensity of the blooms. Hydrodynamic and water quality models applied to aquatic ecosystems allow for the simulation of the behavior of such complex interconnected systems. In this study we used a coupled 3D hydrodynamic and water quality model (ELCOM-CAEDYM), which has been reasonably calibrated for Lake Erie in previous applications, to evaluate its capability to reproduce phytoplankton blooms. The modeling assumptions, findings, challenges, and recommendations for future research are presented. *Keywords: Water quality, Hydrodynamic model, Lake Erie.*

LEPAK, R.L.[1], YIN, R.S.[1], DEWILD, J.F.[2], OGOREK, J.M.[2], TATE, M.T.[2], THOMPSON, C.D.[2], KRABBENHOFT, D.P.[2], and HURLEY, J.P.[1], [1]University of Wisconsin-Madison, Environmental Chemistry and Technology Program, 660 North Park Street, Madison, WI, 53706; [2]Wisconsin Water Science Center, United States Geological Survey, 8505 Research Way, Middleton, WI, 53562. **Utilizing Ambient Mercury Stable Isotopes in Lake Erie.**

The diverse trophic gradient and multiple mercury (Hg) sources in Lake Erie present an ideal setting to apply Hg stable isotopes to help refine our understanding of Hg sources, pathways and processes. We applied multi-collector inductively coupled plasma mass spectrometry to elucidate Hg sources to Lake Erie sediment. Our measurements revealed decreasing total mercury (HgT) concentrations (676 - 82 ng/g) along a west to east gradient, and large isotopic variations of $\delta^{202}$Hg (-1.28 to -0.17 ‰). A triple mixing model indicated that the primary contributor of Hg to the west basin sediment is watershed (tributary) derived; the central basin sediment is dominated by industrial sources; and that the east basin sediment reflected equal influence of industrial- and watershed-derived Hg. Results of a similar mixing model to infer the relative importance of various Hg sources will be presented on suspended particles, filter-passing aqueous samples, and the lower food web. Initial findings indicate that source attribution differs significantly among these environmental media. The varying isotopic Hg signatures of these components will allow researchers to better understand the source specific impacts on the aquatic ecosystem. This is important to natural resource management and restoration decisions. *Keywords: Mercury, Lake Erie.*

LESHKEVICH, G.A.[1] and NGHIEM, S.V.[2], [1]1NOAA/Great Lakes Environmental Research Laboratory, 4840 South State Road, Ann Arbor, MI, 48108; [2]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, MS 300-235, Pasadena, CA, 91109. **Preliminary Assessment of Sentinel-1 SAR Data for Great Lakes Ice Type Classification and Mapping.**

Using our library of calibrated polarimetric synthetic aperture radar (SAR) ice backscatter signatures, an algorithm was developed to classify and map major Great Lakes ice types using SAR data. Although initial algorithm validation using RADARSAT-1 data showed that the algorithm correctly classified ice types in the library, open water was often misclassified owing to the ambiguity encountered in single polarization data due to variations in wind speed and direction over water. Radarsat-2 co-polarization data was then used to create an ice/water mask for both small and large incidence angles encountered in the data. During March/April 2014 an operational demonstration was conducted on Lake Superior aboard the USCGC Mackinaw. Using Radarsat-2 data, ice type classification charts were downloaded to the icebreaker in near real-time. Ice/water masks for the Radarsat-2 ScanSAR Wide mode data were created by the National Ice Center (NIC) to identify open water with subsequent classification of ice types in the imagery by incident angle using our library of signatures. Sentinel-1, a European C-band SAR satellite, was launched in April 2014. A preliminary assessment of Sentinel-1 data shows that it can also be used with our library of ice backscatter signatures to classify and map Great Lakes ice types. *Keywords: Remote sensing, Satellite technology, Ice.*

LESHT, B.M.[1], BARBIERO, R.P.[2], and WARREN, G.J.[3], [1]CSC and Univiersity of Illinoit at Chicago, 845 W. Taylor St., Chicago, IL, IL, 60607; [2]CSC, 1359 W. Elmdale Ave, Suite 2, Chicago, IL, 60660; [3]USEPA Great Lakes National Program Office, 77 W. Jackson Boulevard, Chicago, IL, 60604. **Mind the Gaps: Using Satellite Observations to Enhance Great Lakes Water Quality Monitoring Programs.**

Although there is no substitute for ship-based direct sampling of water quality in the Great Lakes, resource limitations restrict the possible spatial and temporal scope of such monitoring programs, particularly given the scale of the system. As a result, interpreting the data collected by these programs can be complicated by questions about their temporal and spatial representativeness. On the other hand, though limited to estimates of only a few variables and by cloud cover, satellite observations can provide measurements that are frequent, synoptic, and have high (~ km) spatial resolution. We have been using satellite observations to enhance the regular water quality monitoring surveys conducted by the Great Lakes National Program Office (GLNPO) of the U.S. EPA. Not only do satellite observations help put the field surveys into spatial and temporal context, allowing us to assess the relationship between the sampling and the annual lake cycles, using satellite data in conjunction with the field observations makes it possible to address issues as diverse as the assessing long-term changes in lake productivity, defining the annual phytoplankton cycle, and evaluating the influence of transient events on lake processes with more detail and confidence. *Keywords: Water quality, Monitoring, Remote sensing.*

LEWIS, C.F.M.[1] and ANDERSON, T.W.[2], [1]Geological Survey of Canada Atlantic, Natural Resources Canada, 1 Challenger Drive (Bedford Institute of Oceanography), Dartmouth, NS, B2Y 4A2; [2]Geological Survey of Canada, Natural Resources Canada (retired), 25 Dexter Drive, Ottawa, ON, K2H 5W3. **Sediment Sequences in Manitoulin Island's South Bay: a Record of Lake Huron's Ups and Downs.**

South Bay on the southern coast of Manitoulin Island is a fiord-like embayment which is protected from Lake Huron waves by a land (barrier) extension from the west. A natural gap permits water circulation between Lake Huron and the Bay. Seismic and acoustic profiles, and pollen, plant macrofossil, and grain size analyses of piston cores from a shallow outer basin provide evidence of high-amplitude lake-level variation since deglaciation about 13,000 years ago, revealing sediment sequences of (1) laminated clay, (2) inter-layered silty clay with marsh deposits, overlain by (3) sand grading up to silty clay, all separated by erosive unconformable sequence boundaries. The sequences relate to the regional evolution of water levels which ranged from (1) submergence by high-level glacial Lake Algonquin, through (2) early Holocene alternating lowstands (Stanley phases) and highstands (Mattawa phases), to (3) a second submergence (mid Holocene Nipissing Great Lakes) followed by emergence to the present land-lake configuration. The erosive unconformities were likely formed when Lake Algonquin fell to the initial Stanley lowstand phase, and when the intermediate-level Nipissing phase rose above the protective land barrier, allowing its strong wave action to erode and redistribute previously-deposited sediment. *Keywords: Paleolimnology, Manitoulin Island, Lake Huron, Sediments.*

LI, J., HAFFNER, G.D., and DROUILLARD, K.G., GLIER, University of Windsor, 401 Sunset Ave, Windsor, On, N9B3P4. **Hg and PCB accumulation of wild bluegill from five lakes at varying latitudes.**

Multiple sizes (0.1 to 130.9g) of bluegill (*Lepomis macrochirus*) were collected in August and October 2006 from Apsey Lake (46.2175°N, 81.7689°W), Sharbot Lake (44.7667°N, 76.6833°W), the Detroit River (42.2167°N, 83.1333°W), Stonelick Lake (39.2203°N, 84.0725°W), and Lake Hartwell (34.4652°N, 82.8455°W). Our hypothesis is: contaminants accumulation by bluegill is slower in warmer water due to growth dilution. Each individual was homogenized and analyzed for moisture, lipid content, and total Hg, followed by PCBs and stable isotope analysis. The mean total Hg concentrations in bluegills were 0.17±0.08, 0.25±0.08, 0.38±0.09, 0.16±0.08, and 0.23±0.12 µg•g-1 dry wt for Apsey Lake, Sharbot Lake, the Detroit River, Stonelick Lake, and Lake Hartwell, respectively. Hg concentrations in bluegills were positively correlated to body weight for all waterbodies, except the Detroit River. The slope of Hg concentration and body weight for different waterbodies is as follows, in order of decreasing magnitude: Lake Hartwell> Apsey Lake> Stonelick Lake> Sharbot Lake> the Detroit River. Hg concentration was also positively related to δ15N of bluegills from Apsey Lake, Stonelick Lake, and Sharbot Lake, but not from the Detroit River and Lake Hartwell. PCB results will be also discussed during our presentation. *Keywords: Varing latitude, PCBs, Wild bluegills, Mercury, Bioaccumulation.*

LI, J.[1], MOLOT, L.A.[1], SHARMA, S.[1], PALMER, M.[2], WINTER, J.[2], YOUNG, J.[2], and STAINSBY, E.[2], [1]York University, 4700 Keele St., Toronto, ON, M3J1P3; [2]Ontario Ministry of the Environment, 125 Resources Road, Toronto, ON, M9P3V6. **Multiple drivers impact on phytoplankton composition in Lake Simcoe, ON, Canada, 1980-2012.**

Phytoplankton are excellent water quality indicators as their short doubling times permit rapid responses to environmental changes. We examined the impact of thermal regime (S), water chemistry, invasive zebra mussels (ZM) and temporal oscillation patterns on phytoplankton composition in Lake Simcoe from 1980-2012. Redundancy analyses found that environmental variables (S, TP, Secchi, Si) and ZM were significantly correlated with phytoplankton composition. Using variation partitioning, we showed that environmental variables and ZM individually explained little variance in phytoplankton composition but collectively explained 28%, indicating ZMs acted on phytoplankton composition indirectly by changing the environmental conditions; 4, 5, 7-year-cycle independent temporal patterns generated by moran's eigenvector maps were significantly correlated with phytoplankton composition and uniquely explained 8% of the variation in phytoplankton composition, indicating that large-scale climatic cycles such as El Niño Southern Oscillation, North Atlantic Oscillation, and solar sunspot cycle, individually and/or collectively, may have been responsible for phytoplankton composition change. We concluded that S, nutrients, water clarity, invasive species, and climatic oscillations collectively altered phytoplankton composition in Lake Simcoe. *Keywords: Lake Simcoe, Algae, Zebra mussels.*

LIANG, A.[1], CUI, Y.[1], FATHOLLAHZADEH, H.[1], CHEN, E.[1], CONTENTO, F.[1], WATSON, S.B.[2], MONREY, A.[3], and DITTRICH, M.[1], [1]Department of Physical and Environmental Sciences, University of Toronto Scarborough, 1265 Military Trail, Scarborough, ON, M1C 1A4; [2]Environment Canada, Watershed Hydrology and Ecology Research Division, 867 Lakeshore Road, Burlingto, 867 Lakeshore Road, Burlington, ON, L7R 4A6; [3]Ontario Ministry of Environment, 900 Bay Street, Toronto, ON, M7A 1N3.
**Internal Phosphorus Loading in the Bay of Quinte 2014: Field and Laboratory Studies.**

The Bay of Quinte affects 19 provincially significantly wetlands (PSWs) and 400,000 residences among the areas. It was designated as an Area of Concern (AOC) in 1986 due to the degradation of water quality. High phosphorus (P) concentration has been associated with excess productivity and algal growth. Although the external P loading sources were restrained by government, the P concentration in the lake remains high. Despite the fact that P concentration could stimulate algal bloom, little is known about P internal loading. This study aims to understand the P binding forms and their impacts to the overall P internal loading. Sediments cores from three stations (Hay Bay, Belleville, Napanee) were collected four times during 2014. Oxygen, pH and redox potential profiles were monitored by microsensors. P binding forms were determined by a sequential extraction of sediment. Pore-water and solid matters were analyzed for nutrient and metal contents. The P fluxes have been calculated and related to geochemical conditions. The P binding forms and their impact on P internal loading have been analyzed. *Keywords: Bay of Quinte, Sediment control, Phosphorus.*

LIETZ, J.[1], GRAYSON, T.S.[2], HANSEN, V.[3], and HINCHEY, E.[4], [1]United States Environmental Protection Agency, Mid-Continent Ecology Division, ORISE Participant, 6201 Congdon Boulevard, Duluth, MN, 55804; [2]United States Environmental Protection Agency, Office of Water, Washington, DC; [3]United States Environmental Protection Agency, Gulf Ecology Division, Retired, Gulf Breeze, FL; [4]United States Environmental Protection Agency, Great Lakes National Program Office, Chicago, IL. **2010 NCCA**

**Oligochaete Trophic Index Results to Inform Benthic Index Development for the Great Lakes.**

Over 400 sites were sampled in the nearshore of the U.S. Great Lakes during the National Coastal Condition Assessment (NCCA) field survey in summer 2010. To assess benthic ecological condition, 393 PONARs were attempted, and collected macroinvertebrates were identified and enumerated. Biological condition at each site was classified as good, fair or poor using the Oligochaete Trophic Index (OTI). The Great Lakes coasts were then classified by calculating percent area within a condition class: good (20.3%), fair (11.6%), and poor (18.0%). Due to unsuccessful PONARs, unclassified oligochaetes or no oligochaetes captured, 50.1% of the sampled area was classified as missing. In order to help focus future discussion and development of a Great Lakes benthic index, OTI results were compared to other traditional biotic integrity indices. In addition, unclassified sites were examined to determine possible methods or metrics that could prevent missing data in a newly developed index. *Keywords: Benthos, Great Lakes basin, Bioindicators.*

LINARES, A.[1], WU, C.H.[1], ANDERSON, E.J.[2], and ANDERSON, J.D.[1], [1]University of Wisconsin, Madison, Madison, WI, 53703; [2]NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI. **Role of High Frequency Water Level Oscillation on Contaminated Sediment Transport in Lake Michigan.**

Contaminated sediments is a significant environmental problem that impairs the uses of many water bodies and is often a contributing factor to fish consumption advisories that have been issued nationwide. The Manistique River is listed by the USEPA as an Area of Concern (AOC) due to its high contaminated sediment concentration. In this talk, we will examine contaminated sediment resuspension caused by the so-called High Frequency Water Level Oscillations (HFWLOs), with periods ranging from a few minutes to 2 hours. Extensive field observations show that HFWLOs up to 3.5 ft were associated with the cross of traveling atmospheric disturbances over Lake Michigan. Since HFWLOs are long waves, the bottom shear stresses induced by HFWLOs can exceed the critical condition to resuspend bottom sediments in even deep water environment. Due to their oscillatory nature, HFWLOs can temporarily reverse flow in the Manistique River and transport contaminated sediments upstream to previously cleaned areas. A coupled hydrodynamic and contaminated sediment model for the Manistique River is developed to assess the residence time of contaminated sediments under the effects of HFWLOs. Overall the outcomes of this study aid to address the sustainable remediation plan of contaminated sediments in river estuary AOC of the Great Lakes. *Keywords: Long waves, Residence time, Atmospheric disturbances.*

LINI, A. and BELROSE, A., University of Vermont Geology Department, 180 Colchester Avenue, Burlington, VT, 05405. **New Insights on the Champlain Sea-Lake Champlain Transition from Shallow Bay Sediments.**

Lake sediments retain information on ecosystem changes within a lake and surrounding watershed. Thus, a multi-proxy analysis of sediment cores is a useful means of creating paleoenvironmental reconstructions. Cores retrieved in Missisquoi and St. Albans Bays, two shallow bodies of water located along the Northeast Arm of Lake Champlain, encompass the last 9,600 years of the lake's history. The transition from Champlain Sea to Lake Champlain was captured in both bays, thus providing the opportunity to investigate the shift from a marine to a lacustrine environment. The end of the Champlain Sea stage and the onset of Lake Champlain were controlled by isostatic rebound, and accompanied by significant changes in water level. Our analyses demonstrate that these two shallow water bodies responded differently to water level change, specifically during the transitional period. The St. Albans Bay record encompasses a peat layer, which we interpret as evidence for a wetland occupying the bay during the earliest Lake Champlain phase. Based on the location of the peat layer in the core, we estimate a 7-8 m water level rise in the bay since 9600 cal yBP. Analysis of diatom assemblages in the peat layer allow us to examine in detail the progressive freshening over the course of the transition from marine to lacustrine environment. *Keywords: Paleolimnology, Lake Champlain, Sediments, Champlain Sea, Holocene.*

LIU, X., QIAN, K.M., XU, C.P., and CHEN, Y.W., Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing, CHINA. **Nutrients and chlorophyll a responses to water level fluctuations in Poyang Lake, China.**

As one of the few remaining lakes that is freely connected with the Yangtze River, Poyang Lake exhibits a unique aquatic ecology embedded in a floodplain which is different from the disconnected lakes. Weekly samples were collected at five sites in the north of Poyang Lake from September 2011 to December 2012, investigating the effects of different water level on nutrients and phytoplankton chl a concentrations. According to the multivariate analysis of limnological parameters two principal periods, the low water level(non-growing season) and the high water level period(growing season) were found. These results were in accordance with correlations among individual parameters revealing that chl a concentrations(annual average = 8.88±5.74 μgL-1) were strongly related to WLFs($p < 0.01$) and temperature($p < 0.01$) indicating the annual peak development of chl a during the growing season. The co-variation of chl a and Secchi depth transparency($p < 0.01$), no significance between chl a and total phosphorus(TP), the inverse variation between chl a and total nitrogen(TN, p =0.0007) and between chl a and the TN/TP ratio(p =0.011, favoring summer cyanobacteria) that was seasonally driven by decreasing TN(and not increasing TP) were different from the seasonal pattern what is commonly expected from shallow lakes of permanent lentic basins. *Keywords: Algae, Great Lakes basin, Nutrients.*

LIU, Y.[1], LEON, L.F.[2], YANG, W.[1], WONG, I.[2], MCCRIMMON, C.[2], and DOVE, A.[2], [1]University of Guelph, Guelph, ON; [2]Environment Canada, Burlington, ON. **Hydrologic Modeling and Evaluation of BMP Scenarios for the Grand River Watershed in Ontario.**

The Grand River is the largest river in southern Ontario feeding Lake Erie with water, sediment and nutrients. Understanding the watershed hydrological processes is crucial in supporting decision making on reducing non-point source pollution in the watershed. In this study, the Soil and Water Assessment Tool (SAWT) is adapted and applied to the Grand River watershed to simulate hydrologic processes based on available geospatial, climate, management, flow, and water quality data; including latest event sampling conducted by EC. The SWAT model predicts flow, sediment and nutrient concentrations. The calibrated model is then used to evaluate Beneficial Management Practice (BMP) scenarios including nutrient management, riparian buffer strips, cover crop, and wetland restoration. The evaluation results show the impact of BMPs on the nutrient reduction at the watershed outlet depending on their implementation scale and extent. The SWAT modeling, findings, challenges, and recommendations for future research are presented. *Keywords: Model studies, Water quality, Grand River.*

LOFGREN, B.M. and ROUHANA, J., NOAA Great Lakes Env Res Lab, 4840 S State Rd, Ann Arbor, MI, 48108. **Reaffirming Strong Systematic Bias in Projections of Climate Change Impacts on Lake Levels.**

A previous publication showed that a method that has long been used for projecting climate change impacts on lake levels, almost to the exclusion of other methods, strongly overpredicts increases in evapotranspiration (ET) from the land portion of the Great Lakes basin. The arguments put forward in that paper fell along three main lines: Unbalanced surface energy budget; ET being *de facto* calibrated based on the relation between air temperature and ET on the annual cycle, but not other modes of variability, including human-cased climate change; and an appeal at the gut level based on several-fold increases in potential ET. Our results were only weakly acknowledged by the National Climate Assessment, with the editors' stated reason being that there needed to be a large number of

model ensemble members to quantify and demonstrate statistical significance of the results. Our new results show positive biases in ET under the traditional method relative to our alternative energy-conserving method, with statistical significance better than one part in 10 million. Discrepancies in lake level projections range up to a full meter, with the largest discrepancies occurring when driving the model with large increases in temperature. This temperature dependency in the bias results in a smaller spread in lake level among GCMs.
*Keywords: Climate change, Surface heat budget, Hydrologic budget.*

LONGSTAFFE, F.J. and HLADYNIUK, R., The University of Western Ontario, 1151 Richmond Street, London, ON, N6A5B7. **Oxygen Isotope Variations in Pleistocene and Holocene Clay Mineral Assemblages from the Great Lakes.**

We have determined the mineralogy and oxygen isotopic compositions of clay assemblages from Lake Superior (10,546-3,315 cal BP) and Lake Ontario (15,035-5,701 cal BP). In western Lake Superior, the <2μm fraction is dominated by 1.0 and 0.7nm clays but also contains significant quantities of clays with swelling properties (1.7 > 1.4nm). In eastern Lake Superior, the assemblage is similar, except that the abundances of 1.7 and 1.4nm clays are about equal. In western and central Lake Superior, the clay assemblage has an oxygen isotopic composition of +10.5±0.5‰. In eastern Lake Superior, the oxygen isotopic composition increases from +9.7‰ at 10,434 cal BP to +12.4‰ at 574 cal BP. In eastern Lake Ontario, the <2μm fraction is characterized by 1.0 ≈ 0.7 > 1.4 >> 1.7nm in sediments younger than ~13,000 cal BP and by 1.0 ≈ 0.7 > 1.7 ≈ 1.4nm in older sediments. There is an increase in oxygen isotopic composition from +10.7±0.5‰ in the oldest sediments to +13.7±0.4‰ in the youngest. These variations reflect changes in contributions from clay sources in space and time across the Great Lakes basin, and in the oxygen isotopic composition of meteoric water during formation of the soil clays prior to deposition.
*Keywords: Great Lakes basin, Clay mineral assemblages, Isotope studies, Paleolimnology.*

LOWE, S.E., Earth Resources Technology under contract to the NOAA Marine Debris Program, Oak Harbor, OH. **2014 Progress Summary of the Great Lakes Marine Debris Action Plan.**

Marine debris is any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes. Throughout the Great Lakes, marine debris threatens wildlife, natural resources, and the environment. Coordinated by NOAA and launched in 2014, the Great Lakes Land-based Marine Debris Action Plan is bringing science, government, industry and NGOs together in a regional partnership to clean up the Great Lakes. The plan's five-year goal: to research the problem of marine debris, guide science-based policies and management decisions, and coordinate actions to prevent and reduce marine debris. The action plan consists of 53 actions which are to be completed within five years (2014-2019). During the first year of the plan, contributors began work on 24 actions and successfully completed two. Information presented will include highlights from the first annual progress report as well as the plan's alignment with other national and international efforts on marine debris. *Keywords: Microplastics, Planning, Great Lakes basin.*

LUCIDO, J.M., MARSH, C., USELMANN, D., and EVERMAN, E., Center for Integrated Data Analytics U.S. Geological Survey, 8505 Research Way, Middleton, WI, 53562. **Tools for Management and Communication of GLRI Projects and Scientific Products.**

The Great Lakes Restoration Initiative (GLRI), through an adaptive management process, is focused on the protection and restoration of the Basin; however this process relies on a thorough understanding of historical and current scientific activities. Moreover, given the number of organizations undertaking these activities the coordination of projects and the communication of scientific findings is a significant challenge for the Great Lakes community, including the U.S. Geological Survey. To improve communication of USGS GLRI project findings a dynamic and user-friendly web application was developed to allow users to both browse and search for information about these projects and their related products, such as publications and datasets. Since the content is managed by multiple people and science centers, the ScienceBase system was used as the website's central content management system (CMS). The benefit of the CMS is that the website content may be managed in real-time by multiple people and made available for integration into partner websites, for example SiGL Mapper, via a web service. These tools assist GLRI efforts by helping scientists and managers strategically plan, implement, and analyze their monitoring and restoration activities by providing easy access to information about USGS GLRI projects and science products. *Keywords: Coordination, Great Lakes Restoration Initiative (GLRI), Data storage and retrieval, Data Management.*

LUOMA, J.A.[1], WALLER, D.L.[1], WEBER, K.L.[1], SEVERSON, T.J.[1], and MAYER, D.A.[2], [1]USGS-UMESC, 2630 Fanta Reed Road, LaCrosse, WI, 54603; [2]NYSED, 51 Fish Hatchery Road, Cambridge, NY, 12816. **Efficacy and Application of Zequanox® in USGS Field Trials.**

The USGS' Upper Midwest Environmental Sciences Center (UMESC) initiated joint research with the New York State Museum Field Research Laboratory (Cambridge, NY) and the USFWS' Genoa National Fish Hatchery in 2010 to evaluate a potential new use for Zequanox®; to manage dreissenid mussel populations impacting native mussel propagation and restoration efforts. In addition to non-target animal studies, this work involved conducting lake-side field efficacy and application trials in 2012 at expected treatment concentrations and exposure durations in order to evaluate the efficacy of Zequanox for killing dreissenid mussels and the use of subsurface Zequanox applications. These studies indicated the potential for a significant dreissenid mussel kill (≥ 87%), with as little as 6 hours of exposure at 50 mg/L, and the potential for using subsurface application methods to reduce the amount of Zequanox applied. Additional in-lake studies were conducted (within enclosures) in 2013 to evaluate the use of Zequanox to control dreissenid mussels adhering to native mussels; and in 2013-14 to further evaluate the use of subsurface application techniques. An overview of the results from these studies, logistical challenges, and future research needs will be discussed. *Keywords: Invasive species, Zequanox®, Zebra mussels, Management.*

LUTSKY, K.O., Austin E. Knowlton School of Architecture,The Ohio State University, 275 West Woodruff Ave, Columbus, OH, 43210. **The Design of Urban Rivers for the Great Lakes Basin.**

The role of the rivers of the Great Lakes Basin as collectors and connectors are essential to the ecological, economic, and social health of the cities and lakes they support. These roles have long been considered and planned for separately, both physically and functionally. In urban centers however, these roles tend to collide. In the Great Lakes Basin, there are over 20 rivers listed as EPA Areas of Concern. The industrial legacy of many Great Lakes cities has left many riverfronts over-structured, contaminated, and inaccessible. At a time of expanding issues of climate change, population growth, and habitat loss, there is a dire need for greater consideration of how river designs are able to address multiple social, ecological, and economic functions. This presentation will introduce and discuss some of the recent successes and pitfalls of local and international riverscape projects. It will examine issues of adaptability, access, and resilience in the landscape architectural design of urban river edges and discuss the spatial and functional considerations that might be best appropriated for future, successful riverscape designs in the Great Lakes Basin. *Keywords: Urban rivers, Adaptable design, Landscape architecture.*

LYANDRES, O.[1], SAMANTA, A.[2], and BRENNAN, T.[1], [1]Alliance for the Great Lakes, Chicago, IL; [2]Cleveland State University, Cleveland, OH. **Enabling change: collaboration to achieve nutrient reductions in the Lower Fox River watershed.**

Through this study, we explore the various social factors that shape the decisions to implement conservation practices in the Lower Fox River watershed and gain an understanding of farmers' interest and willingness to participate in and collaborate to address nutrient pollution. We use an action research approach to develop an understanding of the watershed and simultaneously engage the stakeholders. Within this approach, collaboration between researchers and community stakeholders is key to identify shared goals and priorities in addressing issues of common concern. Agricultural professionals in the watershed were an integral part of the research process by helping to design the survey, identify participants, and collect data. Their engagement and feedback contributed greatly to the analysis methodology and conceptual framework. We identified four value-based constructs as well as present conditions related to nutrient management that play important roles in perception and implementation of conservation practices to reduce nutrient loadings. We also found that there was significant interest among respondents to engage in more collaborative initiatives. The study informed the selection of target group of landowners for engagement and offered insights into landowners' approach to conservation and water. *Keywords: Management, Collaborative watershed planning, Green Bay, Conservation, Nutrients, Stakeholder engagement.*

# M

MADENJIAN, C.P.[1], YULE, D.L.[2], CHERNYAK, S.M.[3], BEGNOCHE, L.J.[1], BERGLUND, E.K.[4], and ISAAC, E.J.[5], [1]USGS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105; [2]USGS Great Lakes Science Center, Lake Superior Biological Station, 2800 Lakeshore Drive, Ashland, WI, 54906; [3]University of Michigan, 1420 Washington Heights, Ann Arbor, MI, 48109; [4]Ontario Ministry of Natural Resources, 435 James Street South, Thunder Bay, ON, P7E 6S8; [5]Grand Portage Band of Lake Superior Chippewa, 27 Stone Road, Grand Portage, MN, 55605. **Males exceed females in PCB concentrations of cisco (*Coregonus artedi*) from Lake Superior.**

We determined whole-fish polychlorinated biphenyl (PCB) concentrations of 25 male and 25 female age-7 ciscoes (*Coregonus artedi*) captured from a spawning aggregation in Thunder Bay, Lake Superior, during November 2010. We also determined PCB concentrations in the ovaries and somatic tissue of five additional female ciscoes.

Bioenergetics modeling was used to determine the contribution of the growth dilution effect toward a difference in PCB concentrations between the sexes. Results showed that the PCB concentration of males (mean = 141 ng/g) was 43% greater than that of females (mean = 98 ng/g), and this difference was highly significant ($P < 0.0001$). Mean PCB concentrations in the ovaries and the somatic tissue of the five females were 135 and 100 ng/g, respectively. Based on these PCB determinations for the ovaries and somatic tissue, we concluded that release of eggs by females at previous spawnings was not a contributing factor to the observed difference in PCB concentrations between the sexes. Bioenergetics modeling results indicated that the growth dilution effect could explain males being higher than females in PCB concentration by only 3 to 7%. We concluded that the higher PCB concentration in males was most likely due to a higher rate of energy expenditure in males. *Keywords: Fish toxins, PCBs, Pollutants.*

MAHLER, B.J.[1], VAN METRE, P.C.[1], INGERSOLL, C.G.[2], KUNZ, J.[2], KIENZLER, A.[3], DEVAUX, A.[3], and BONY, S.[3], [1]U.S. Geological Survey, 1505 Ferguson Lane, Austin, TX, 78751; [2]U.S. Geological Survey, 4200 New Haven Road, Columbia, MO, 65201; [3]Université de Lyon, rue Maurice Audin, Vaulx-en-Velin, F-69518, FRANCE. **Pavement Sealcoat, Polycyclic Aromatic Hydrocarbons (PAHs), and Water Quality of Urban Water Bodies.**

Coal-tar-based (CT) sealcoat is used to protect and beautify the asphalt pavement of driveways and parking lots primarily in the central, southern, and northeastern U.S. and in Canada. CT sealcoat typically is 20 to 35% crude coal tar or coal-tar pitch and contains from 50,000 to 100,000 mg/kg PAHs. PAH concentrations in fine particles (dust) from CT-sealcoated pavement are about 1,000 times higher than in dust from asphalt-sealcoated pavement (median total PAH concentrations 2,200 and 2.1 mg/kg, respectively). Acute 2-d toxicity testing of simulated runoff from CT-sealcoated pavement to a cladoceran (*Ceriodaphnia dubia*) and fathead minnows (*Pimephales promelas*) demonstrated that toxicity continues for samples collected for weeks or months following sealcoat application. Runoff collected as much as 36 days following CT-sealcoat application caused DNA damage and impaired DNA repair capacity in the fish-liver cell line RGL-W1. These results demonstrate that CT runoff is a potential hazard to aquatic ecosystems for at least several weeks after sealant application, and that exposure to sunlight can enhance toxicity and genetic damage. Recent research has provided direct evidence that restricting use of CT sealcoat in a watershed can lead to a substantial reduction in PAH concentrations in receiving water bodies. *Keywords: Phototoxicity, PAHs, Runoff, Urban areas, Toxic substances.*

MAKAREWICZ, J.C., SUNY Brockport, Brockport, NY, 14420. **Physical and Chemical Structure of the Nearshore of Lake Ontario.**

A weighted SeaBird CTD was towed horizontally in Lake Ontario at a depth of ~1 m from the mouth of Sandy Creek 8000 m to the offshore on thirteen dates. The SeaBird CTD was equipped with the following sensors: depth, temperature, turbidity, transmissivity, PAR, pH, chlorophyll a, dissolved oxygen, and conductivity and was connected to a laptop which acquired the sonde's data as well as a GPS (GlobalSat BU-353) data stream via Sea-Bird's Seasave data acquisition software. The objective was to describe the variability in physical and chemical nearshore structure over the spring, summer, and autumn period. Results are discussed for four sampling dates that include pre-thermal bar, thermal bar, summer thermal stratification, and a typical structure for the nearshore. These results demonstrate the significant variability in physical and chemical structure that occurs in the nearshore of Lake Ontario. *Keywords: Lake Ontario, Spatial distribution, Coastal processes.*

MALCOLM, G.O., JACKSON, D.A., and MANDRAK, N.E., University of Toronto, Toronto, ON. **An Objective Method to Quantify the Location Criterion used to Classify Species at Risk in Canada.**

Number of locations is an indicator often used in the conservation assessments of species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The guidelines on the definition and calculation of location have received criticism for their ambiguity, which could result in subjective calculations and improper assessments of conservation status. To examine the application of location, I summarized the use of locations in COSEWIC assessment reports of 86 Canadian freshwater taxa. I propose an alternative method for calculating location using a standardized geographic buffer. Simulations to test the applicability of the buffer were conducted in ArcGIS using distribution data, scale of the primary threat, and minimum area for viable population for 20 imperilled freshwater fish species of southern Ontario. The shape of the buffer is dependent on the species habitat and the primary threat to the species. My proposed objective method of calculating location will contribute to more accurate conservation assessments of species, and subsequent development and implementation of conservation strategies. *Keywords: Conservation, Species at risk, Risk assessment, COSEWIC, Fish.*

MALINICH, T.D.[1], ROSWELL, C.[2], POTHOVEN, S.[3], and HÖÖK, T.O.[1], [1]Purdue University, 195 Marsteller Street, West Lafayette, In, 47907-2033; [2]Illinois Natural History Survey, 17th Street, Zion, IL, 60099; [3]NOAA Great Lakes Environmental Research

Laboratory, 1431 Beach St, Muskegon, MI, 49441-1098. **Isotope and Diets for Perch and Goby Suggest Site-Specific Diet Specialization in Saginaw Bay.**

Many fish species, including yellow perch and round goby, display highly variable diet patterns, including spatial variation related to location-specific feeding patterns. Past analyses of yellow perch diets in Saginaw Bay, Lake Huron demonstrate consistent spatial differences in diet constituents. Such patterns may suggest that the Saginaw Bay food web is composed of spatially distinct sub-compartments. On the other hand, diet data are reflective of recent prey consumption and if individual fish move throughout the system, long-term diet variation among individuals may be negligible. Moreover, local prey specialization may not be consistent across species and life-stages. To evaluate site-specificity, we analyzed carbon, nitrogen, hydrogen and oxygen isotopes to look for long-term trends of fish residence. Our analysis of isotopes found that carbon and nitrogen differed significantly among sites. These isotopes are strongly related to diets of an individual and support our hypothesis of site-specific feeding fidelity. We often view aquatic systems to have homogenous fish populations, however our recent work supports the prevalence of smaller, separated sub-groups. This could have implications for management of Great Lakes fish, which most often occurs within a larger regional management unit. *Keywords: Stable isotopes, Saginaw Bay, Diets.*

MANDRAK, N.E., University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C1A4. **Fish Assemblages of the Great Lakes have Changed, but not Homogenized.**

As a result of the loss of native species and the spread of non-native species, fish communities are becoming increasingly homogenous globally. The native fish species richness in the Great Lakes exhibits a latitudinal gradient that reflects postglacial history and current climate. Since the 1800s, 21 native fish species have been extirpated in one or more of the Great Lakes basins as a result of habitat alteration and destruction, overexploitation, and invasive species. Over the same time period, 35 non-native species have become established in one or more of the basins as a result of authorized and unauthorized introductions. These changes to the Great Lakes fish fauna were used to develop species lists by decade for each of the Great Lakes basins. Changes in the fish fauna over time were measured within and between basins using Jaccard's similarity coefficient. Fish communities in Erie, Huron, and Superior basins have changed the most (~20%) and in the Ontario basin the least (~12%) since 1870. The similarity of fish communities among basins has averaged 66-69% per decade; however, the fish communities have not become more similar to one another over time; hence, they have not homogenized. *Keywords: Invasive species, Species diversity, Fish.*

MANLEY, T.O. and MANLEY, P., Middlebury College, 242 Bicentennial Way, Middlebury, VT, 05753. **Prehistoric Landslides and the Potential for Tsunami in Lake Champlain.**

Thirteen years of high-resolution CHIRP (compressed high intensity radar pulse) seismic reflection profiles combined with newer multibeam bathymetric data within Lake Champlain reveal the presence of an ever increasing number of slumps and landslides. With volume displacements ranging from 0.01 - 9 x106 m3 and horizontal translations from 10s of meters to as much as 1.5 km, they represent a wide spectrum of variability for the generation of tsunami. Two essential parameters for modeling of tsunami are the initial physical structure of the sediment mass before disturbance along with its subsequent vertical throw. Both of these could only be based on estimates obtained from both multibeam and CHIRP data. The Cornell ocean tsunami model (COMCOT) was modified for Lake Champlain and used to gather a basic understanding of surface wave dynamics and potential inundation of the shoreline regions within the Main Lake.

MANNINEN, C.L.[1], SEELBACH, P.W.[2], READ, J.G.[3], BUCKNER, K.A.[4], and EDER, T.[1], [1]Great Lakes Commission, 2805 South Industrial Hwy. Suite 100, Ann Arbor, MI, 48104; [2]USGS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105; [3]Univ. of Michigan Water Center, 214 S. State St., Suite 200, Ann Arbor, MI, 48104; [4]Council of Great Lakes Industries, 3600 Green Ct. #710, Ann Arbor, MI, 48105. **Great Lakes Blue Accounting: Empowering Decisions to Realize Regional Water Values.**

In 2013, the Great Lakes governors and premiers called for a comprehensive approach to monitoring Great Lakes water resources. In response, the Great Lakes Commission (GLC) convened a binational workgroup with broad expertise from the government, industry, academic and NGO sectors. Building on their collective wisdom, the GLC proposed adoption of Great Lakes Blue Accounting to the governors at their April 2014 summit in Chicago. The development of an information monitoring, strategy and delivery system that supports achievement of the region's priority water "outcomes" is vital and will be initiated through the Blue Accounting program. The August 2014 drinking water crisis in Toledo, Ohio, highlighted the need for a better system of monitoring, which, tied together with information about the quality and status of municipal water infrastructure, could provide greater predictability and vital information to anticipate, prevent and assist with response efforts in such emergencies. The priority "outcome," in the case of Toledo, is

safe and sustainable municipal water services. Even before the Toledo event, Municipal Water Supply had been chosen as a pilot for the Blue Accounting program. The full Blue Accounting report is accessible at glc.org/docs/2014-blue-accounting-recommentations-glc.
*Keywords: Monitoring, Water resources management, Water quality, Municipal water supply, Indicators, Information delivery system.*

MANNING, N.F., SMITH, S.D.P., DICKINSON, C., JOSEPH, C., and ALLAN, J.D., University of Michigan SNRE, 440 Church St., Ann Arbor, MI, 48109. **Lake Scale Planning: Unpacking Cumulative Stress and Ecosystem Services at Multiple Spatial Scales.**

Maps of environmental stressors across the Great Lakes allow visual comparison of regions of stress, but management decisions are often implemented at finer spatial scales. This research utilizes the Great Lakes Environmental Assessment and Mapping (GLEAM) project's stressor and ecosystem service (ES) maps to develop a data-driven approach to support spatially explicit management priorities at the scale of an individual lake and finer spatial resolutions. A range of spatial boundaries were selected to reflect both governmental and ecological divisions within Lake Erie. Several statistical tools (star plots, Gini index) were employed to identify priority stressors within sub-regions of Lake Erie. Stressor and ES delivery data were merged to create a prioritization of management activity at multiple spatial scales. We found that the assemblage of stressors that contribute to cumulative stress are locally specific, and coincide to varying degrees with ES and biodiversity targets that we value. Such analyses provide an integration of data and mapping that can help inform management priorities and offer a paradigm for use in the other Laurentian Great Lakes.
*Keywords: Lake Erie, Stressors, Management, Mapping, Ecosystems.*

MANOME, A.[1] and WANG, J.[2], [1]University of Michigan, 4840 S State Rd, Ann Arbor, MI, 48108; [2]NOAA-GLERL, 4840 S State Rd, Ann Arbor, MI, 48108. **Ice-Hydrodynamic Simulation with Data Assimilation of Satellite-Deriviced Ice Surface Temperature.**

Ice surface temperature of Lake Erie is one of several unknown variables that is important in determining the heat flux at the ice surface and the thermal growth of ice thickness. However it is difficult to measure over a large area, but can be measured via satellite under clear skies. We will conduct ice-hydrodynamic simulations with data assimilation of the ice surface temperature, which is derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor. The hydrodynamic model is based on the Princeton Ocean Model. The ice dynamic model employs the elastic-viscous-plastic rheology

for the ice internal stress and the one-dimensional ice thermodynamic model is used. The performance of the data assimilation will be evaluated by comparing the simulated ice extent and ice thickness with satellite and in-situ observations. *Keywords: Ice, Lake Erie, Model studies.*

MARCACCIO, J.V., MARKLE, C.E., and CHOW-FRASER, P., McMaster University, 1280 Main Street West, Hamilton, ON, L8S 4K1. **Unmanned Aerial Vehicles Produce High-resolution Seasonal Maps for Wetland Habitat Identification.**

With recent advances in technology, personal aerial imagery acquired with unmanned aerial vehicles (UAVs) has transformed the way in which ecologists can map wetland habitat through the season. In particular, major strides in GPS technology have allowed for easier flight plans to be charted, while first-person view (FPV) systems have decreased post-processing time and increased the quality of images, making UAVs easier to operate and capable of flying long distances. Using a consumer quad-copter, the DJI Phantom 2 Vision+, we have created a high- resolution (<8cm) photo composite, which has been manually georectified via ArcGIS. We used the quad-copter to acquire a summer image in 2014, which was more appropriate for mapping turtle habitat in a wetland than was available orthoimagery from the most recent Southwestern Ontario Orthoimagery Project (SWOOP), which corresponded to the spring of 2010. The UAV imagery could be used to identify wetland vegetation with similar or greater accuracy than with the SWOOP images. The price for this complete quad-copter system is less than $2,500 USD. New UAV regulations in Canada make this an easy and affordable way to obtain the best possible imagery of small (<1.0 km2 ) wetlands, or portions of larger wetlands. *Keywords: Vegetation, UAV, Wetlands, Habitats.*

MARCARELLI, A.M.[1], HUCKINS, C.J.[1], COBLE, A.A.[1], OLSON, J.C.[1], NICOLAS, G.[2], and AHO, R.[3], [1]Department of Biological Sciences, Michigan Technological University, 1400 Townsend Dr., Houghton, MI, 49931; [2]Houghton Keweenaw Conservation District, Houghton, MI, 49931; [3]USDA-NRCS, Houghton, MI, 49931. **Stream ecosystem process responses to stamp sand stabilization in tributaries of Lake Superior.**

Historical copper-rich mining residue in the form of stamp sands were deposited widely along streams and lakes in the Western Upper Peninsula and are an important source of pollution affecting Lake Superior and its tributaries. The Hills Creek Stamp Sand Stabilization project has taken an innovative approach to stabilize and vegetate riparian aggradations of stamp sand, with the ultimate goals of reducing copper concentrations and benefiting the riverine food web and fisheries. We aimed to enhance understanding of ecological responses to this restoration by measuring ecosystem processes (material retention, nutrient uptake, decomposition, primary production, respiration, and organic matter transfer to fishes) in restored and unrestored reaches of Hills Creek and in two adjacent rivers without stamp sands. We found that different processes respond to varying degrees to restoration activities. For example, ammonium uptake was rapid in the restored and all reference reaches, but not detected in an unrestored reach dominated by stamp sands. However, organic matter retention showed little difference among reaches, and was instead related to presence large woody material. Ecosystem processes may be useful for understanding the mechanisms underlying responses of fish populations and stream food webs to river restoration. *Keywords: Ecosystems, Streams, Great Lakes Restoration Initiative (GLRI), Stamp sand, Nutrients, Restoration.*

MARINO, J.A., JAMES, T.Y., and FAHNENSTIEL, G.L., University of Michigan, Ann Arbor, MI, 48103. **Spatio-temporal Patterns in the Fungal Community Associated with Lake Erie Harmful Algal Blooms.**

Recent record harmful algal blooms (HABs) in Lake Erie have been attributed in large part to a combination of nutrient inputs and climatic factors. However, additional environmental factors may also influence the magnitude of HABs but have received little attention. Fungal pathogens can strongly influence phytoplankton populations and are known to infect bloom-forming species, but the role of fungi in Great Lakes HABs is unknown. For this project, we took steps towards better understanding the role of fungi in Lake Erie blooms by characterizing the composition and dynamics of the fungal community during the 2014 L. Erie bloom. Samples were collected across the season at multiple sites and the fungal community characterized using next generation (PacBio RS II) sequencing. We found broad representation of several major fungal groups, including members of phyla (Chytridiomycota and Cryptomycota) known to include parasites of bloom-forming species, including *Microcystis aeruginosa*. Furthermore, we observed changes in the fungal community across sites and over time from the initiation of the bloom to its peak and subsequent decline. Our findings thus provide novel insights into the contribution of an understudied but potentially important component of the Lake Erie ecosystem. *Keywords: Microcystis, Microbiological studies, Harmful algal blooms.*

MARSDEN, J.E.[1] and LADAGO, B.J.[2], [1]University of Vermont, 81 Carrigan Dr., Burlington, VT, 05405; [2]Vermont Department of Natural Resources, 3696 Roxbury Rd, Roxbury, VT, 05669. **The Champlain Canal as an exotic species vector.**

Preventing exotic species invasions is vastly less expensive than post-invasion management; however, prevention requires identification of potential invasion vectors, and an understanding of which species might use those vectors. Of the 50 exotic species currently established in Lake Champlain, at least 40% entered the lake via the Champlain Canal. The 97 km canal was opened in 1823 and links Lake Champlain to the Hudson River and Great Lakes. We sampled a 16-km stretch of the canal and three dewatered locks using gillnets, electroshocking, hand nets, and hand-picking to document all fishes, plants, and molluscs present, both native and exotic. We collected 42 fish species, 25 plants, and 21 molluscs, including three molluscs that are not yet established in one of the connected ecosystems. All of the plants and over half of the fish species showed evidence of reproducing in the canal. The canal is not simply a connecting channel, it is a semi-natural ecosystem that supports a rich community of self-sustaining species; thus, invasions can occur by direct transit of species through the canal, or more likely by gradual colonization of the canal by populations of organisms. Prevention of future invasions will necessitate hydrological separation within the canal. *Keywords: Invasive species, Mitigation.*

MARTIN, M.L. and WEBB, K., Ryerson University, 350 Victoria St, Toronto, ON, M5B 2K3. **Adaptive Approaches to Governance in the Great Lakes Context: Beyond Command and Control Regulation.**

A number of scholars have noted the limitations associated with relying exclusively on conventional state-based command and control regulatory approaches to address complex, multi-jurisdictional and evolving environmental and other societal challenges in the 21st century (Ostrom et al., 1990; Webb, 2005). For this reason, there is increasing recognition of the value of more flexible and adaptive management and governance approaches, made possible by combining the energies and resources of government, industry and civil society actors, referred to by scholars variously, including participatory governance (Fung & Wright, 2001), collaborative governance (Innes & Booher, 2010), and sustainable governance (Webb, 2005). The purpose of this paper is to explore the potential applicability and implications of these governance frameworks in the context of remedial water quality protection of the Great Lakes, with a particular focus on two Great Lakes Remedial Action Plans (RAPs): the Toronto and Region RAP and the Hamilton Harbour RAP. The paper examines the roles, instruments, processes and interactions of relevant governments, the private sector and civil society involved in the remediation activities of the two RAPs, with a view to identifying the most appropriate governance framework to describe their governance activities. *Keywords: Hamilton Harbour, Environmental policy, Management.*

MARTY, J.[1], POTTER, S.[2], and LALUMIERE, C.[1], [1]WSP Canada, 2611 Queensview Drive, Suite 300, Ottawa, ON, K2B8K2; [2]SLRoss, 200 - 1140 Morrison Dr., Ottawa, ON, K2H8S9.
**Assessing the risk of marine spills in Canadian Great Lakes waters: oil and HNS.**

This study reports on the first risk assessment aiming to characterize the risk of marine spills of oil and hazardous noxious substances (HNS) in Canadian waters. Risk was defined as the product of the probability of a spill occurring and the potential impacts should a spill occur. These two elements were estimated for 4 regions of Canada, including the Great Lakes- St Lawrence River ecosystem. Oil spill frequency was estimated based on mean annual Canadian traffic and oil cargo volumes as crude oil and refined products. Oil spill frequencies were described according to four spill volume categories ranging from 10 m3 to ≥ 10,000 m3. HNS frequencies were expressed as mean annual volumes of 4 classes of chemicals. Impacts were estimated using an Environmental Sensitivity Index (ESI) based on geographic layers describing the physical, biological and human environments. The highest risk values for small to medium size spills of oil were observed in the St Lawrence River and in Lake Ontario. For HNS, the highest risk values were observed for organic and inorganic chemicals, close to large urban areas. Within each lake, nearshore areas had a higher risk compared to off shore areas. Results will be discussed based on data availability in the Great Lakes and in the light of the Canadian context. *Keywords: Risk assessment, Transportation, Toxic substances.*

MASH, H., DUGAN, N., SANAN, T., and LYTLE, D., US Environmental Protection Agency, 26 W. Martin Luther King Dr., Cincinnati, OH, 45268. **Impact of Harmful Algal Blooms on Several Lake Erie Drinking Water Treatment Facilities.**

Recent events in Ohio have demonstrated the challenge treatment facilities face in providing safe drinking water when encountering extreme harmful algal bloom (HAB) events. Over the last two years the impact of HAB-related microcystins on several drinking water treatment facilities with source water originating from Lake Erie were measured, during which time multiple bloom events were observed. The propagation of toxins through the treatment train were monitored using both LC-MS/MS and ELISA techniques, allowing for measurement of specific toxin varieties as well as the total toxin level. In addition, water quality parameters were measured to determine if correlations could be observed with HAB occurrence and intensity to provide improved guidance to treatment operators. From the determination of both extracellular and total toxin it appears that certain treatment techniques can effect toxin release prior to removal of intact cyanobacterial cells. Results also showed that effective conventional water treatment designed to reduce turbidity effectively

reduces intact algal cells provided the plant is operating properly. *Keywords: Drinking water, Harmful algal blooms, Lake Erie.*

MASON, A.M.[1], PANKO, J.[2], and KINGSBURY, T.[3], [1]American Chemistry Council, 700 Second St., NE, Washington, DC, 20002; [2]Cardno ChemRisk, 20 Stanwix Street, Suite 505, Pittsburgh, PA, 15222; [3]Cardno ChemRisk, 101 2nd St. Suite 700, San Francisco, CA, 94105.
**Hazard screening tools, how do they compare?**

This presentation will present the findings of a project that tested seven chemicals representing a breadth of chemistry having differing properties from natural to synthetic and from EPA identified as 'safe' to one with persistent and bioaccumulative characteristics. Each of these chemicals was assessed using leading hazard screening tools according to the tool provider's guidelines. The presentation will report the project findings and related suggest possible enhancements. *Keywords: Priority pollutants, Hazard screening tools, Environmental contaminants, Chemical assessments, Assessments, Chemical substitution.*

MATISOFF, G.[1], STEELY, R.[1], KALTENBERG, E.[1], HUMMEL, S.[1], SEO, J.[1], GIBBONS, K.J.[2], BRIDGEMAN, T.B.[2], SEO, Y.[2], JOHNSON, L.T.[3], EVANS, M.A.[4], CHAFFIN, J.D.[5], and DITTRICH, M.[6], [1]Case Western Reserve University, Dept. Earth, Environmental and Planetary Sciences, Cleveland, OH, 44106; [2]University of Toledo, Depts. Environmental Sciences, Chemical and Environmental Engineering, Lake Erie Center, Toledo, OH, 43606; [3]Heidelberg University, National Center for Water Quality Research, Tiffin, OH, 44883; [4]United States Geological Survey, 1451 Green Road, Ann Arbor, MI, 48105; [5]The Ohio State University, F.T. Stone Laboratory, Put-in-Bay, OH, 43456; [6]University of Toronto Scarborough, Department of Physical and Environmental Sciences, Toronto, ON, M1C 1A4. **Internal Loading of Phosphorus in Western Lake Erie.**

In western Lake Erie there is considerable uncertainty of the amount of phosphorus that is recycled to the water column by internal loading from the bottom sediments. This study was to obtain estimates using seven different techniques. We quantified directly the flux of phosphorus released during both (1) aerobic and (2) anaerobic incubations of whole cores and by (3) monitoring the water encapsulated in chambers placed on the lake floor. We measured the phosphate concentrations in the pore waters near the sediment water interface with (4) a phosphate microelectrode and (5) a colorized phosphate DET gel and calculated the diffusional flux from the sediment to the overlying water. We also used two (6,7) biogeochemical models to estimate the phosphate concentration gradient at the sediment water interface and hence the phosphate flux. Fluxes ranged from 0.007 to 36.6 mg/m2/d and displayed very high spatial variability on scales as small as a centimeter. An overall estimate of the flux (6.32 mg/m2/d) indicates that the diffusive flux from the sediments in the western basin is about 7700 metric tons per anum, or about 70% of the target external phosphorus load to the lake. *Keywords: Phosphorus, Lake Erie, Sediments.*

MAY, C.J., LUDSIN, S.A., GLOVER, D.C., and MARSCHALL, E.A., The Ohio State University, 1314 Kinnear Rd., Columbus, OH, 43212. **Larval Growth as a Limiter of Lake Erie Walleye Recruitment.**

Central hypotheses concerning fish recruitment assume that fast growth during the larval stage confers a survival advantage to older life stages. To test for the occurrence of such growth selection, we quantified larval (i.e., original cohort) and juvenile (i.e., age-0 survivors) growth during the first 20 d of life from walleye *Sander vitreus* collected in western Lake Erie during 2011-2013. During 2012 and 2013, survivors to the juvenile stage (i.e., new year-class) had high growth rates as larvae. By contrast, during 2011, slow-growing larvae survived disproportionately better to the juvenile period than fast-growing ones. None of the years resulted in a strong year-class, however, nor did year-class strength vary much among years. Analysis of historical (1994-1999) larval growth and environmental data can help explain this disconnect between larval growth-selection and year-class strength. In particular, we discovered that, while growth-selective mortality occurred during 2011-2013, mean larval growth rate during these years was slow relative to the 1990s. Because current zooplankton densities and walleye feeding incidences also were poor during 2011-2013 in relation to earlier years, we suggest that the absolute levels of prey availability are limiting larval survival and subsequent recruitment. *Keywords: Zooplankton, Otolith, Life history studies, Food chains.*

MCCABE, D.J.[1] and MANLEY, P.[2], [1]Saint Michael's College Biology, Colchester, Vt, 05439; [2]Middlebury College, Middlebury, VT. **Benthic communities in Missisquoi Bay of Lake Champlain.**

Missisquoi Bay is a shallow bay in Lake Champlain straddling the Vermont Quebec border. The bay covers approximately 78 km ^2 and drains a predominantly agricultural catchment. We took 369 ponar samples on a 500 m grid in Missisquoi Bay as part of a Sediment Trend Analysis study. Sediment silt fraction exceeded 70% in most samples with some near shore samples exceeding 50% sand content. We extracted macroinvertebrates from the samples using a 0.6 mm sieve and identified them to the lowest practical taxonomic level. Macroinvertebrate community variables and individual taxa responded weakly to differences in constituents of benthic sediments. There were robust interspecific macroinvertebrate patterns consistent with interspecific interactions. Samples containing zebra mussels had significantly more macroinvertebrates and these samples were also significantly richer. Zebra mussels increased significantly in abundance with native mussel abundance. Nearly twice as many zebra mussels were found in samples containing the empty shells of native mussels than in samples lacking shells. Lack of responses to sediment differences despite very large sample size may in part be explained by the relative uniformity of benthic sediments. Habitat uniformity makes Missisquoi Bay ideal for studies of benthic community dynamics. *Keywords: Sediment quality, Biodiversity, Benthos.*

MCCARTHY, F.M.G.[1], VOLIK, O.[2], RIDDICK, N.[1], and DANESH, D.[3], [1]Brock University, St. Catharines, ON, L2S 3A1; [2]University of Waterloo, Waterloo, ON; [3]Queen's University, Kingston, ON. **Microfossil Evidence of Anthropogenic Impact on Lake Simcoe.**

The greatest impact on Lake Simcoe occurred over the last few centuries, in response to human activities in the watershed. *Ambrosia*-rich sediments record increased flux of nutrients, heavy metals, and siltation, particularly in Cook's Bay -associated with the draining of the Holland Marsh for agriculture in the 1920s and 30s and with the rapid urbanization of the watershed since the end of WWII. Anthropogenic impact is also evident prior to the ragweed rise, not only in the aquatic microfossil record from the main basin and Smith's Bay, but also in elevated concentrations of nutrients and some heavy metals in the core from Smith's Bay. The marked increase in abundance of dinoflagellate cysts, *Pediastrum* spp., *Botryococcus* spp., and desmids in *Ambrosia*-rich sediments is attributed in part to enhanced preservation due to low dissolved oxygen concentrations resulting from cultural eutrophication. This is evident in the decline of benthic testate amoebae and the abundance of the ciliate *Codonella cratera* upcore. The abundance of desmids in our study relative to other palynological investigations of North American lakes is attributed to our avoidance of acetolysis during processing. This harsh oxidant destroys most desmids, but highlights other non-pollen palynomophs like *Pediastrum*. *Keywords: Microfossils, Eutrophication, Lake Simcoe.*

MCCARTHY, M.J.[1], NEWELL, S.E.[2], and GARDNER, W.S.[1], [1]The University of Texas at Austin Marine Science Institute, 750 Channelview Drive, Port Aransas, TX, 78373; [2]Wright State University, 3640 Col Glenn Hwy, Dayton, OH, 45345. **The importance and challenges of accurately measuring ammonium in aquatic systems.**

Ammonium is the most favorable nitrogen (N) form for aquatic primary producers. The bioavailability of ammonium makes it difficult to quantify accurately, especially when primary and secondary producers are active. Many systems receiving anthropogenic nutrient loads are impacted by cyanobacteria blooms, some of which produce toxins and interfere with human activities (e.g., Toledo, Aug 2014). These cyanobacteria cannot fix atmospheric N, excluding them from the pervasive phosphorus limitation paradigm, which is too simplistic for current eutrophication patterns (e.g., Lake Erie). Ammonium is assimilated and recycled rapidly, which makes it difficult to measure/quantify using conventional sampling and analysis techniques. We have long known that reduced nitrogen forms (e.g., ammonium and urea) are favorable for many bloom- and toxin-forming cyanobacteria genera (e.g., non-N-fixing), but we still have not implemented external nutrient controls that will address these issues. Even though non-N-fixing cyanobacteria cause the majority of issues impairing human usage of water resources, most of the recent literature and regulatory reports (e.g., IJC and EPA) do not address N loading. We will use examples from Lake Taihu and other hypereutrophic systems to show how and why we are not sufficiently accounting for reduced N forms. *Keywords: Nutrients, Ammonium, Eutrophication, Nitrogen, Cyanophyta.*

MCCORMICK, M.J.[1], TROY, C.D.[2], CHOI, J.[2], RUBERG, S.A.[3], and ANDERSON, E.J.[3], [1]University of Michigan, 440 Church St, Ann Arbor, MI, 48109; [2]Purdue University, 550 Stadium Mall Drive, West Lafayette, IN, 47907; [3]NOAA/GLERL, 4840 S. State Rd, Ann Arbor, MI, 48108. **Impact of Natural Heave Frequency on Surface Drifter Performance.**

Six satellite-reporting surface drifting buoys were released in the middle of Lake Michigan's southern basin in July 2013. Over the next seventeen days the drifters experienced everything from calm conditions to significant wave heights of 2.5 m and strong inertial oscillations. The buoys were identical in mass and drogue dimensions except that three of the drifters had their main buoyancy concentrated on a horizontal plane on the main spar ($D_h$) while the other three had their main buoyancy vertically aligned on the spar ($D_v$). The orientation of buoyancy affects the natural heave frequency of the drifter and consequently the importance of wave induced buoy slippage. Using a simple harmonic analogy we estimate the heave motion periods of $D_h$ and $D_v$ to be approximately 0.7 s and 1.1 s, respectively. Although this difference appears small it led to the drifters completely segregating themselves into two distinct groups. The mean separation between the centroids of the two clusters was 2.4 km whereas the mean separation about the centroid for $D_h$ and $D_v$ was 2.8 km and 1.5 km respectively. Implications of buoy design are often subtle and can have profound effects on a drifter's trajectory and Lagrangian effectiveness. *Keywords: Lake Michigan, Drifter buoy, Water currents, Hydrodynamics.*

MCDONALD, K.[1], TONINGER, R.[1], CHRESTON, A.[1], and FRASER, G.[2], [1]Toronto and Region Conservation Authority, 5 Shoreham Drive, Downsview, On, M3N1S4; [2]York University, 4700 Keele Street, Toronto, ON, M3J 1P3. **Twenty-Four Years of Cormorant Monitoring at Tommy Thompson Park: What Have we Learned?**

In the late 1980s Double-crested Cormorants (*Phalacrocorax auritus*) began nesting at Tommy Thompson Park (Leslie Street Spit). In 1990 Toronto and Region Conservation (TRCA) began monitoring the colony by geo-referencing their nest trees, counting nests and quantifying the impact of nesting on trees through annual field surveys. What started as a few nests in a few trees is now more than 12,000 nests in hundreds of trees, as well as on the ground. This has compelled TRCA and researchers to look other methods of determining the nesting population size, including ground nest surveys, ground nest area perimeter marking and aerial surveys. Data are shared with other agencies from across the region so that a better understanding of the regional population is achieved, and monitoring and management efforts can be improved. The data from this long term monitoring project has also been critical in informing management decisions and garnering public support for management. By understanding habitat preference, impact on trees, interspecific competition and the impact of monitoring, TRCA has developed an adaptive cormorant management plan that launched in 2008. Management is successfully limiting further tree canopy impact and is encouraging cormorants to nest on the ground where impacts to trees are significantly reduced. *Keywords: Cormorants, Management, Monitoring.*

MCGOLDRICK, D.J.[1] and MURPHY, E.W.[2], [1]Water Science and Technology Directorate, Environment Canada, 867 Lakeshore Rd, Burlington, On, L7R4A6; [2]Great Lakes National Program Office, U.S. Environmental Protection Agency, 77 W. Jackson Blvd., Chicago, IL, 60604. **Beth and Daryl's "Top 40" terrible, horrible, no good, very bad contaminants in Great Lakes Fish.**

Formal biomonitoring programs for chemicals of concern in fish have been operated by the governments of Canada and the United States in the Great Lakes since the 1970's. In the beginning, monitoring was focussed on the so-called "dirty dozen" POPs listed on the Stockholm convention and mercury. These chemicals are well known in the public sphere and are the subject a many scientific publications based in the Great Lakes Basin. In the last decade, initiatives in both Canada under the Chemicals Management Plan (CMP) and the Great Lakes Restoration Initiative (GLRI) in the United States have allowed an expansion of the list of chemicals being monitored to include additional contaminants which have emerged or are of emerging concern in terms of potential harmful impacts to the

environment. Examples of these compounds include polybrominated diphenylethers (PBDEs), perfluorinated compounds (PFCs), and many other chemicals used in a variety of consumer goods and personal care products. In this review, we have summarized all data contained in the fish contaminant databases of Environment Canada and the United States Environmental Protection Agency for chemicals measured from 2008 to 2012 from each of the five Great Lakes to provide an integrated picture of the current status of contaminant burden of upper trophic level fish. *Keywords: Environmental contaminants, Biomonitoring, Fish, Great Lakes basin.*

MCGREW, A.R. and MCNAUGHT, A.S., Central Michigan University, Department of Biology, Mount Pleasant, MI, 48859. **Herbivorous Feeding Behaviors of an Invasive Omnivore, *Hemimysis anomala* .**

*Hemimysis anomala* invaded the Great Lakes nearly a decade ago, and has since been associated with anthropogenic structures in nearshore waters. *Hemimysis* is an omnivore; however, its ability to feed on phytoplankton has received little attention. To investigate herbivory and omnivory by juvenile and adult *Hemimysis*, five individuals of each age were isolated, starved, and provided with varying densities of algae in all experiments. Omnivory experiments included a gradient of zooplankton prey. Ingestion and clearance rates were calculated from subsamples of all prey. Both juveniles and adults appear to exhibit a Type II functional response towards algae. Clearance rates are unaffected by algal density. When offered both algae and zooplankton, adults consumed most of the *Daphnia* within the first two hours. Algal ingestion rates differ across time and zooplankton density, and the lowest ingestion rate occurs at the highest *Daphnia* concentration. While *Hemimysis* has been shown to be an effective predator, these experiments suggest that it is also efficient at feeding on algae even when zooplankton is present. The potential for this mysid to act as both predator and competitor may influence its position in food webs and the magnitude of its impact on invaded habitats. *Keywords: Invasive species, Phytoplankton, Zooplankton.*

MCKENNA, JR., J.E., CHALUPNICKI, M.A., and DITTMAN, D.E., Tunison Lab of Aquatic Science USGS GLSC, 3075 Gracie Rd, Cortland, NY, 13045. **Simulation of Benthic Dreissenid Mussel Invasion of Lake Ontario with Possible Recovery of Diporeia.**

Two aspects of the recent changes to Lake Ontario include invasion of Driessenid mussels and widespread loss of the native amphipod Diporeia spp. The mechanisms of mass and energy flow were greatly altered by this invasion. Causes for the loss of Diporeia may include competition for settling organic matter, habitat alteration, disease, or toxins. We developed a benthic simulation model of carbon flow through the Lake Ontario benthic ecosystem that tracks biomasses and abundances of the major guilds of benthic organisms, Deposit-feeders (DF), Surface Deposit-feeders (SDF, i.e. Diporeia), and Filter-feeders (FF, i.e., Dreissenid mussels). Drift of larvae allowed re-distribution and colonization of new areas. After stabilizing (150 years) with only DF and SDF guilds present, FFs were introduced. Different mortality scenarios during the mussel invasion were tested to identify which best reproduce observed changes. The best scenario implies a disease like response for loss and recovery of Diporeia, enhanced by decline of mussel density after Round Goby invade. Model projections indicate continued recovery of Diporeia with northern deep water areas lagging behind southern deepwater areas, and a lakewide stabilization of mussel populations at a much lower level of abundance from their peak. *Keywords: Lake model, Lake Ontario, Benthos.*

MCLEOD, A.M. and HAFFNER, G.D., Great Lakes Institute for Environmental Research, 401 Sunset Ave, Windsor, On, N9C3P4. **All You Need Is Trout.**

Quantifying *in situ* nutrient and energy flows in aquatic ecosystems represents an important ecological challenge, especially as anthropogenic change is altering aquatic systems. Nowhere is this more important than Lake Huron which is experiencing substantial change including ultra-oligotrophication of the lake, regime shifts in the pelagic fish community, invasive species, and fishing pressures. The influence of these stressors have affected the lake's top predators causing decreased growth rates of Lake Trout populations, increasing the dominance of older (age 5+) individuals, and causing substantial declines in the Pacific Salmon abundances. Previously, we proposed the use of polychlorinated biphenyls (PCBs) as a metric to track the number of meals eaten by a fish and hence monitor nutrient and energy flow in aquatic systems. We further this concept by using a non-steady state PCB bioaccumulation model to quantify nutrient and energy flows in both Pacific Salmon and Lake Trout to contrast the influence of life history traits and growth rates on nutrient and energy dynamics in Lake Huron. The results of this study demonstrate that lake trout are more effective at recycling nutrients and are critical for food web stability in these highly oligotrophic ecosystems, whereas salmon tend to act mostly as nutrient sinks. *Keywords: Lake Huron, Lake trout, Nutrients.*

MCPHILLIPS, L.E. and WALTER, M.T., Cornell University, Ithaca, NY, 14853.
**Biogeochemical cycling in grassed roadside ditches.**

Roadside ditches are a ubiquitous feature in developed landscapes. They are implemented to route water off of roads for safety reasons, which leads to pulses of pollutant -laden runoff moving towards streams and other downstream water bodies. Nutrients like nitrogen can come from atmospheric deposition on impervious surfaces as well as from fertilizer on adjacent lawns. Our research focuses on nutrient cycling in grassed ditches in a suburban watershed draining to Cayuga Lake in upstate New York, comparing measurements within twelve ditches to reference locations directly adjacent to the ditches. Potential denitrification, which transforms nitrate into nitrogen gases, in the ditches is much higher than adjacent lawns (avg= 3.45 vs. 0.98 mg N /kg /hr) and is comparable to rates measured in biogeochemical hotspots such as riparian areas. Some microbial processes taking advantage of nutrients in the ditches could provide 'ecosystem dis-services' by producing greenhouse gases, and preliminary data indicates that methane emissions are occurring in wetter ditches, while nitrous oxide emissions can occur when ditches dry out. As we continue this research, we hope to inform better design of these ditches to maximize ecosystem services like denitrification and minimize disservices like greenhouse gas emissions. *Keywords: Biogeochemistry, Nutrients, Urbanization.*

MEADOWS, G.[1], GRIMM, A.G.[2], BROOKS, C.N.[2], and SHUCHMAN, R.A.[2], [1]Michigan Technological University, Great Lakes Research Center, 1400 Townsend Dr., Houghton, MI, 49931; [2]Michigan Technological University, Michigan Tech Research Institute, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105. **Remote sensing-based detection and monitoring of dangerous nearshore currents.**

Strong nearshore currents in the Great Lakes pose a threat to swimmers and contribute to several drownings and many more rescues each year. It is widely accepted that better forecasting and greater public awareness would mitigate this common coastal hazard, but the Great Lakes region lags behind the ocean coasts in these areas, and differences between ocean coastlines and the enclosed basins of the Lakes make it important to conduct research specific to this region. By analyzing a time series of high-resolution aerial and satellite images of the Michigan Great Lakes coasts, we delineated physical features of the nearshore zone that are potentially correlated with the development of rip and/or channel currents. Spatial and temporal patterns in these features were compared to the NOAA Great Lakes Current Incident Database to identify the strongest predictors of current-related incidents (drowning fatalities/rescues). The patterns revealed by these results highlight the "hot spots" for dangerous currents within the Michigan State Parks system, suggest an effect of water level change on rip current density, and contribute to improved forecasting of such currents. *Keywords: Hydrogeomorphology, Public education, Remote sensing.*

MEHLER, K.[1], KARATAYEV, A.Y.[1], BURLAKOVA, L.E.[1], and GORSKY, D.[2], [1]Great Lakes Center, 1300 Elmwood Ave, Buffalo, NY, 14222; [2]U.S. Fish & Wildlife Service, 1101 Casey Road, Basom, NY, 14013. **Benthic habitat mapping using remote sensing and GIS in the Niagara River.**

We used bathymetric data based on side scan sonar and GIS software to create benthic habitat maps in the lower Niagara River. These maps link the distribution of physical habitat characteristics with biological information obtained from direct benthic sampling to predict distribution, abundance and diversity of benthic invertebrate communities in the river. Benthic maps were created in ArcMap 10.1 to delineate major habitat classes in the river. To verify map accuracy we collected 60 sediment samples for particle size distribution and 80 underwater videos to describe the substrate in areas which could not be sampled due to strong currents and/or bedrock. A comparison between the substrate in the sonar image and reference data revealed a strong correlation ($r^2 = 0.75$) for bedrock and rocky areas. However, the correlation coefficient was lower ($r^2 = 0.41$) for fine-textured sediment, most likely due to the heterogeneous mixture of different grain sizes signifying the importance of groundtruthing for this type of substrate. Our study provide data on the spatial distribution, quality and quantity of benthic resources fundamental to the understanding and management of the Niagara River ecosystem. *Keywords: Remote sensing, GIS, Niagara River.*

MIANO, A.J. and FARRELL, J.M., SUNY-ESF, 1 Forestry Drive, Syracuse, NY, 13210. **Invasive Round Goby Diet Patterns and Egg Predation on Broadcast Spawning Fishes in Coastal Habitats.**

Egg predation by round goby is a commonly referenced concern associated with their recent invasion of the Great Lakes. While nest-building species may be affected by egg predation, broadcast spawning species may be particularly vulnerable as they do not guard their eggs. An experiment was used to investigate round goby egg predation rates on two broadcast spawning species, northern pike and muskellunge, among seven different habitat treatments (bare, silt, sand, rubble, gravel, filamentous algae, and submerged aquatic vegetation). Round goby egg predation rates were higher on substrates with lower complexity such as bare, sand, and silt, although the rates were similar between species. Across all substrates and egg types, predation was at least 50% eggs allotted to treatments in 24 hours, with bare, sand, and silt substrates nearly reaching 100%. Additionally, round goby were collected in known spawning locations of northern pike and muskellunge and their diet and stable isotopes were analyzed. Both diets and stable isotopes were used to determine round goby feeding patterns in coastal spawning habitats and to test for differences across goby sizes. These results suggest that the continued expansion of the round goby has the potential to negatively impact these and other broadcast spawning species due to egg predation. *Keywords: Invasive species, Fish diets, Habitats.*

MIHUC, T.B., Lake Champlain Research Institute SUNY Plattsburgh, 101 Broad Street, Plattsburgh, NY, 12901. **Plankton Community Long-Term Patterns in Lake Champlain, U.S.A.**

We compared Lake Champlain long-term patterns in Lake Champlain zooplankton, including major flood years such as 2011. Zooplankton exhibited major shifts from 1992-present, including a decline in rotifer abundance in the mid-1990s, a pattern that is linked with the invasion of zebra mussels into Lake Champlain. More recent community shifts can be attributed to major flood events. These shifts represent a major change in community structure with implications for the Lake's food web dynamics. In general the primary driver of change in Lake Champlain's plankton over the past two decades appears to be two fold, increased flooding and species invasions. Community shifts were not correlated with changes in the Lake's water quality or trophic status. We predict future shifts in composition associated with increased flooding/climate change and the invasion of the Spiny Waterflea *Bythotrephes longimanus*. *Keywords: Zooplankton, Invasive species.*

MILLER, K.A. and FACEY, D.E., Saint Michael's College - Biology Dept, One Winooski Park - Box 283, Colchester, VT, 05439. **Zooplankton Community and White Perch Diet in Southern Lake Champlain.**

The goal of this research was to develop a baseline understanding of the zooplankton community and diet of zooplanktivorous White Perch (*Morone americana*) in southern Lake Champlain during the early stages of invasion by the Spiny Water Flea (*Bythotrephes longimanus*). Zooplankton samples and stomach contents of White Perch were collected on five dates from June 11 to July 21, 2014. Zooplankton in sample tows and stomach contents were identified and counted, and the Manly-Chesson selectivity index was calculated for each sample date. No Spiny Water Fleas were found in either plankton samples or fish stomachs, but they were found elsewhere in Lake Champlain for the first time later during the summer of 2014. *Daphnia retrocurva* was the most common zooplankton found in our samples. White Perch ate primarily zooplankton on the first four sample dates, and especially *D. retrocurva* on June 17 and July 10, whereas macroinvertebrates dominated the diet on the last collection date. Southern Lake Champlain may not be susceptible to invasion by Spiny Water Flea due its warm temperature and muddy water. *Keywords: Fish diets, Zooplankton, Food chains.*

MILLER, Z.A. and WATKINS, D.W., Michigan Technological University Department of Civil and Environmental Engineering, 1400 Townsend Drive, Houghton, MI, 49931.
**Management of Combined Sewer Overflows in Cleveland, Ohio.**

Combined sewer overflows (CSOs) are instances in which stormwater runoff combined with raw human and industrial waste are discharged directly into natural water bodies, adversely affecting human health and the natural environment. Cleveland, Ohio is one of approximately 772 cities in the U.S. that have CSOs, and these CSOs discharge into the Cuyahoga River, other rivers and streams, and directly into Lake Erie. Today, the Northeast Ohio Regional Sewer District (NEORSD) manages stormwater and wastewater in the greater Cleveland area, and is therefore responsible for the U.S. Environmental Protection Agency (EPA) required Long Term Control Plan (LTCP). In 2011, a Consent Decree was settled between the U.S. EPA and the NEORSD, requiring the NEORSD to spend 3 billion dollars over 25 years to reduce the volume of raw sewage discharged into the environment. This research integrates a suite of sewer, stream and hydrodynamic models to assess the impacts of CSOs on surrounding water quality. Results from sampling from a storm in 2014 demonstrate that this integrated modeling approach is promising. Future work will entail continuous simulations and developing a decision-support model to help the NEORSD prioritize which alternatives and improvements are most cost-effective. *Keywords: Urban watersheds, Combined sewer overflows, Integrated hydrologic modeling, Clean Water Act.*

MILLIGAN, M.S.[1], COCCARELLI, T.W.[1], CRIMMINS, B.S.[2], XIA, X.[2], HOLSEN, T.M.[2], HOPKE, P.K.[2], and PAGANO, J.J.[3], [1]SUNY Fredonia, Fredonia, NY, 14063; [2]Clarkson University, Potsdam, NY, 13699; [3]SUNY Oswego, Oswego, NY, 13126. **Identification and quantitation of legacy contaminant degradation products in Great Lakes fish.**

As part of our ongoing work with the EPA-sponsored Great Lakes Fish Monitoring and Surveillance Program, we have been analyzing Great Lakes fish tissue samples for possible stable environmental degradation products that may have been derived from legacy pollutants such as PCBs, organochlorine pesticides, PBDEs, and perhaps others. Whole fish Lake Trout composites from all five Great Lakes were extracted, and cleaned-up using automated GPC and deactivated silica gel columns. For identification, final extracts were analyzed using comprehensive two-dimensional gas chromatography, coupled with time-of-flight mass spectrometry (GCxGC-TOF). For identification, targeted and non-targeted approaches were used employing scripting algorithms and library database searching, resulting in many isomers of polychlorinated and polybrominated methoxyphenol and methoxybenzene isomers. Where available commercially, neat standards were purchased, and quantification of specific isomers was accomplished using GC/MS in selected ion monitoring mode (SIM). Combined concentrations of these compounds often reached levels in the hundreds of ng/g, rivaling total concentrations of PCBs in the same samples. *Keywords: Environmental contaminants, Fish, PCBs.*

MOFFITT, C.M.[1], WATTEN, B.J.[2], BARENBERG, A.[3], and HENQUINET, J.W.[4], [1]US Geological Survey, Idaho Cooperative Fish and Wildlife Research Unit, Department of Fish and Wild, Moscow, ID; [2]US Geological Survey, S.O. Conte Anadromous Fish Research Center, Turner Falls, MA; [3]Department of Fish and Wildlife Sciences, University of Idaho, Moscow, ID; [4]Henquinet Consulting, LLC, Houghton, MI. **Hydroxide Stabilization as a New Tool for Ballast Disinfection: Efficacy of Treatment on Zooplankton.**

Increased global human travel and commerce have created substantial challenges for aquatic managers and regulators that seek to protect natural ecosystems from infestation by invasive aquatic species. We studied the efficacy of elevated pH (ranging from 11.4 to 12) as a tool to treat and disinfect tanks, including ballast systems to prevent the transfer of selected target and non-target aquatic invasive species. Shipboard trials aboard the National Park Service's Ranger III evaluated the efficacy of sodium hydroxide at pH 11.6. We conducted two tests, each of which had replicated test and control tanks filled with a natural array of plankton pumped into the tanks though the ship's ballast pumps. Our trials lasted from 12 to 18 h including retention at target pH, followed by a neutralizing step using an engineered carbonization/mixing system attached to the ship's diesel engine. Our tests were 100% effective in killing all plankton regardless of size. These results provide promising data to support use of elevated pH as a safe, economical and effective disinfection treatment for applications in large or small scale systems. *Keywords: Ballast, Invasive species, Zooplankton.*

MOLLOY, D.P., Department of Biological Sciences, University at Albany (SUNY), 1400 Washington Avenue, Albany, NY, 12222. **The Future of Dreissenid Control in Open Waters.**

There is a growing interest in the selective control of driessenids in open waters. Unfortunately there is currently no dreissenid-specific control method capable of drastically reducing populations throughout an entire lake. Small high-value areas within lakes, however, like beaches, boat ramps, and unionid restoration beds will likely see increased use of the highly specific biological control agent Zequanox®. But these isolated control efforts will likely have little effect on the continual spread of dreissenids from lake to lake nor will they significantly reduce the ecological perturbations a dreissenid population is causing in the lake as a whole. In addition, no matter how dreissenid-specific a control agent is, organizations such as lake associations will rarely have the financial resources needed to treat an entire water body even once, much less annually. Ideally a control agent is needed that is applied just once, is self-spreading throughout an entire water body, and subsequently gives multi-year lake-wide control. This presentation will discuss the need for such an "entire-lake control agent" and will suggest that the only hope for such a powerful control agent is a highly virulent, highly-specific lethal parasite that when introduced into a lake would become established and self-spreading. *Keywords: Biological invasions, Dreissena, Zebra mussels.*

MONTGOMERY, F.A.[1], MANDRAK, N.E.[1], and REID, S.M.[2], [1]University of Toronto, Toronto; [2]University of Toronto, Toronto; [3]Ministry of Natural Resources, Peterborough.

**Predicting the Distribution and Habitat of Fish Species at Risk in a Lake St. Clair Tributary.**

Agricultural drains provide important habitat for freshwater fishes, including species at risk, but the sensitivity of fishes in these systems to physical alteration is not well understood. Little Bear Creek (LBC) drain, a tributary to Lake St. Clair in southwestern Ontario, supports six fish species listed under the Canadian *Species at Risk Act*. Proposed flood risk management techniques include the removal of substrate and vegetation from the creek, which may lead to the loss of critical fish habitat. To quantify the risk of drain maintenance to the species at risk in LBC, this project will identify regions of critical habitat occupied by two of the six fishes, the Threatened Pugnose Shiner, (Notropis anogenus), and Special Concern Blackstripe Topminnow, (Fundulus notatus). Regression trees will be used to describe macrophyte cover as a function of water depth, water velocity, stream width and turbidity. Due to the high abundance of zero captures, zero-inflated models will be related to occurrences of both species. Results of the overall species-environment analysis will inform applied drain management mitigation techniques and modeling techniques used to describe species at low abundance. *Keywords: Model testing, Fish populations, Conservation.*

MOORE, T.S.[1], MOUW, C.B.[2], SULLIVAN, J.M.[3], TWARDOWSKI, M.S.[3], BARNETT, A.B.[2], STOCKLEY, N.D.[3], and YU, A.W.[2], [1]University of New Hampshire, Durham, NH;

[2]Michigan Technological University, Houghton, MI; [3]WET Labs, Narragansett, RI.
**Improving Detection and Understanding of HABs in Western Lake Erie Using New In-water Instruments.**

Harmful algal blooms (HABs) in western Lake Erie are annually recurring and natural summertime/fall phenomena that pose a serious health risk to the regional community. In our funded research study, we deployed new instrumentation in western Lake Erie in the summers of 2013 and 2014 to further understand their ecology and bio-optical physiology. A Land/Ocean Biogeochemical Observatory (LOBO) buoy was deployed for both summers in the western basin that continuously measured water properties every hour, and captured the initiation, peak, and senescence of blooms for both years. Spatial surveys conducted during the peak bloom period in both years deployed advanced instrumentation to measure optical properties of the water and the HAB organisms, including in situ microscopic holographic imagery capable of resolving their size, orientation and concentrations. These measurements provide important information on the vertical and horizontal distributions of bloom properties relevant for improving bio-optical algorithms specific to HABs for remote sensing applications. This data and ancillary data are also being used to develop an ecological niche model to better understand the ecological drivers of HAB initiation. We present and summarize our findings in the context of the HAB events of 2013 and 2014. *Keywords: Lake Erie, Harmful algal blooms, Observing systems.*

MOOS, M.T.[1], GINN, B.K.[2], and VERMAIRE, J.C.[3], [1]Ryerson University, Toronto, ON, M5B 2K3; [2]Lake Simcoe Region Conservation Authority, Newmarket, ON, L3Y 4X1; [3]Carleton University, Ottawa, ON, K1S 5B6. **Setting Effective and Sustainable Lake Management Objectives: An Applied Paleolimnological Approach.**

Environmental management strategies are often hindered by a lack of detailed environmental information on the pre-disturbance condition of an ecosystem and, as such, we are unable to fully quantify the impacts of ecological stressors, account for natural variations in the ecosystem, or determine a science-based sustainable end state for mitigation strategies. Using sediment cores and paleoecological methods, we investigated three lakes in southern Ontario that have been of concern to shoreline and watershed residents. Canal and Mitchell lakes are man-made waterbodies located along the Trent-Severn Waterway system and are of concern due to nutrient inputs and dense aquatic plant growths. Musselman Lake is located in the Greater Toronto Area and residents have expressed concern over nutrient inputs, aquatic plant biomass, and harmful algal blooms. By reconstructing diatom-inferred trends in phosphorus and macrophyte biomass, as well as changes in $\delta^{15}N$ values, we have tracked the amount of environmental change attributable to anthropogenic activities, relative to pre-disturbance conditions, and proposed a strategy and target for restoration to ecologically sustainable states. *Keywords: Lake management, Aquatic plants, Paleolimnology, Diatoms, Phosphorus.*

MORDEN, A.L.[1], CONN, D.B.[2], HENDRY, A.P.[1], and RICCIARDI, A.[1], [1]McGill University, Montreal, QC; [2]Berry College, Mount Berry, GA. **Interpopulation Variation in Hypoxia Tolerance of the Invasive Asian Clam.**

The Asian clam (*Corbicula fluminea*) is a high-impact invasive species that has established widely in warm temperate and subtropical waterbodies. Cold temperate habitats with seasonal ice cover are thought to be resistant to invasion, owing to the clam's presumed thermal and oxygen requirements. Research from our lab has shown significant variation in cold tolerance among Asian clam populations in North America, and suggests that northern freshwater habitats are at higher risk of invasion than previously assumed. This is supported by recent discoveries of Asian clam populations established in cold temperate waterbodies, including a satellite pond of Lake Erie. Here we present the results of a novel experiment testing interpopulation differences in hypoxia tolerance at low temperatures, approaching conditions in winter ponds. We tested Asian clams from Lake George (New York), Lake Cheston (Tennessee) and the Nolichucky River (Tennessee). Populations exposed to 5% dissolved oxygen saturation at ~5°C for 50 days in experimental chambers showed significant variation in survivorship. Our results caution against risk assessments based on tolerance data from a single population in the invaded range. *Keywords: Invasive species, Asian clam, Risk assessment, Hypoxia.*

MUHAMETSAFINA, A.[1], HLINA, B.L.[1], TESSIER, L.R.[1], BIRCEANU, O.[1], LONG, T.A.F.[1], SLADE, J.W.[2], and WILKIE, M.P.[1], [1]Department of Biology, Wilfrid Laurier University, 75 University Avenue West, Waterloo, ON, N2L3C5; [2]Ludington Biological Station, Ludington, MI, 49431. **Effects of Temperature on Sensitivity of Larval Sea Lampreys to 3-Trifluoromethyl-4-Nitrophenol, TFM.**

To control invasive sea lamprey (*Petromyzon marinus*) populations in the Great Lakes, the lampricide 3-trifluoromethyl-4-nitrophenol (TFM) is applied to lamprey infested rivers and streams. TFM sensitivity in larval sea lamprey varies seasonally, but the underlying causes are not understood. The goal of this study was to determine if this variability can be explained by seasonal changes in water temperature. Larval sea lampreys were collected in April, June, August and October 2013 and held at their collection temperatures. Toxicity tests were performed and the respective LC50s in April, June, August and October were 1.18, 2.55, 3.15 and 1.64 mg/L, indicating that TFM sensitivity is greatest in the spring, tolerance is highest in late summer, before dropping in the fall. The following year, animals were collected in August and acclimated to three experimental temperatures (6, 12 and 21 °C). The respective LC50s were 1.41, 1.96 and 3.27 mg/L, demonstrating that TFM tolerance increases with water temperature. We conclude that seasonal differences in the TFM sensitivity of larval sea lampreys is strongly correlated with increases in water temperature during the late summer. *Keywords: Toxic substances, Sea lamprey, Fish, Invasive species.*

MUNAWAR, M.[1], FITZPATRICK, M.[1], NIBLOCK, H.[1], ROZON, R.[1], and LORIMER, J.[2], [1]Fisheries & Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7S 1A1; [2]Aquatic Ecosystem Health & Management Society, Burlington, ON. **Evaluating Natural Phytoplankton Communities by In Situ Fluorescence and Utermöhl Microscopy.**

Recent advances of digital technologies have increased our capacity for rapid and intensive sampling of phytoplankton including a multi-spectra fluorometer capable of identifying pigment based algal groups. While many studies have examined the effectiveness of fluorometry for measuring chlorophyll a, few studies have considered how multi-spectra pigment analysis compares with traditional microscopy. Fisheries & Oceans Canada has been active in conducting an in depth evaluation of these two methods across the Great Lakes. In Lake Superior (August 2011) for example, the fluorometer indicated that the "Brown" pigment group represented 30-45% of the standing crop which compared favourably to the combination of Chrysophyceae, Diatomeae and Dinophyceae (20-50%) but failed to detect any "blue-greens" although Cyanophyta were found to compose 10-50%. This paper will present case studies from the Great Lakes. Our analyses demonstrated that fluorometric pigment based algal classifications can be misleading and not compatible with the community structure data generated by the traditional microscopy (groups, species, size, biomass). However, fluorometric assessments can be useful in conducting rapid chloropohyll surveys of large lakes for assessing trophic state. *Keywords: Assessments, Probes, Algae, Taxonomy.*

MURBY, A.L.[1], HANEY, J.F.[1], HENEGAN, P.L.[2], and STOMMEL, E.W.[2], [1]University of New Hampshire, Department of Biological Sciences, Durham, NH, 03824; [2]Dartmouth-Hitchcock Medical Center, One Medical Center Drive, Lebanon, NH, 03756. **Microcystins and Picocyanobacteria in Lake Water Aerosols.**

Organic substances are natural components to the atmosphere. Particles may become aerosolized by various factors such as wind, animal transport, and water or land disturbances. We examined cyanobacteria aerosolized from lakes by novel collection methods described here. Cells were enumerated with epifluorescence microscopy and microcystins were measured with ELISA methods modified for detection of low concentrations. Microcystins were detected in lake generated aerosols and the smallest cyanobacteria, picocyanobacteria (0.2-2.0 micrometers), were abundant in air samples. Picocyanobacteria concentrations in aerosols collected from 8 lakes in Vermont and New Hampshire during the summer 2014 ranged from 1.5 x 104 to 2.0 x 105 cells m-3. This work suggests potential importance of as a mechanism related to public health exposure to cyanobacteria and their toxins. *Keywords: Airsheds, Microcystin, Cyanophyta, Aerosols, Human health.*

MURPHY, E.W.[1], LANDON, M.W.[2], WELLENKAMP, W.[3], PAGANO, J.J.[4], DOWNEY, P.C.[5], HOLSEN, T.M.[6], CRIMMINS, B.S.[6], MILLIGAN, M.S.[7], HOPKE, P.K.[6], and HE, J.[3], [1]USEPA Great Lakes National Program Office, 77 W. Jackson Blvd., Chicago, IL, 60604; [2]Michigan Department of Natural Resources, Alpena, Mi; [3]Computer Sciences Corporation, Alexandria, Va; [4]SUNY Oswego, Oswego, NY; [5]Aquatec Biological Sciences, Inc., Williston, VT; [6]Clarkson University, Potsdam, NY; [7]SUNY Fredonia, Fredonia, NY. **Shifts in Age of Great Lakes Lake Trout; an interlaboratory comparison.**

The Great Lakes Fish Monitoring and Surveillance Program and the Michigan Department of Natural Resources (MiDNR), Alpena Field Station, are employing a new aging technique that may be better able to determine age quickly and accurately using the maxillary bone of lake trout. This new method is being compared to traditional methods, otolith and coded wire tags, in a blind comparison study between two laboratories to gauge accuracy, refine aging rules and techniques, and to allow for compositing of GLFMSP samples around a known age. Fish age is used to help explain the changes in fish tissue concentration for some legacy contaminants, like PCBs, in lake trout collected as part of the long term GLFMSP. Results of this collaboration may alter the standard collection procedures for the GLFMSP into the future for Lake Huron and / or other Great Lakes to better reflect the environmental condition. *Keywords: Environmental contaminants, Age, Great Lakes basin, Growth, Fish.*

MUSIC, B. and FRIGON, A., Ouranos - Consortium on regional climatology and adaptation to climate change, 550 Sherbrooke W, Montreal, QC, H3A 1B9. **Projecting Great Lakes Water Supplies Under a Changing Climate Using Regional Climate Models.**

In this study, we investigate the response of the Great Lakes Basin to global warming using an ensemble of sixteen climate change simulations generated by three different Regional Climate Models (RCMs): CRCM4, HadRM3 and WRFG. Annual and monthly means of simulated hydro-meteorological variables that affect Great Lakes levels are first compared to observation-based estimates. The climate change signal is then assessed by computing differences between simulated future (2041-2070) and present (1971-1999) climates. Finally, an analysis of the annual minima and maxima of the Net Basin Supply (NBS) is conducted using Generalized Extreme Value distribution. Results reveal notable model differences in simulated water budget components throughout the year, especially for the lake evaporation component. These differences are reflected in the resulting NBS. Although uncertainties in observation-based estimates are quite large, our analysis indicates that all three RCMs tend to underestimate NBS in late summer and fall. The climate change signal derived from the RCM ensemble indicates small changes in future mean annual NBS, an amplification of the NBS annual cycle and an intensification of the annual NBS minima in future climate. *Keywords: Hydrologic cycle, Atmosphere-lake interaction, Climate change.*

MUZANA, A.[1], GUILLARD, J.[2], ADAMS, J.V.[3], and YULE, D.L.[3], [1]Rwanda Energy Group, Lake Kivu Monitoring Programme, kn82 st3, Kigali, RWANDA; [2]UMR INRA Centre Alpin de Recherche sur les Réseaux Trophiques et les Ecosystèmes Lacustres, Avenue de Corzent, Thonon-Les-Bains, 74203, FRANCE; [3]United States Geological Survey, Lake Superior Biological Station, Lakeshore Drive, Ashland, Wisconsin, 54806. **Seasonal and spatial stock assessment of *Limnothrissa miodon* in Lake Kivu.**

*Limnothrissa miodon*, deliberately introduced in Lake Kivu in 1959, is now the most abundant pelagic fish species and supports important fisheries for people surrounding the lake in the two sharing countries - Rwanda and D.R. Congo. The seasonal and spatial distribution of *L. miodon* was assessed during eight hydroacoustic surveys conducted between 2012 and 2014, during both rainy and dry seasons. With the exception of the first survey of July 2012, no significant variation of the fish stock was observed during the two-year study. Total fish biomass estimates for the remaining seven surveys ranged between 4000 and 6000 metric tons. Fish stock biomass was significantly higher in the southern and the western basins without any apparent seasonal pattern. Juveniles were constantly more abundant than adults in the four basins during both seasons; supporting the hypothesis that *L.miodon* reproduces throughout the year. The stock of *L. miodon* seems to be lower compared to earlier hydroacoustic estimates. Suggestion of a sampling survey design based on the data set analysis, including temporal and spatial effects, is discussed. *Keywords: Hydroacoustics, Stock estimation, Limnothrissa miodon.*

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NEESON, T.M.[1], MOODY, A.T.[1], GUYETTE, M.Q.[1], DIEBEL, M.[2], HERBERT, M.[3], KHOURY, M.[3], YACOBSON, E.[3], DORAN, P.[3], FERRIS, M.[4], O'HANLEY, J.R.[5], and MCINTYRE, P.B.[1], [1]Center for Limnology, University of Wisconsin, Madison, WI; [2]Wisconsin Dept. of Natural Resources, Madison, WI; [3]The Nature Conservancy, Lansing, MI; [4]Computer Sciences, University of Wisconsin, Madison, WI; [5]Kent Business School, University of Kent, Canterbury, ENGLAND. **Prioritizing barrier removals to restore native fish migrations in Great Lakes tributaries.**

Tributaries to the Great Lakes are highly fragmented by dams and road crossings that act as potential barriers to migratory fishes, restricting their access to historical riverine spawning grounds. There is growing investment in removing or modifying barriers to restore native fish migrations and ecosystem function, but these efforts may also increase available habitat for invasive species like sea lampreys. The restoration community lacks a systematic method for comparing these costs and benefits to assess which barrier removal projects would offer the greatest return on investment. To address this problem, we developed a basin-scale mathematical optimization model to prioritize barriers for removal on the basis of upstream breeding habitat for both native and invasive fishes. We parameterized this model using a recently developed database of dams (n=7,091) and road crossings (n=268,818); economic models of projected barrier removal costs; and historical data describing distributions of native and invasive species. We describe the optimal trade-offs between native migratory fishes and sea lampreys that would accompany numerous barrier removal scenarios. We will discuss the sensitivity of the model to uncertainty in our estimates of the suitability of tributaries for native and invasive species. *Keywords: Conservation, Connectivity, Fish, Dam, Planning, Culvert.*

NEFF, B.P., Independent, Adrian, MI. **Panarchy 101. A tool to help scientists and urban planners understand one another.**

Urban coastal restoration and revitalization are complex processes which require contributions from a wide range of disciplines to navigate. Unfortunately, professionals from contrasting backgrounds typically perceive the world differently and often operate independently. Building a common vision for urban coastal restoration and revitalization is difficult, at best. I argue that panarchy is an academic concept with real, implementable potential to build common understanding of the interconnections between, and value of, seemingly disparate perspectives. I will present a basic explanation of social-ecological resilience and panarchy, with examples from urban coastal restoration and revitalization successes and challenges within the Great Lakes Basin. Attendees will be challenged to think broadly about the value of their work and the potential for a common vision of urban coastal restoration and revitalization. *Keywords: Urban areas, Restoration, Management, Revitalization, Planning, Social-Ecological Systems.*

NELSON, H.[1], POULTON, N.[2], LEATHEM, M.[1], and COHRS, M.G.[1], [1]Fluid Imaging Technologies, 200 Enterprise Drive, Scarborough, ME, 04074; [2]Bigelow Laboratory for Ocean Sciences, 60 Bigelow Drive, Esat Boothbay, ME, 04544. **Improved methodology for automated identification of plankton using an Imaging Flow Cytometer.**

In 1999, Dr. Christian K. Sieracki left the Bigelow Laboratory for Ocean Sciences and founded Fluid Imaging Technologies (FIT) with the intention to manufacture a digital imaging flow cytometer that he and his colleagues from Bigelow developed. Since then, over 300 FlowCAMs in 45-plus countries have been put to use for the application of characterizing microorganisms in aquatic systems. Building upon advances in technology, input from the user community, and expanded resources, FIT have recently transformed the FlowCAM of 1999, designing the 4th Generation FlowCam. Informally referred to as the 'High Sensitivity FlowCAM' (HSFC), the instrument provides more precise information over earlier versions - especially with regard to fluorescence data and size and concentration information. Included among the next-gen FlowCAMs is an optics configuration (specific laser and optical filters) allowing for the detection of phycocyanin, thus providing for an improved method to identify and characterize cyanobacteria. In addition to a hardware overhaul, the image recognition algorithm and user interface for identifying and classifying organisms has been redesigned, as have the method to estimate biovolume. Included will be an overview of the various new designs, how they work, along with a review of data from the HSFC FlowCAM. *Keywords: Phytoplankton, Semi-automated Plankton Identification, Zooplankton.*

NEUBAUER, A.K.[1] and DOMSKE, H.M.[2], [1]Illinois-Indiana Sea Grant, 1101 W. Peabody Dr., 374 NSRC, Urbana, IL, 61801; [2]New York Sea Grant, 228 Jarvis Hall, SUNY at Buffalo, Buffalo, NY, 14260. **The Center for Great Lakes Literacy: Creating Synergy among Educators, Scientists, and Students.**

This session will highlight the work of the Great Lakes Sea Grant Network's Center for Great Lakes Literacy (CGLL). The Center works toward improving the sustainability of Great Lakes watersheds by enhancing the Great Lakes stewardship ethic of students and stakeholders. The Center provides experiential professional development workshops and effective community-school partnerships, as a means to strengthen Great Lakes literacy and place-based education. Through CGLL's innovative shipboard program on the USEPA R/V Lake Guardian, researchers and educators make valuable connections. In partnership with a myriad of organizations throughout the Great Lakes basin and funding from the Great Lakes Restoration Initiative, the CGLL staff continues to develop a vibrant network of educators and scientists who are involved in action-oriented Great Lakes stewardship and restoration activities. Presenters will share the methodology used to build understanding about critical Great Lakes issues and concepts, utilizing the eight Great Lakes Literacy Principles that are integrated into each of CGLL's workshops and other educational practices. Learn about the Center and its award-winning programs designed to improve Great Lakes education around the basin. *Keywords: Environmental education, Great Lakes literacy, Professional development.*

NEVORSKI, K.C.[1], GALAROWICZ, T.L.[1], GEHRING, T.M.[1], and CLAPP, D.F.[2], [1]Central Michigan University, Mount Pleasant, MI, 48859; [2]Michigan DNR:Charlevoix Fisheries Research Station, 96 Grant Street, Charlevoix, MI, 49720. **Relationships between Smallmouth Bass Distribution and Habitat in Lake Michigan.**

Shifts in the Lake Michigan ecosystem over the past several decades have had a destabilizing influence on several Lake Michigan fisheries. Continued disturbances to the system necessitate ongoing research to understand how these important fisheries may be impacted. The Smallmouth Bass (*Micropterus dolomieu*) fishery is of high economic and ecological importance and although it is currently doing well a better understanding of Smallmouth Bass habitat needs is required to maintain the fisheries current condition. This study used regression techniques to better understand how and why Smallmouth Bass are distributed based on habitat using fine and coarse scale models. Fine scale models were based on trap net and local habitat sampling while linear and polynomial regressions were used to develop the model. Coarse scale models were based on Michigan Department of Natural Resources Lake Michigan creel surveys from 2010-2014 and lake-wide habitat information was retrieved from MODIS remote sensing and the Great Lakes Operational Forecast System using linear, logistic and polynomial regressions to develop the model. Preliminary data reveals that habitat is selected differently on a coarse and fine scale and the type of relationship between Smallmouth Bass varies depending on the habitat type. *Keywords: Habitats, Lake Michigan, Fisheries.*

NEWSTED, J.L.[1], ZWIERNIK, M.J.[2], and BURSIAN, S.J.[2], [1]Natural Resource Technology, 2260 E. Saginaw Street, East Lansing, MI, 48823; [2]Michigan State University, Department of Animal Science, East Lansing, MI, 48824. **Mink Jaw Lesions, A Sensitive Bio-indicator of Environmental Health To Dioxin-like Compounds.**

One of the major obstacles often noted in ecological risk assessments it that assessment endpoints are not always clearly linked to measurable goals. Here we present a sensitive biomarker in a recognized sentinel species, the American mink, that can be used to identify contaminant exposure and establish measurable criteria for AOCs containing dioxin-like compounds (DLCs). We have characterized a mink jaw lesion that responds over a wide range of DLC exposures and will present data that establish DLC /jaw lesion dose-response relationships based on its occurrence and severity. The lesion is quantifiable microscopically in animals exposed to DLCs at concentrations 2- to 10-fold lesser than those known to adversely affect reproduction and health. As a result, it could be used as an early predictor of possible problems in growth and reproductive parameters in wild mink. As such, this biomarker could be of great use to expand the environmental monitoring for DLC compounds in individuals and/or population for the presence of biologically significant exposures of DLCs in those areas where sources are yet to be identified as well as monitoring the effectiveness of remedial activities. The ecotoxicological significance of using in this lesion to assess past and current DLC concentrations in the Great Lakes basin will be discussed. *Keywords: Ecosystem health, Mink, PCBs, Biomarker, Risk assessment.*

NIBLOCK, H., MUNAWAR, M., and FITZPATRICK, M., Fisheries & Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7S 1A1. **Assessing the Eutrophication Beneficial Use Impairment in the Toronto Harbour Area of Concern.**

The Toronto and Region Area of Concern covers ≈ 2000 km2 and includes the Toronto waterfront and 6 watersheds. About 3 million people live in the region and 9 Beneficial Use Impairments have been listed including "eutrophication or undesirable algae". Fisheries & Oceans Canada launched a preliminary assessment of the health of the AOC in September 2013. The study consisted of sampling at 10 sites distributed across western (3), Inner harbour (4) and Eastern (3) regions and included major nutrients, Chlorophyll a, microbial loop, phytoplankton, and size fractionated primary productivity. Total phosphorus concentrations ranged from 23 ug/L (west) to 35 ug/L (Inner harbour). Similarly

Chlorophyll a was higher in the inner harbour (5.1 ug/L) than the west (2.1) and east (1.8). Primary productivity was also highest in the inner harbour (11.9 mg C/m3/h) as was phytoplankton biomass (1.3 g/m3). Although TP was somewhat higher than Water Quality guidelines, the biological parameters indicate that Toronto Harbour could be classified as oligotrophic during this limited survey. A more detailed biological assessment including thorough taxonomy is required to confirm these preliminary observations. *Keywords: Algae, Ecosystem health, Urban watersheds.*

NICHOLSON, M.E.[1], JOHNSON, T.B.[2], and ARNOTT, S.E.[1], [1]Queen's University, 116 Barrie Street, Kingston, ON, K7L 3J9; [2]Ontario Ministry of Natural Resources, R.R.#4, 41 Hatchery Lane, Picton, ON, K0K 2T0. **Community-level Response to Zequanox® in Aquatic Mesocosms.**

Zequanox® is an emerging biopesticide for Dreissenid mussel control, and may be widely used to control zebra and quagga mussel infestations in open water systems in North America. Previous research has shown that Zequanox® is highly effective and specific (Molloy *et al.* 2013; Meehan *et. al.* 2014), but has yet to characterize non-target effects at a community scale. We carried out a 43-day experiment in aquatic mesocosms to determine the potential direct and indirect community-level responses (effects and recovery) of zooplankton, macroinvertebrates, and algae to manufacturer-prescribed Zequanox® treatment at 100 mg/L (a.i.). Results of this study will be discussed. *Keywords: Dreissena, Zequanox®, Zooplankton, Community ecotoxicology.*

NODINE, E.R. and STOCKWELL, J.D., University of Vermont, Burlington, VT. **Phytoplankton community responses to Hurricane Irene differ across Lake Champlain.**

Water column stability is an important driver of phytoplankton community composition and succession. The relative abundance of species as well as taxonomic or functional groups often changes in response to stratification and mixing; for example, stratification may favor cyanobacteria that can control buoyancy, while mixing may favor groups like diatoms that thrive in turbulence. In large lakes, complex geomorphology generates a mosaic of stability across different areas; deep basins may be strongly stratified while shallow inlets remain well mixed through late summer. Storms add to the complexity by disrupting water column stability on different scales depending on their intensity and duration, but the timing and nature of phytoplankton community dynamics in response to storms are poorly understood. We examined phytoplankton and water column data collected from 15 sites across Lake Champlain from 2010 to 2012, the period encompassing the passage of Hurricane Irene in 2011, to evaluate phytoplankton response differences across sites. The relative abundance of cyanobacteria declined at all sites but one following Hurricane Irene, but the timing and duration of changes differed across sites and appear to be related to basin morphology. Responses are compared to seasonal changes over the same time period in 2010 and 2012. *Keywords: Phytoplankton, Climatic data, Species diversity.*

NORTON, R.K.[1], DAVID, N.P.[2], and BUCKMAN, S.[1], [1]University of Michigan, 2000 Bonisteel Blvd., Ann Arbor, MI, 48109; [2]University of Delaware, 298B Graham Hall, Newark, DE, 19716. **Local Planning for Climate Change Adaptation on Michigan's Great Lakes.**

The Great Lakes touch some 4,900 miles of U.S. shoreline, about 3,050 (60%) of which are in Michigan. While the Great Lakes like oceans generate substantial hazards to shorelands both from ongoing erosion and periodic storms, Great Lakes coasts are different from ocean coasts in several key respects physically and institutionally. Most prominently, lake water levels fluctuate on the order of 1 to 2 meters over decades, and state-local governance of Great Lakes shorelands is highly fragmented and institutionally complex (Norton and Meadows 2014). Management of shoreland areas is left largely to localities, but they have limited capacity to manage those areas given the complexities of Great Lakes shoreline dynamics and institutional arrangements, a task that is becoming yet more challenging with global climate change (Gronewold et al. 2013). This paper presents a systematic analysis of local efforts to plan for the management of Great Lakes shoreland areas in Michigan through master plans, zoning codes, and infrastructure policies. Findings are drawn from content analyses of plans and zoning codes, surveys of coastal officials, and case study analyses of selected coastal communities. The paper concludes with a brief analysis of the applicability of these findings to other Great Lakes coastal settings. *Keywords: Planning, Decision making, Shore protection.*

# O

O'CONNOR, E.M., ASPDEN, L.P., and LEMBCKE, D., Lake Simcoe Region Conservation Authority, 120 Bayview Parkway, Newmarket, ON, L3Y 4X1. **Using in-situ turbidity measurements to calculate loads from streams of the Lake Simcoe watershed.**

Streams supply a large portion of the total phosphorus load to Lake Simcoe. The use of turbidity as a surrogate for estimation of phosphorus loads has been evaluated in this study. Turbidity can be highly related to phosphorus in river water and can be measured continuously using in-situ sensors. The objectives are to: 1) increase understanding of phosphorus patterns using turbidity, 2) calculate accurate loadings using their relationship, and 3) identify the suitability of this method for other streams of the watershed that have varying phosphorus behaviours. Continuous monitoring of turbidity was accomplished using probes placed in four river systems of varying landuse (urban, agricultural and natural) in the Lake Simcoe watershed. Daily, or subdaily, water quality samples (for phosphorus) were available for a portion of the time period, but otherwise samples were collected on a biweekly and episodic event basis via the routine monitoring program. Continuous flow data was available also. Ultimately, greater understanding will be acquired regarding hydrochemical behaviour, and this knowledge could lead to application of the method in other tributaries of Lake Simcoe. This would strengthen the monitoring program of the watershed by providing superior water quality trend analysis and load quantification. *Keywords: Turbidity, Loadings, Phosphorus, Streams, Lake Simcoe.*

O'DONNELL, D.M., STRAIT, C.M., and EFFLER, S.W., Upstate Freshwater Institute, PO Box 506, Syracuse, NY, 13214. **Underway measurements of the inherent optical properties of Lake Erie and Lake Ontario.**

The inherent optical properties (IOPs) of natural waters are important regulators of the signal available to assess water quality from remote sensing. A flow-through system for measuring spectral IOPs was developed and then deployed aboard the EPA research vessel Lake Guardian during a six day period in August 2014. The measurements made along the ship's track covered over 1000 km and consist of over a million spectral scans. The IOPs of absorption (both total minus water, $a_{t-w}$ and dissolved, $a_{cdom}$), scattering and backscattering are presented. Ancillary measurements, made coincidentally with the IOP measurements, included temperature and fluorescence measurements of chlorophyll-a, phycocyanin and CDOM. The flow-through system's results are compared to laboratory derived measurements of $a_{t-w}$ and $a_{cdom}$ at selected stations. *Keywords: Remote sensing, Underwater optics, Lake Erie, Lake Ontario.*

O'MALLEY, B.P. and STOCKWELL, J.D., Rubenstein Ecosystem Science Laboratory, 3 College St., Burlington, VT, 05401. **Exploring Causes and Consequences of Lake Champlain's *Mysis* Decline: A Food Web Perspective.**

*Mysis* is an important benthic and pelagic prey resource supporting many common fish species in the Great Lakes and Lake Champlain. *Diporeia*, another key prey item, has declined substantially in Lakes Michigan, Ontario, and Huron, suggesting that fish communities may be increasing their reliance on *Mysis* in response, thus raising questions about the ability of *Mysis* to continue supporting fish production. *Mysis* densities in Lake Champlain were historically among the highest reported for the species, however their density declined drastically in the 1990s and have not shown any progress towards recovery since. The cause of this decline is not yet known. Concomitant with this decline were the zebra mussel invasion, changes in rotifers and smelt age-structure, and the initiation of sea lamprey control. This project seeks to explore potential biotic drivers (top-down and bottom-up) associated with the *Mysis* decline in Champlain and evaluate the direct and indirect consequences of reduced *Mysis* availability on fish communities. Using simulation modeling we hope to highlight bottlenecks limiting *Mysis* population recovery. Our findings will provide insight to predicting fish community response under varying scenarios of reduced *Mysis* in the Great Lakes. *Keywords: Lake Champlain, Zooplankton, Mysis.*

OBENOUR, D.R.[1], ROWE, M.D.[2], NALEPA, T.F.[3], VANDERPLOEG, H.A.[2], YOUSEF, F.[4], and KERFOOT, W.C.[4], [1]North Carolina State University, 2501 Stinson Drive, Raleigh, NC, 27607; [2]NOAA Great Lakes Environmental Research Laboratory, 4840 S. State Road, Ann Arbor, MI, 48108; [3]University of Michigan Water Center, 214 S. State Street, Suite 200, Ann Arbor, MI, 48104; [4]Michigan Technological University, 740 Dow Building, Houghton, MI, 49931. **Mapping the Dreissenid Mussel Invasion of Lake Michigan.**

Invasive dreissenid mussels are now found commonly throughout the lower four Laurentian Great Lakes. Previous studies have shown that these mussels are voracious filter-feeders, substantially altering the nutrient cycle and trophic status of aquatic systems. However, to fully understand the impacts of a dreissenid mussel invasion, it is important to compare the spatiotemporal variability in mussel biomass to other ecological indicators. In this study, we develop a geostatistical modeling approach to mussel mapping, and apply it to Lake Michigan. The approach utilizes benthic grab samples from lake-wide mussel surveys, and predicts biomass across space based on deterministic trends with spatial coordinates and bathymetry, along with a rigorous accounting of spatially correlated (and uncorrelated) stochasticity. Using these methods, we demonstrate biomass mapping at a high level of spatial resolution, and also demonstrate the probabilistic estimation of total biomass in different regions of the lake and in different years. Using the resulting biomass distributions for 1994-95, 2000, 2005, and 2010, along with satellite-derived chlorophyll concentration maps, we quantitatively assess how mussels have impacted phytoplankton abundance in the lake both spatially and temporally. *Keywords: Lake Michigan, Spatial analysis, Dreissena.*

OGOREK, J.M.[1], KRABBENHOFT, D.P.[1], DEWILD, J.F.[1], TATE, M.T.[1], THOMPSON, C.D.[1], MAGLIO, M.M.[1], LEPAK, R.L.[2], NETTESHEIM, T.[3], and WARREN, G.J.[3], [1]U.S. Geological Survey, Middleton, WI; [2]University of Wisconsin-Madison, Madison, WI; [3]U.S. Environmental Protection Agency, Chicago, IL. **Mercury and Methylmercury Content of Seston across the Great Lakes.**

In a joint effort by the U.S. Geological Survey and U.S. Environmental Protection Agency, an assessment of methylmercury (MeHg) and total mercury (HgT) was initiated across the Great Lakes; the focus of this paper is to describe results from seston sampling. Seston (>63 µm) was collected from all lakes in April and August (2011-2014) in surficial waters (top 20 meters) and analyzed for MeHg and HgT. Clear seasonal differences for seston MeHg were observed; April MeHg concentrations were approximately 2 times higher than August in all lakes except Erie, which decreased to half of August levels. Mean lake seston MeHg concentrations varied considerably (Superior>Huron>Michigan>Ontario>Erie), ranging 3.1 - 17.7 ng/g dry weight. Seston-water MeHg partitioning (log-$k_d$ ranged from 5.4 to 7.0 kg/L) reflected both seasonal and between-lake trends observed for MeHg concentrations. Seston HgT concentrations were more variable than MeHg, with April concentration increases only observed in some lakes. Mean lake seston HgT concentrations did not have strong trends between lakes and ranged 42.8 - 538 ng/g dry weight, with some notably high concentrations (>300 ng/g) in Erie and Ontario. Beginning August 2012, seston was size fractioned and weighed to provide standing masses; a more detailed data set will be reported. *Keywords: Environmental contaminants, Methylmercury, Mercury, Seston, Plankton.*

OKUM, S.[1], HOFFMAN, J.C.[2], PETERSON, G.S.[2], LIETZ, J.[2], MARTINSON, J.[1], and PILGRIM, E.[1], [1]U.S. EPA, 26 W. Martin Luther King Dr., Cincinnati, OH, 45268; [2]U.S. EPA, 6201 Congdon Blvd., Duluth, MN, 55804. **Investigating PCR Bias in Genetic Analyses of Larval Fish Communities.**

DNA barcoding, in conjunction with high-throughput DNA sequencing, has been used to investigate a more efficient and accurate way to perform bioassessments and detect invasive species. For early detection of invasive species, identification of rare and unusual specimens is especially important. In this study, larval fish samples were collected using various techniques from multiple shipping ports and other embayments of the Great Lakes.

Collected samples were initially identified morphologically to the lowest taxonomic level, and then were processed through our molecular workflow. Initial analyses of one genetic locus (COI) showed no strong correlation between species biomass and strength of genetic signal. We then investigated PCR biases by comparing sequence results to known quantities of fish DNAs combined in 10 mock communities. We will compare our samples using multiple genes to identify the structure of the sample and highlight apparent PCR biases that may affect detection of rare species. *Keywords: Genetics, Invasive species, Fish populations.*

ONI, S.K.[1], WELLEN, C.C.[2], and OSWALD, C.J.[3], [1]Department of Forest Ecology & Management, Swedish University of Agricultural Sciences, Umeå, 90183, SWEDEN; [2]School of Geography & Earth Sciences, McMaster University, 1280 Main St. West, Hamilton, ON, L8S 4K1; [3]Department of Geography & Environmental Studies, Ryerson University, 350 Victoria St, Toronto, ON, M5B 2K3. **Chloride Storage Across a Gradient of Urban Watersheds in Southern Ontario, Canada.**

In seasonally frozen environments such as Canada, de-icers (chloride salts) are widely used to maintain safe driving conditions. While the beneficial role of winter salt usage for public safety is unequivocal, recent studies suggest that chloride accumulates in watersheds causing summer baseflow concentrations to approach chronic exposure levels. In this study, we carry out watershed-scale chloride mass balance estimates for multiple urbanizing watersheds in southern Ontario. Chloride inputs to the study watersheds are estimated using municipal, regional/provincial road salt usage data coupled with geospatial information on road length and classification. While our mass balance calculations are designed to estimate the mass of chloride storage within each watershed they also incorporate significant uncertainty related to inputs of chloride salts for winter maintenance on private properties. To address this uncertainty, we use geospatial analysis of remote sensing imagery to estimate privately-owned impervious areas and apply a range of salt application rates to these areas to determine potential private inputs. The results of our mass balance estimates are used to examine the timing and magnitude of chloride movement through a watershed with respect to the extent, topology and connectivity of impervious areas. *Keywords: Urban watersheds, Chloride, Hamilton Harbour, Lake Simcoe.*

ORLANDO, S.A.[1], LUCENTE, J.E.[1], TOMAN, E.[2], HEEREN, A.[2], and HUTCHINS, E.G.[2], [1]Ohio Sea Grant College Program, 1314 Kinnear Road, Area 100, Columbus, OH, 43212; [2]The Ohio State University, School of Environment and Natural Resources, 316C

Kottman Hall, 2021 Coffey Road, Columbus, OH, 43210. **Preparing Marinas for the Next Super Storm: Addressing the Social Challenges Posed by Coastal Storms.**

The damage inflicted by Superstorm Sandy caused many marina managers in the Great Lakes to become concerned about the vulnerability of their marinas to coastal storms. While there are tools and resources available to help marinas prepare for coastal storms, it is not known whether marina owners in the Great Lakes are aware of these resources or if they are able to implement these recommendations to improve their coastal resiliency. Therefore, several of the vulnerabilities posed by coastal storms to marina operators are social challenges. For example, are the available tools and resources for preparing for (or responding to) coastal storms in a format that is accessible to marina operators? Is the information in tools developed elsewhere relevant to marina operators in the Great Lakes? Have marina operators experienced any limitations in preparing for coastal storms and how can future tools and resources be crafted to address these concerns? This project uses a series of focus groups, a type of qualitative social science methodology, conducted with marina operators in several Great Lake states. We will provide a mid-project update on what challenges marina operators are facing and how future resources and tools can help operators become more resilient when preparing for and responding to coastal storms.
*Keywords: Coastal ecosystems, Climate change, Water level.*

ORTIZ, J.D.[1], LEKKI, J.[2], PARAB, S.[1], ALI, K.A.[3], TOKARS, R.[2], ANDERSON, R.[2], AVOURIS, D.[1], BONINI, N.[1], ZHENG, F.[1], and HOLLISTER, K.[3], [1]Kent State University, Dept. of Geology, Kent, OH, 44242; [2]NASA Glenn Research Center, 21000 Brookpark Rd., Cleveland, OH, 44135; [3]College of Charleston, Dept. of Geology and Env. Sci., Charleston, SC, 29424. **An estimate of the composition of the 2014 Lake Erie CyanoHAB by VNIR derivative spectroscopy.**

The summer of 2014 resulted in significant economic losses for the of the City of Toledo and the regional economy due to the contamination and shutdown of the Toledo water supply and the loss of clean water for over 500,000 people during a three-day period. Was this bloom a monoculture? Here we apply a new analysis technique to hyperspectral field observations collected before and after the shutdown to better characterize the Lake Erie CyanoHAB. This new method developed in the Water Quality Lab at Kent State University allows the identification of phytoplankton and cyanophytes, suspended sediment and CDOM using visible derivative spectroscopy, a method with the potential to transform monitoring of algal composition and CyanoHABs in aquatic systems (Ortiz et al, 2013a,b, Ali et al. 2013, Ali et al. 2014). Our approach can be applied to multispectral and hyperspectral reflectance data collected in the field using handheld instruments, in the lab, or through airborne or satellite remote sensing. The results indicate the 2014 CyanoHAB exhibited considerable bio-complexity, with contributions from several types of cyanophytes, algae, suspended sediment, and colored dissolved organic matter. *Keywords: Harmful algal blooms, Cyanophyta, Lake Erie.*

OSBORNE, C., SNYDER, R., PÉREZ-FUENTETAJA, A., CLAPSADL, M.D., COCHRAN, J., and LANG, J., Suny Buffalo State, Buffalo, NY, 14216. **Reproductive Effort of the Emerald Shiner (Notropis atherinoides) in the Upper Niagara River, NY.**

The study of trade-offs between reproductive effort and physiological condition of breeding fish is an important aspect of life history theory. The relationship between reproduction and parental condition has been shown to be influenced by innate factors such as body size, age, and sex as well as by environmental factors including food availability and temperature. This study will use two different measures of reproductive effort to determine how reproductive effort varies among age classes, sexes, and across the spawning season for a small-bodied iteroparous fish, the emerald shiner (*Notropis atherinoides*). I will measure percent somatic lipid stores, gonadosomatic indices, and Fulton's condition factor "k" to determine the reproductive investment as well as the cost of reproduction for this species. This study will provide a detailed measure of reproductive energy allocation strategies for this important native forage species in a riverine environment. *Keywords: Life history studies, Fish, Niagara River.*

OSWALD, C.J.[1], MCCARTHY, L.H.[1], ONI, S.K.[2], and WELLEN, C.C.[3], [1]Ryerson University, 350 Victoria Street, Toronto, ON, M5B 2K3; [2]Swedish University of Agricultural Sciences, Umea, SWEDEN; [3]McMaster University, 1280 Main Street West, Hamilton, ON, L8S 4K1. **Meta-Analysis of Chloride Chronic and Acute Toxicity to Freshwater Invertebrates in Southern Ontario.**

In seasonally frozen environments, de-icers (chloride salts) are widely used to maintain safe driving conditions. While the beneficial role of road salts for public safety is unequivocal, their use may pose toxicity risks to benthic invertebrates, the foundation of many stream and lake ecosystems. In many urbanized catchments in southern Ontario, stream chloride (Cl) concentrations often exceed environmental protection guidelines set out by the Canadian Council of Ministers of the Environment during winter high flows and summer baseflow. However, the toxicity of Cl is lower in hard water environments, so there is uncertainty in how applicable the national guidelines are to southern Ontario's hard waters. Here we present probability distributions of acute (LC50) and chronic (reproductive success, growth rates) toxicity of Cl concentrations to freshwater invertebrates. This review will provide a foundation for proposing management targets that are specific to southern Ontario watersheds through quantitatively synthesizing the results of previous toxicity tests on key local species in many environments. Special focus will be given to the effect of hard water on reducing invertebrate Cl toxicity and the implications of this knowledge for setting effective winter maintenance management targets. *Keywords: Urban watersheds, Road salt, Benthic flora, Environmental management, Ecosystem health.*

OVERMIER, G. and COMER, B., Great Lakes Commission, South Industrial highway, Ann Arbor, Mi, 48104. **Great Lakes Tributary Modeling Program - Program Examples.**

The Great Lakes Tributary Modeling Program promotes partnerships and a coordinated approach to modeling sediment transport and implementing erosion and sediment control practices in priority watersheds. The program is a joint initiative between the U.S. Army Corps of Engineers (Corps), the Great Lakes states, federal agencies, universities, consulting firms and nongovernmental partners. Under the Tributary Modeling Program, the Corps and its partners develop watershed-specific modeling tools that can be used by state and local agencies and other stakeholders to plan and implement soil conservation and nonpoint source pollution implementation programs. While these programs are basin-wide in scope, numerous sediment modeling and soil erosion control projects have been developed for tributaries and watersheds in the Lake Erie basin. There are five completed models and nine that are in-progress that address nonpoint source priorities for Lake Erie. These models provide an insight into the sources and processes that deliver sediment to the harbors, bays and open lake. The models help conservation professionals and landowners locate and protect priority sediment source delivery areas. The models can also show land managers where the priority areas are to target implementation and help them identify areas for future implementation. *Keywords: Great Lakes basin, Nutrients, Model testing.*

# P

PAERL, H.W.[1], GARDNER, W.S.[2], MCCARTHY, M.J.[2], OTTEN, T.G.[3], PEIERLS, B.L.[1], ROSSIGNOL, K.L.[1], and WILHELM, S.W.[4], [1]Institute of Marine Sciences, The University of North Carolina at Chapel Hill, 3431 Arendell Street, Morehead City, NC, 28557; [2]Marine Science Institute, The University of Texas at Austin, 750 Channel View Drive, Port Aransas, TX, 78373; [3]3Department of Microbiology, Oregon State University, Corvallis, OR, 97331; [4]Department of Microbiology, The University of Tennessee, Knoxville, TN, 37996-0845. **Mitigating harmful cyanobacterial blooms: The case for dual nutrient (N & P) input reductions.**

Mitigating harmful cyanobacterial blooms (CyanoHABs) has historically focused on phosphorus (P) inputs, based on the assumption that nitrogen (N) fixation will supply ecosystem N needs. Much has changed in terms of human nutrient inputs to and climatic alterations of bloom-sensitive waters since this paradigm was introduced. Recent studies indicate that cyanobacteria flourish in response to combined N and P loading, or even N enrichment. The toxic CyanoHAB genus Microcystis often dominates under these conditions. This genus cannot fix atmospheric N2, and thus requires combined N sources to support growth. Despite decades of P loading controls in the Great Lakes basin and elsewhere, Microcystis blooms are proliferating worldwide, threatening drinking water supplies, fishing, tourism and sustainability of impacted systems. Burgeoning usage of N fertilizers, urban, agricultural wastes, and atmospheric N deposition have increased bioavailable N in receiving waters. N occurs in gaseous forms, unlike P, and is "lost" to the atmosphere via denitrification and other N sinks, perpetuating N-limitation. In-system N2 fixation does not appear to compensate for N loss, so external N input is a key driver of eutrophication. We suggest that the "P-only" management paradigm should be amended to incorporate controls on N inputs. *Keywords: Cyanophyta, Nitrogen, Eutrophication, Phosphorus, Nutrients.*

PALERMO, C.P. and DITTRICH, M., University of Toronto Scarborough campus, 1265 Military Trail, Toronto, ON, M1C 1A4. **Bacterial community analysis: Evidence for the biogenic origin of manganese-enriched sediment layers.**

The bacterial communities of Lake Superior sediments were examined to evaluate the biogenic origin of manganese (Mn)-enriched layers. The potential for anaerobic Mn(II) oxidation occurring in the Mn-enriched layer was investigated using enrichment cultures, 16S rDNA pyrosequencing, and high resolution electron microscopy and spectroscopic mapping.

Pyrosequencing analysis revealed that the Mn-enriched layer, compared with the Fe-enriched layer below, exhibited higher bacterial diversity and a higher proportion of classes with known Mn(II)-oxidizing members. These classes included the Alphaproteobacteria and Betaproteobacteria. Electron microscopy images showed bacterial cells encrusted with structures resembling Mn oxides, suggesting that the accumulation of Mn is linked to bacterial cells. Pyrosequencing of enrichment cultures suggested that these bacteria may be *Bacillus* species, indicating that *Bacillus* species may be responsible for Mn(II) oxidation under fluctuating redox conditions in Lake Superior sediments. Several virus-like particles encrusted with precipitates in close proximity to bacterial cells were observed, suggesting a significant role of viruses in the formation of the layers. Iron (Fe) and phosphorus (P) mapping revealed the potential for biogenic formation of Fe-phosphates. *Keywords: Biogeochemistry, Oxic-anoxic boundaries, Microbial communities.*

PALLADINO, D.A.[1], JOHENGEN, T.H.[1], RUBERG, S.A.[2], PURCELL, H.L.[1], MILLER, R.J.[1], ANDERSON, E.J.[2], VANDER WOUDE, A.J.[1], BURTNER, A.M.[1], and SMITH, J.P.[1], [1]Cooperative Institute for Limnology and Ecosystems Research, 440 Church Street, Ann Arbor, MI, 48109; [2]National Oceanic and Atmospheric Administration, 4840 South State Road, Ann Arbor, Mi, 48108. **Creating a More Complete Picture: Advancements in HAB Detection and Prediction in Western Lake Erie.**

The detrimental effects of HABs on ecosystems and human health are known, however the factors contributing to bloom initiation and persistence are not well understood in western Lake Erie (WLE). Advancements in our HABs detection and prediction have occurred through integration of weekly monitoring and continuous/real-time data, hyperspectral imagery and innovative modeling programs. The combination of nutrient and cyanobacterial data from these monitoring sites over the course of bloom seasons provide input for generating models of bloom development, such as the HABs Tracker. The HABs Tracker is an experimental information portal including a particle model incorporating satellite imagery and modeled/projected currents from the Great lakes Coastal Forecasting System to show probable bloom progression, real-time data from buoys and toxicity updates at sampling locations in WLE. The 2015 season will see the incorporation of autonomous underwater vehicle (AUV) equipped with temperature, conductivity, chlorophyll, blue green algae and turbidity sensors and aircraft flyovers with hyperspectral sensors into the tracker. Continuous in situ monitoring and nowcast wave time series are being used to examine local responses in water quality and HABs and indicate a tight coupling between physical drivers and ecological responses. *Keywords: Water quality, Harmful algal blooms, Model studies.*

PARSONS, C.T., REZANEZHAD, F., MAAVARA, T., O'CONNELL, D., and VAN CAPPELLEN, P., Ecohydrology Research Group, University of Waterloo, 200 University Avenue West, Waterloo, On, N2L 3G1. **Redox Controlled Internal Loading of Phosphorus and Silicon to Cootes Paradise Marsh.**

P concentrations in many wetland sediments have increased substantially over the last century due to excessive anthropogenic P loading to surface water. In contrast, Si loads to surface water have decreased during the same time frame. Wetland sediments are additionally subject to fluctuating redox conditions due to variable biological, physical and climatic drivers. We show through the use of in situ mesocosms and batch sediment suspension experiments that fluctuating redox conditions strongly influence the coupled biogeochemical cycles of C, N, Fe and S which in turn affect the speciation and mobility of P and Si. Results from batch experiments show that the mobility of both P and Si increases under reducing conditions due to both the dissolution of poorly crystalline FeOOH, and pH changes. However, solid phase speciation of P and Si and aqueous P:Si ratio varied considerably with redox conditions. This demonstrates a decoupling of the biogeochemical cycles of P and Si which could potentially influence algal community composition. In situ mesocosms suggest that diurnal redox cycling driven by photosynthesis and respiration does not exert a strong influence on internal loading of P or Si due to inhibition of Fe reduction by high nitrate concentrations in surface water. *Keywords: Phosphorus, Silicon, Nutrients, Redox, Sediments, Bioturbation.*

PATERSON, G.[1], RUSH, S.A.[2], JOHNSON, T.B.[3], DROUILLARD, K.G.[4], HAFFNER, G.D.[4], HEBERT, C.[5], ARTS, M.T.[6], MCGOLDRICK, D.J.[7], BACKUS, S.M.[7], LANTRY, B.F.[8], LANTRY, J.R.[9], SCHANER, T.[3], and FISK, A.T.[4], [1]SUNY-ESF, 1 Forestry Drive, Syracuse, NY, 13210; [2]Mississippi State University, Starkville, MS, 39759; [3]Ontario Ministry of Natural Resources, Glenora, ON, K0K 2T0; [4]Great Lakes Institute for Environmental Research, Windsor, ON, N9B 3P4; [5]Environment Canada, Ottawa, ON, K1A 0H3; [6]Ryerson University, Toronto, ON, M5B 2K3; [7]Environment Canada, Burlington, ON, L7R 4A6; [8]United State Geological Survey, Oswego, NY, 13126; [9]New York State Department of Environmental Conservation, Cape Vincent, NY, 14048; [10]Environment Canada, Burlington, ON, L7R 4A6. **Surviving the meltdown? Lake Ontario lake trout chemical tracer & biomonitoring data 1984 - 2008.**

The establishment of Ponto-Caspian species in the Great Lakes basin has resulted in ecosystem level changes that have been characterized as an invasional meltdown in part owing to the facilitative establishment of secondary and tertiary invaders during this

phenomenon. In this study, we quantified stable isotope (SI) and fatty acid (FA) ecological tracers and reviewed biomonitoring data for Lake Ontario lake trout collected between 1984 - 2008 to investigate this species' responses during the Ponto-Caspian species invasion. SI and FA tracers indicated that the nearshore shunt as associated with dreissenid establishment has changed the production pathways that have historically supported Lake Ontario lake trout. Biological metrics including total length and mass for 2 - 8 year old fish exhibited significant ($p < 0.001$) temporal increases with Fulton's condition index (K) increasing from $1.03 \pm 0.01$ to $1.21 \pm 0.01$ from 1984 - 2008. Energy densities estimated for lake trout demonstrated temporal declines but half-lives associated with these changes were negligible relative to the life-span of lake trout in Lake Ontario. These results demonstrate the adaptability of lake trout to Ponto-Caspian species induced ecosystem change and provide supporting evidence for lake trout rehabilitation in the Great Lakes. *Keywords: Biomonitoring, Lake trout, Lake Ontario.*

PATERSON, W.L.[1], BURLAKOVA, L.E.[1], KARATAYEV, A.Y.[1], and WATKINS, J.M.[2], [1]SUNY Buffalo State; Great Lakes Center, 1300 Elmwood Ave., Buffalo, NY, 14222; [2]Cornell University; Biological Field Station at Stackelton Point, 900 Shackelton Point Road, Bridgeport, NY, 13030. **An international approach to improve early detection of alien species in the Great Lakes.**

The Great Lakes Center of the Buffalo State College in collaboration with the U.S. Fish and Wildlife Service and the Baltic Marine Environment Protection Commission (HELCOM) tested detection methods of alien species in commercial shipping ports of the Great Lakes (Buffalo and Oswego Harbors). The methods used were adapted from HELCOM's 2013 survey protocol for identifying alien species, and the data will be shared with European partners using their Risk Assessment Tool database. We tested seven different sampling methods in May and September of 2014 and collected 28 vertical zooplankton tows, 15 ponar samples, 18 wall scrapings, six benthic sled tows, four minnow trap samples, four light trap samples, and three settlement plate samples. The results from this year's study will be used to determine which method or a combination of methods are most effective and help to direct the application of these methods when the project is expanded to other ports in the Great Lakes. *Keywords: Invasive species, Benthos, Zooplankton.*

PATTERSON, K.A.[1], ROBILLARD, S.R.[2], and STEIN, J.A.[1], [1]Illinois Natural History Survey, University of Illinois, Champaign, IL; [2]Illinois Department of Natural Resources,

Des Plaines, IL. **If it's There, They'll Find it: Reef Utilization by Lake Trout Populations in Southern Lake Michigan.**

Lake Michigan Lake Trout populations collapsed in the 1950s and a variety of stocking strategies have been implemented to facilitate reestablishment. All Lake Trout stocked in Lake Michigan have been marked with fin clips or adipose fin clip and coded-wire tag (CWT); Julian's Reef, a designated Lake Trout stocking area in Illinois waters, has been stocked since 1981. To evaluate success of reestablishment we monitored the spawning population at Julian's Reef with annual (1999-2014) October-November gill net surveys and compared this to the success of a nearby undesignated location, Waukegan Reef. There was no difference in catch per unit effort between the spawning sites ($P = 0.18$). Unmarked fish have increased exponentially at both locations with ~50% of the recent catch having no fin clips. Information from CWTs indicated that a greater proportion of fish sampled on both reefs were stocked outside of southern Lake Michigan (90-680 km away), and these fish were significantly older (P's<0.01) compared to those stocked on Julian's reef. Trends in age, origin, abundance and location offers valuable insight into the populations utilizing designated and undesignated reefs, and should be considered in a lake wide monitoring context by Lake Michigan managers. *Keywords: Lake Michigan, Population dynamics, Lake trout, Fish management.*

PATTRIDGE, R.[1], RINCHARD, J.[1], and WALSH, M.G.[2], [1]College at Brockport, State University of New York, Brockport, NY; [2]USGS Lake Ontario Biological Station, Oswego, NY. **Use of Fatty Acid Signatures to Assess Food Web Trophic Interactions in Lake Ontario.**

Fatty acid signatures (FAS) are currently used in food web studies to assess trophic interactions between predator and prey. If we are able to distinguish differences in the FAS of major prey fish in Lake Ontario, we can use these FAS to assess feeding habits of top predators. In this study, three major prey fish (alewife, rainbow smelt, and round goby) were collected at three sites along the south shore of Lake Ontario (Olcott, Rochester, and Oswego) during the spring and fall of 2013. Major predator species (including lake trout, brown trout, chinook salmon, and coho salmon) were collected along the south shore of Lake Ontario during the summer of 2013. Using multivariate statistics, FAS were compared among all predator and prey species as well as among location and between seasons for prey fish. Differences in FAS among prey species were greater than any spatio-temporal differences detected. FAS among predator species were also significantly different. Our results demonstrate the applicability of FAS as a tool for assessing predator feeding habits and provide needed FAS data for species of interest in Lake Ontario. Moreover, differences found in the FAS of prey species enables us to compare predator FAS to assess trophic interactions in Lake Ontario's food web. *Keywords: Fish, Food chains, Trophic level.*

PAUER, J.J.[1], ZHANG, X.[2], MELENDEZ, W.[3], DE PETRO, P.A.[4], and KREIS, JR., R.G.[1], [1]US Environmental Protection Agency, 9311 Groh Road, Grosse Ile, MI, 48138; [2]Trinity Engineering Associates, 9311 Groh Road, Grosse Ile, MI, 48138; [3]CSC, 9311 Groh Road, Grosse Ile, MI, 48138; [4]Michigan DEQ, 525 West Allegan Street, Lansing, MI, 48909. **What Models can Teach us about Watershed-Nearshore Relationships that Observational Studies Cannot.**

The nearshore waters of the Laurentian Great Lakes are a valuable resource for drinking water, recreation, fishing, wildlife and industrial usage. However, environmental concerns such as eutrophication and the colonization of invasive species have resulted in the call for an overall assessment of this zone in the most recent Great Lakes Water Quality Agreement. Several observational studies in the Great Lakes have been performed to improve our understanding of the nearshore and the impact of the watershed on this zone. A limitation of these studies is that they only provide a snapshot of the nearshore conditions. In contrast, mathematical models have the ability to describe and forecast spatial and temporal changes of these conditions under different loadings, meteorology and lake hydrodynamics. Here we will present the results of a model showing the cause-effect relationship between the Grand River discharge and the nearshore zone of Lake Michigan. A 2km x 2km grid encompassing the nearshore area around the river mouth was nested within a lake wide model; mathematical equations were implemented to describe nearshore conditions. The model results show the impact the riverine load on areas adjacent to the river mouth over time, and in addition reveal some surprising findings not previously apparent in observational studies. *Keywords: Coastal ecosystems, Model studies, Lake Michigan.*

PEARSALL, D.R.[1], KAHL, K.J.[1], ANNIS, G.[1], DORAN, P.[1], and GAME, E.T.[2], [1]The Nature Conservancy, 101 E. Grand River Ave., Lansing, MI, 48906; [2]The Nature Conservancy, 245 Riverside Drive, West End Brisbane, QLD4101, AUSTRALIA. **Conservation for People: Integrating Human Wellbeing into Coastal Conservation for Western Lake Erie.**

The western basin of Lake Erie and its coastal region (WLE) are recognized globally for high biodiversity value, and also support substantial economic and cultural values. Prior conservation planning for WLE has focused on ecological features and threats to these features. We have extended that focus by identifying and integrating aspects of human wellbeing to create a vision for conservation that can meet ecological and socioeconomic goals. We've engaged public and private partners in Ohio, Michigan, and Ontario to clarify priorities and obtain data to spatially represent these ecological and socioeconomic values, and have optimized conservation areas to achieve multiple goals. Results suggest that achieving biodiversity conservation goals would benefit most of the socioeconomic values considered. Coastal areas that contain current and potential wetlands and high terrestrial biodiversity are of greatest importance for conservation and support values such as hunting, birding, and public access to water. Large inland areas are critical migratory bird stopover habitat and also include trails and water intake areas. The mapped products of this multi-objective effort will enable a diverse set of regional partners to focus and prioritize conservation investment and actions in areas to benefit both biodiversity and human wellbeing. *Keywords: Coastal ecosystems, Socioeconomic values, Conservation, Spatial optimization, Lake Erie.*

PEARSON, R.A.[1], GOODALE, W.[2], and WILLIAMS, K.[2], [1]Great Lakes Commission, Ann Arbor, MI, 48104; [2]Biodiversity Research Institute, Gorham, ME, 04038. **Monitoring and Mapping of Avian Resources over the Great Lakes to Support Management.**

Without adequate knowledge of pelagic bird migration patterns and other use of the Great Lakes, wildlife agencies are poorly equipped to recommend measures to avoid and minimize take and habitat loss. The Great Lakes Commission (GLC) and the USFWS have coordinated aerial surveys of pelagic birds over selected areas of lakes Michigan, Huron, St. Clair and Erie. Phase 3 is planned for the development of a data management system, engagement with natural resource and wildlife managers, and a comprehensive dissemination of project results. This project is making significant contributions toward filling critical data gaps about bird distribution and abundance to inform future management and conservation decisions related to offshore wind and other human activities that might affect these birds through their life cycles. Data is distributed through the Midwest Avian Data Center and the GLC Wind Atlas. These data can enhance our understanding and ability to predict impacts of botulism outbreaks on avian communities. Additionally, this regional project will inform many USFWS programs, state wildlife programs and spatial planning efforts undertaken by the state coastal programs. *Keywords: Great Lakes pelagic birds, Data acquisition, Decision making, Coastal ecosystems, Data storage and retrieval.*

PENG, F. and EFFLER, S.W., Upstate Freshwater Institute, P.O. Box 506, Syracuse, NY, 13214. **Single-particle optics approach in studying IOPs of mineral particles and optical variability.**

Light attenuation by suspended particles in aquatic systems regulates water clarity (thus water quality) as well as the magnitudes and the spectral features of remote-sensing reflectance. Mineral particles, efficient light scatters, are important to the optical regimes of coastal and inland waters where mixed particle assemblages are more prevalent than in the open oceans. A unique individual particle analysis (IPA) technique (scanning electron microscopy with automated image and X-ray analyses; SAX) has been used to provide characterizations of the light-attenuating attributes (size and composition) of individual mineral particles collected from the Great Lakes and other aquatic systems. IPA results are used in Mie theory calculations of scattering and backscattering coefficients (i.e., inherent optical properties, IOPs) of the mineral particle populations. We have documented the application of this SAX-Mie approach in the following areas: (1) partitioning the bulk particulate IOPs into contributing components (algae, calcite, clay minerals), (2) understanding the optical variability of natural waters, (3) pursuing closure of optical modeling (particulate scattering and backscattering) with bulk measurements (promising results documented), and (4) acquiring surface 'ground-truth' for remote-sensing algorithm development. *Keywords: Water quality, Hydrologic optics, Satellite technology, Inherent optical properties of mineral particles, Sediments, Single-particle optics.*

PENNUTO, C.M.[1] and RUPPRECHT, S.M.[2], [1]Great Lakes Center, Buffalo State College, 1300 Elmwood Avenue, Buffalo, NY, 14222; [2]Biology Department, Buffalo State College, 1300 Elmwood Avenue, Buffalo, NY, 14222. **Round Goby Swimming Behavior and Fin Morphology May Facilitate Upstream Range Expansion.**

Range expansion by invasive taxa can be facilitated by a wide range of life history traits, behavioral repertoires, or via human-aided transportation. Since other Gobiidae are adept waterfall climbers, we investigated whether body scaling morphometrics or swimming patterns in round gobies (*Neogobius melanostomus*) were comparable, and thus suggestive of climbing capability. Round gobies swam less frequently, limited their swimming mode to caudal thrusts, and sought shelter more as velocity increased. Caudal fin area, but not pelvic fin area, exhibited an allometric growth patterns versus weight in adult gobies, whereas neither caudal nor pelvic fin area showed allometric increases versus weight in juveniles. Pelvic fin area in both adults and juveniles grew allometrically compared to length, whereas caudal fin area increased allometrically only in juveniles. Fin morphometric results suggest, theoretically, that neither adults nor juveniles have pelvic fin areas large enough to support their weight against gravity forces, but the areas are sufficient to withstand hydraulic drag forces. Collectively, our results suggest in-stream barriers which force migrating fish to overcome gravity should be impassable, but that barriers allowing fish to remain submerged would be navigable. *Keywords: Round goby, Fish behavior, Invasive species.*

PERELLO, M.M.[1], DONER, L.A.[2], and SANTRY, V.A.[2], [1]Center for the Environment, Plymouth State University, 17 High Street, MSC 63, Plymouth, NH, 03264; [2]Environmental Science and Policy Department, Plymouth State University, 17 High Street, MSC 63, Plymouth, NH, 03264. **Linking the Impacts of Land Use and Changing Climate with Lake Water Quality in New Hampshire (USA).**

With water quality as a key issue in water resource management, the need to understand the impacts of land use and climate on freshwater systems has never been greater. Lakes are particularly responsive to watershed changes, many of which are ephemeral, captured only by continuous monitoring. Lake sediments continuously record and archive lake conditions, potentially filling gaps in monitoring datasets. This study aims to identify transient, sub-annual changes in sedimentary archives, using integrated data from lake water chemistry, sediment traps and sediment cores in two northern lakes: Ossipee and Squam, NH. We compare our findings with documented records of local land use and climate change to determine how these manifest in our lake records. Our resulting time series include water column data for temperature, dissolved oxygen, major ions and phosphorus in depth profiles in every season, and a sedimentary time series, extending to pre-Colonial times, which includes Pb-210 activity, particle size, diatom community assemblages, and mineral chemistry. We use PCA to identify sediment variables closely associated with water quality, climate, and land use indicators, which is then used to inform local community stakeholders on potential impacts of land use and changing climate in their respective watersheds. *Keywords: Climate change, Water quality, Sediments.*

PÉREZ-FUENTETAJA, A.[1], SNYDER, R.[2], CLAPSADL, M.D.[1], COCHRAN, J.[1], OSBORNE, C.[2], and LANG, J.[2], [1]Great Lakes Center, SUNY - Buffalo State, 1200 Elmwood Ave., Buffalo, NY, 14222; [2]Biology Dept., SUNY - Buffalo State, 1200 Elmwood Ave., Buffalo, NY, 14222. **Population dynamics and reproduction of the emerald shiner in the upper Niagara River.**

The emerald shiner (*Notropis atherinoides*) is a native fish to the Great Lakes that enters tributaries and connecting rivers in early spring seeking warmer waters. A prey fish, the shiners not only support avian and piscivorous fish food webs, but also the bait industry in the region. Little is known on the population dynamics of this important species in key habitats, such as the Niagara River (a designated Important Bird Area), where they sustain migrating and resident bird populations. An intensive electrofishing sampling effort in the upper Niagara in 2014 revealed a size-frequency distribution with a mean length range from 40-52 mm total length; the largest fish reached 100 mm. Young-of-year shiners recruited into our gear at 19 mm. Shiners were in their best condition from late June to early September, indicating increased resources in the river, which preceded gonad development and reproduction. Female gonadosomatic index (GSI) peaked from June 25th to July 10th when water temperatures reached 20ºC-22ºC, indicating a spawning event during that time period. The heaviest gonads corresponded to females 75 mm or above, however, reproduction likely involved females over 60 mm in length. Juvenile shiners formed large figure-eight schools near marinas along the river. *Keywords: Fish populations, Niagara River, Life history studies.*

PERHAR, G. and ARHONDITSIS, G.B., University of Toronto, 1265 Military Trail, Toronto, ON, M1C1A4. **Using Daphnia physiology to drive food web dynamics: Lotka Volterra revisited.**

Daphnia represents a key trophic link between primary producers and secondary consumers in aquatic food webs. Because of their large community density, relatively short life spans, high phenotypic diversity, and ability to exert grazing pressure on algae, they can be reliable indicator organisms for physical, chemical, and biological processes in aquatic ecosystems. Here, we present the integration of a mechanistic metabolite-driven model of an individual daphnid into a food web setting. Our daphnid model explicitly considers multiple physiological functions (e.g., neurotransmission, bioenergetics, osmoregulation, excretion, anabolism, reproductive investment), accounts for organism priorities/strategies, and uses both mass and energy as currency. We highlight the smoothing effect of added physiological complexity on well-understood Lotka Volterra dynamics, and discuss the sequence of events that take place leading up to abrupt and non-linear shifts in ecosystem dynamics. The aim of this work is to lay the foundation for a strategic early warning system. Ideally, our modeling approach of blending aquatic ecology with organism physiology will help articulate the shifts in Daphnia physiology preceding abrupt ecosystem shifts into meaningful metrics. *Keywords: Mathematical models, Fatty acids, Zooplankton, Metabolomics, Bioindicators, Ecosystem integrity.*

PERHAR, G., University of Toronto, 1265 Military Trail, Toronto, ON, M1C1A4. **Using large-scale machine learning and public sentiment for a more informed decision making process.**

Real time public sentiment has long been a difficult measure to quantify, but the advent of social media and the dropping costs of data storage have created a new interest in data mining and machine-learning. Using Natural Language Processing, the basic attitude (e.g., positive, neutral, negative) underlying a body of text can be extracted. Twitter (TWTR, Nasdaq) has nearly 1 billion users, with 500 million tweets sent out every day. Analyzing these signals gives us the opportunity to understand what is being said online, why, and from where. Here I present a sentiment analysis program that crawls blogs, newspapers, scholarly articles, and Twitter for information on a user-defined environmental topic, disaster, or policy. Online posts and Twitter feeds are automatically assessed for sentiment and summarized, providing the general mood towards the user-defined input. The ultimate goal is to provide the user with a one-stop snapshot of the topic at hand. As an example, I illustrate the geo-, temporal-, and political disparities in sentiment for the Keystone XL pipeline. Leveraging social media with artificial intelligence makes it possible to understand the sentiment of constituents in real-time, and is thus a potentially priceless tool for informed decision-making. *Keywords: Public participation, Machine learning, Policy making, Water quality.*

PERRI, K.A.[1], WATSON, S.B.[2], and BOYER, G.L.[1], [1]State University of New York - College of Environmental Science and Forestry, 1 Forestry Drive, Syracuse, NY, 13210; [2]Environment Canada - Watershed Hydrology and Ecology Research Division, 867 Lakeshore Road, Burlington, ON, L7S 1A1. **Photosynthetic Yield ($F_v/F_m$) as a Cellular Health Indicator for Cyanobacteria.**

Photosynthetic yield ($F_v/F_m$), based on measures of fluorescence, has been used as a measure of cellular health in both field populations and laboratory cultures of freshwater phytoplankton. It has been applied to assess the condition of Great Lakes plankton communities. The traditional value of $F_v/F_m$ of ~0.6 as the benchmark for healthy cells was derived using eukaryotic organisms. As such, it may not be appropriate for cyanobacteria due to their different photosystem structure. We compared the $F_v/F_m$ values obtained for multiple strains of eukaryotic algae and cyanobacteria, including bloom-forming taxa (*Anabaena/Dolichospermum*, *Microcystis*) from the Great Lakes, under replete and limited nutrient conditions. $F_v/F_m$ was measured using the traditional DCMU method and different instrumentation of increasing complexity including the Genty parameters from a bbe Algal

Online Analyzer, a Turner Designs PhytoFlash, and a Waltz PhytoPAM. Findings of this study and their implications for culture and fieldwork in the Great Lakes will be presented. *Keywords: Cyanophyta.*

PETCHPRAYOON, P.[1], BLANKEN, P.D.[2], and HUSSEIN, K.[3], [1]Geo-Informatics and Space Technology Development Agency, Bangkok, THAILAND; [2]Geography Department, University of Colorado, Boulder; [3]CIRES, University of Colorado, Boulder. **Spatiotemporal Distribution of Evaporation over Lake Huron.**

This study examines the spatiotemporal variability of instantaneous daily lake-wide evaporation using remotely-sensed data from MODerate resolution Imaging Spectroradiometer (MODIS) onboard Terra satellite together with field measurements. A good agreement was found between evaporation calculated from satellite data and the measured evaporation from in-situ eddy covariance measurements over a time period from 2002-2012. The seasonal and the annual values of the two methods were very close with a correlation coefficient of 0.95. The spatial distribution of the over lake evaporation showed temporal and spatial heterogeneities. About 70 % of the annual mean evaporation occurred during the fall (September, October, and November) and winter (December, January and February) seasons. The highest evaporation rate was in December, with about 16 % of the annual mean 30-minute lake-wide evaporation, particularly in the middle and northern part of the lake, whereas the lowest evaporation rate occurred in June with only 4% of the annual 30-minute mean evaporation, especially in the deep, mid-region of the lake. Here, we discuss variations in the spatial distribution patterns of lake-wide evaporation and the relationship to recent climate change, Also, the effect of ice cover on spatiotemporal distribution of evaporation is discussed. *Keywords: Spatial distribution, Evaporation, Air-water interfaces, Remote sensing.*

PETERSON, G.S.[1], LIETZ, J.[2], HOFFMAN, J.C.[1], and PILGRIM, E.[3], [1]Environmental Protection Agency, Duluth, MN; [2]Environmental Protection Agency, ORISE participant, Duluth, MN; [3]Environmental Protection Agency, Cincinnati, OH. **Morphological Features to Distinguish the Larval Stage of Invasive Ruffe from Native Fish Species.**

Larval fish surveys are used in a variety of research and monitoring activities, including identification of nursery habitat and invasive species early detection. Morphologically-based taxonomic identification of larvae collected from these surveys, however, is often challenging. Current keys for Great lakes basin larval fishes are limited for many species, often lacking descriptions for certain developmental stages. Families such as

Cyprinidae, Percidae and Centrarchidae present particular challenges for species-level identification. In our surveys, we had difficulty correctly identifying Ruffe, (*Gymnocephalus cernuus*), a recently-introduced species in the family Percidae. Ruffe is not included in the existing Great Lakes larval fish key and is inconsistently described in the scientific literature. Using DNA-based taxonomic identification we discovered and verified erroneous descriptions of larval Ruffe that may have led to misidentification by confusing it with native species. Here, we describe key morphological diagnostics for larval Ruffe identification, as well as morphologically similar and potentially confusing native species of the families Percidae and Centrarchidae. This is the first study to provide such diagnostics, and thus aids correct morphologically-based identification of Great Lakes fish larvae. *Keywords: Invasive species, Monitoring, Fish.*

PEZZUOLI, A.R., FARRELL, J.L., EICHLER, L.W., BOYLEN, C.W., and NIERZWICKI-BAUER, S., Rensselaer Polytechnic Institute - Darrin Freshwater Institute, 5060 Lakeshore Dr, Bolton Landing, NY, 12184. **Examination of the Zooplankton Community of Lake George NY With Regards to Trophic Status.**

Extensive lake wide chemical monitoring since 1980 has shown a noticeable increase in chlorophyll levels in Lake George NY. This inferred increase in phytoplankton density coupled with the recent introduction of the invasive spiny waterflea (*Bythotrephes cederstroemii*) are two changes to the state of the lake that have potential to greatly alter the zooplankton community over this time period. The changes are not consistent throughout the entire lake, and this study examines differences in the rotifer communities between the basins as a function of trophic status, and presents a comparison of the current abundance and distribution with values reported nearly 30 years earlier. The communities in the north and south basins of the lake have different structures, likely influenced by the chemical and biological differences between their environments. Furthermore this study also reports four species *Conochiloides dossuarius*, *Conochiloides natans Ploesoma truncatum* and *Collotheca pelagica* for the first time in Lake George demonstrating the biological impact of the eutrophication process in the last 30 years. Since Lake George is approaching mesotrophic conditions at the southern end, the changes in community structure may be related to the early effects of eutrophication. *Keywords: Zooplankton, Eutrophication.*

PHILLIPS, P.J., SCOTT, T.M., KOLPIN, D.W., FOREMAN, W.A., FURLONG, E.T., COLELLA, K.A., and GRAY, J.A., US Geological Survey, Troy, NY, 12020. **Long-term Trends in Pharmaceuticals and Other Contaminants in Wastewater Plant Eflfuents.**

There are very few data available to assess long-term trends (>5 years) and seasonal variability in pharmaceutical concentrations in WWTP effluents. In order to assess different factors affecting observed long-term trends of pharmaceuticals, three wastewater treatment plants were sampled between 2004-2013. For this study four different WWTP's were sampled in upstate NY. Three sites were sampled on at least a quarterly basis between 2004-2013. Seven pharmaceuticals (butalbital, diazepam, metaxalone, methadone, oxycodone, phendimetrizine, and carisoprodol) and caffeine were assessed during the study. Changes in pharmaceutical concentrations observed in NY2 effluents corresponded to the phase out of production at the PMF site discharging to this site; for example, butalbital concentrations ranged from 0.1 to over 10 ug/L before 2010, but decreased to around 0.1 after 2010. Some pharmaceutical concentrations in this effluent declined just after the announcement of the PMF shutdown, but others did not decline until just before the final shut down two years later. Concentrations of pharmaceuticals at NY3 (the plant that did not have a PMF shutdown) did not generally show declines. *Keywords: Endocrine disruption, Environmental contaminants, Water quality.*

PICHEL, W.G.[1], MONALDO, F.M.[2], JACKSON, C.[3], and LESHKEVICH, G.A.[4], [1]NOAA/NESDIS/STAR/SOCD, 5830 Univ. Res. Ct., College Park, MD, 20740; [2]Johns Hopkins Univ. APL Space Exploration Sector, 11100 Johns Hopkins Rd., Laurel, MD, 20723; [3]GST at NOAA NESDIS/STAR/SOCD, 5830 Univ. Res. Ct., College Park, MD, 20740; [4]NOAA/OAR/GLERL, 4840 S. State Rd., Ann Arbor, MI, 48108. **Current NOAA Operational Satellite SAR-Derived Wind Products and Plans for Utilizing Sentinel-1 Data.**

In May 2013, the U.S. National Oceanic and Atmospheric Administration (NOAA) began operational production of high-resolution sea/lake surface winds derived from satellite synthetic aperture radar (SAR) imagery from the RADARSAT-2 satellite. These unique wind products are at a resolution of 500 m and measure winds right up to the coast and in lakes, bays and straits, making these products particularly valuable for safety of coastal transportation and low-flying aircraft in regions with rugged coastal topography and in smaller bodies of water. There are emerging applications for these SAR wind products in support of offshore wind farms, to provide unique information on the structure of hurricanes and severe storms, and in illuminating many coastal wind phenomena such as gap winds, barrier jets, and island wakes. Current efforts to further develop this new product include use of SAR imagery from the recently-launched Sentinel-1a satellite; new wind product formats and product distribution methods include CoastWatch, the Advanced

Weather Interactive Processing System (AWIPS), and Thematic Real-time Environmental Distributed Data Services (THREDDS); and archive of the wind products by NOAA's National Oceanographic Data Center (NODC). *Keywords: Remote sensing, Wind fields, Satellite technology, Great Lakes basin.*

PILGRIM, E.[1], OKUM, S.[1], MARTINSON, J.[1], LIETZ, J.[2], PETERSON, G.S.[2], and HOFFMAN, J.C.[2], [1]U.S. EPA, 26 West Martin Luther King Dr., Cincinnati, Oh, 45268; [2]U.S. EPA, 6201 Congdon Blvd., Duluth, MN, 55804. **Detecting larval invasive fish with high-throughput DNA sequencing.**

The ability to detect propagules of invasive species is a key element in any invasive species monitoring and detection program for the Great Lakes. These propagules of many invaders, such as larval fish, can be difficult to distinguish from native species. Genetic methods like DNA barcoding can be applied to these troublesome larval specimens for species-level identification. High-throughput DNA sequencing further advances molecular detection of invasive propagules by describing the species diversity of samples with a few or many individuals. We have applied this DNA metabarcoding technique to a variety of recent samples from the Great Lakes. In this presentation, we will compare our results to morphological identification, discuss techniques that make genetic analyses successful, and outline the utility of this method as a potential application for monitoring invasive fish propagules in the Great Lakes. *Keywords: Invasive species, DNA barcoding, Genetics, Fish populations.*

PILGRIM, K.M.[1], HAWLEY, J.J.[1], BANKSTON, J.L.[1], WAGNER, T.S.[1], SHEETS, B.A.[1], and SMITS, J.[2], [1]Barr Engineering Company, 4700 West 77th Street, Minneapolis, MN, 55435; [2]Deltares, Boussinesqweg 1, Delft, NETHERLANDS. **Evaluation of Nutrient Management Benefits With 3-D Lake Hydrodynamic and Water Quality Modeling.**

Predicting the potential effect of management actions for lakes of all sizes is a worthy endeavor given the high expense of many restoration efforts. A 3-dimensional hydrodynamic and ecological model (Delft 3D) was developed for Fountain Lake in Albert Lea, MN, to predict water quality and habitat benefits with: 1) targeted removal of sediment that contributed to internal phosphorus loading, and 2) management of external phosphorus loads. One of the benefits of the Delft 3D model was its capability to include differences in sediment chemistry across the lake bottom as well as sediment chemistry changes with dredging. Dredging affects bathymetry, water column stratification, mixing frequency, and light penetration. The model was chosen because it could integrate these physical and chemical changes in Fountain Lake and hence produce a more mechanistic prediction of water quality with internal and external load reductions. Dredge prisms were defined to maximize the removal of phosphorus species that contribute most to internal phosphorus loading. A range of external nutrient loads were also evaluated to determine if external nutrient management alone could achieve in-lake nutrient criteria. This tool was critical for evaluating lake management strategies and communicating outcomes to project stakeholders. *Keywords: Algae, Ecosystem modeling, Nutrients.*

PILLA, R.M.[1], WILLIAMSON, C.E.[1], ZHANG, J.[2], SMYTH, R.L.[3], LENTERS, J.D.[4], BRENTRUP, J.A.[1], and KNOLL, L.B.[5], [1]Department of Biology, Miami University, Oxford, OH; [2]Department of Statistics, Miami University, Oxford, OH; [3]Center for Environmental Policy, Bard College, Annandale-on-Hudson, NY; [4]LimnoTech, Ann Arbor, MI; [5]Lacawac Sanctuary, Lake Ariel, PA. **Lakes as Sentinels of Climate Change: Lake Responses to Precipitation and DOC.**

Lakes can serve as one of the most valuable sensors of climate change because they quickly integrate watershed-scale signals into their physical, chemical, and/or biological characteristics. One pronounced sentinel response of lakes is increases in surface water temperatures and strength of thermal stratification, which have been largely attributed to warming air temperatures. An initial phase of this project found that two small lakes in Pennsylvania have experienced surface warming, hypolimnion cooling, and strongly increased strength of stratification over 27 years; however, no increases in air temperature were observed over the same study period. These changes in thermal structure were shown to be largely related to increases in precipitation leading to increases in dissolved organic carbon and consequent decreases in water transparency, causing changes in vertical distribution of absorbed solar radiation. A second phase considers long-term temperature profile data from lakes around the world to better understand deepwater temperature and stratification trends and to assess whether lakes in some regions are particularly responsive, and whether climate teleconnections (e.g., ENSO) are an important driver of the thermal responses of lakes in different regions. *Keywords: Dissolved organic matter, Lake temperature, Climate change.*

PINHEIRO, V.M., MARSDEN, J.E., and STOCKWELL, J.D., University of Vermont, 3 College st, Burlington, VT, VT, 05401. **Lake Trout Spawning Site Utilization in Lake Champlain.**

Lake Trout (*Salvelinus namaycush*) disappeared from Lake Champlain by 1900, though the causes of this disappearance are poorly understood. Lake Trout have been stocked since 1972 and the population still shows no evidence of natural recruitment. Initial research was focused on describing the spawning habitats, but remarkably little is known about how Lake Trout use them. Males are more abundant than females on spawning sites early in the spawning season and specific sites may be used, perhaps year after year. The focus of this project is to describe the spawning movements of male and female Lake Trout within and among spawning seasons via acoustic telemetry. We hypothesize that males will show site fidelity and remain at a preferred site during the spawning season, whereas females will 'sample' multiple spawning reefs to maximize their reproductive success. This hypothesis will be supported if males spend more time on spawning sites than females, visit fewer sites, and return to the same preferred site year after year. We are using the unique approach of defining site residence by comparing the detection rates of tagged organisms to real-time detection probabilities of onsite sentinel tags to account for dynamic detection ranges. Limited data to date suggest both sexes select a preferred spawning site. *Keywords: Acoustic Telemetry, Lake trout, Spawning Behavior.*

POINT, A.D., DELACH, D.L., CRIMMINS, B.S., and HOLSEN, T.M., Clarkson University, 8 Clarkson Ave, Potsdam, NY, 13699. **Perfluoroalkyl Acid (PFAA) Concentrations and Accumulation Potential Among Great Lakes Fish.**

Since their first reported presence in biota in 2001, perfluoroalkyl acids (PFAAs) have been found worldwide in environmental media. Though their sources are still being characterized, these compounds have been detected in many components of the Great Lake food webs with contrasting conclusions on their bioaccumulative tendencies. Predator and prey species were collected from Lake Superior in 2011, Lake Huron in 2012, and Lake Ontario in 2013 (Lake Ontario analysis is currently ongoing).PFAAs were detected in all samples. Prey fish in both lakes Superior and Huron typically have greater total PFAA concentrations than those observed in predator fish. For example, Lake Huron where smelt concentrations (22.49 ± 12.48 ng/g w.w.) far exceeded those of lake trout (16.51 ± 8.49). PFOS consistently measured at the highest concentration relative to other compounds. In Lake Superior fish, PFOS concentrations were the greatest in deepwater sculpin (14.06 ± 11.40 ng/g w.w.). Total PFAAs were detected in lake trout at concentrations as high as 46.17 ± 43.50 ng/g w.w. in Lake Superior. The presentation provides a detailed analysis of the food chain flow of PFAAs bioaccumulation using dietary metrics such as stable isotopes of C and N, and fatty acid profiles. *Keywords: Bioaccumulation, Environmental contaminants, Fish.*

POMARI, J. and NOGUEIRA, M.G., São Paulo State University, Distrito de Rubião Jr. S/N, Botucatu, SP, 18618-970, BRAZIL. **An Inter-Decade Limnological Study on Jurumirim Reservoir - a Subtropical Spatially Complex System.**

Jurumirim is a large reservoir located in São Paulo State (southern Brazil) built up in 1962 for electric power generation and water accumulation for flow regulation in a downstream cascade. The structure seems to be determined by a longitudinal gradient in the trophic conditions. A reevaluation of the spatial compartmentalization, from the perspective of the water quality evolution, is presented after two decades of the first studies. Physical, chemical and biological data and water quality index (WQI-NSF) were determined. Recent sampling campaigns (March, May and October 2012) in six stations were selected in order to embrace seasonal variations and compartmentalization - established between the lotic (Paranapanema River entrance) and lentic (dam area) zones, and also the mouths of main tributaries. Results reinforce the spatial complexity (horizontal and vertical scales), as well as the maintenance of good water quality (e.g. high oxygen and low chlorophyll, conductivity and nutrients). All parameters are in agreement with the national water quality standards for class 1 (unrestricted use). The Jurumirim reservoir should be considered as a strategic source for the water policy of the State, the most populous and industrialized in the country and where an accelerated process of deterioration of surface water predominates. *Keywords: Reservoirs, Monitoring, Water quality.*

POON, D.[2], MICHAUD, A.R.[1], and WHALEN, J.K.[3], [1]Research and development Institute for the agri-environment (IRDA), 2700 Einstein, Quebec, QC, G3E 1V5; [2]British Columbia Ministry of Agriculture, 1767 Angus Campbell Road, Abbotsford, BC, V3G 2M3; [3]Department of Natural Resource Sciences, McGill University, 21 1111 Lakeshore Road, Ste-Anne-de-Bellevue, QC, H9X 3V9. **Modeling subsurface nutrient pathways to Missisquoi bay, Lake Champlain.**

Efforts to manage eutrophication of Missisquoi bay, Lake Champlain, should recognize the importance of phosphorus (P) preferential subsurface transport to surface waters via tile drain systems installed on farmland. The objective of this study was to develop and evaluate a new algorithm partitioning subsurface hydrological flows into macropore and matrix components. The algorithm was evaluated within SWAT-MAC, a re-conceptualized version of SWAT (Soil and Water Assessment Tool). The predicted episodic macropore flows were shown to increase with greater daily rainfall if infiltration exceeded a threshold that was lower for finer-textured soils. The algorithm improved SWAT's partitioning between surface runoff and subsurface flow. SWAT-MAC also predicted reasonably the

separation between macropore and matrix subsurface flows, upon comparison with results from a chemical-based hydrograph separation of Ewing brook streamflow (30 $km^2$), an agricultural subwatershed of Pike River, tributary to the Missisquoi bay of Lake Champlain. By partitioning percolation into macropore and matrix portions, the preferential flow algorithm developed and validated in this study provides a framework for better descriptions of subsurface drainage and P transport through tile drains within agricultural watersheds. *Keywords: Hydrologic cycle, SWAT, Nutrients, Hydrologic modeling, Eutrophication, Phosphorus transport.*

PREVOST, M., DORNER, S., and ZAMYADI, A., Polytechnique Montreal, C.P. 6079, succ Centre-Ville Montréal, montreal, qc, H3C 3A7. **Toxic cyanobacteria in a drinking water treatment plant: Source to tap challenges.**

Potentially toxic cyanobacterial species have been increasingly detected in North American drinking water sources. The objective of our research activities was to monitor the breakthrough and accumulation of toxic cyanobacteria in three Quebec (Canada) water treatment plant. Upon observation of cyanobacterial blooms at source, intensive sampling (for cell count and toxin analysis) and in vivo monitoring were conducted inside a full scale plant at raw water, clarification, filtration and oxidation processes. Total cyanobacteria cell numbers exceeded World Health Organisation and local alert levels in raw water (690,000 cells/mL). Extensive accumulation of cyanobacteria species in sludge beds and filters, and interruption of treatment were observed. Aphanizomenon cells were poorly coagulated and they were not trapped efficiently in the sludge. It was also demonstrated that Aphanizomenon cells passed through the filter resulting in severe treatment disruption leading to plant shutdown. However, Microcystis, Anabaena, and Pseudanabaena cells were adequately removed by clarification and filtration processes. Application of intervention threshold values restricted to raw water does not take into consideration the major long term accumulation of potentially toxic cells in the sludge and the risk of toxins release. *Keywords: Cyanophyta, In vivo monitoring, Water quality, Treatment of cyanobacterial cells, Algae.*

# Q

QIAN, S.S.[1] and CHAFFIN, J.D.[2], [1]The University of Toledo, 2802 W. Bancroft Street, Toledo, OH, 43606; [2]Ohio State University, Stone Lab, Put-In-Bay, OH, 43456. **Risk**

**Assessment of Microcystin Contamination in Drinking Water - A Bayesian Approach.**

We present a statistical analysis of all available microcystin concentration measurements in 2014 from Ohio drinking water facilities using Lake Erie as the source, to illustrate the inherent statistical problems associated with the current microcystin measurement and reporting process. Our analysis suggests that (1) individual microcystin measurement is associated with a high level of uncertainty and such uncertainty is not taken into consideration in important management decision making process, and (2) pooling data from multiple drinking water facilities can reduce the overall uncertainty in estimating the mean concentrations of microcystin in individual facilities. We present (1) a detailed analysis of the measurement process to illustrate sources of uncertainty, (2) statistical methods for reducing uncertainty by partially pooling data from multiple facilities, and (4) a risk assessment based drinking water safety management approach for multiple drinking water facilities. We also discuss the statistical basis for pooling data from multiple sources.
*Keywords: Microcystis, Drinking water, Risk assessment.*

# R

RAAB, D.[1], MANRAK, N.E.[2], and RICCIARDI, A.[1], [1]Redpath Museum, Biology Department, McGill University, 859 Sherbrooke St. West, Montreal, QC, H3A 0C4; [2]Department of Biological Sciences, University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A4. **Round Goby Impact on Native Fishes in a Dammed Great Lakes Tributary.**

Quantifying the role of environmental factors in mediating the dispersal and impact of Round Goby (*Neogobius melanostomus*) is of value to scientists and decision-makers in Europe and North America, where analogous invasion scenarios are occurring. In the Laurentian Great Lakes, the Round Goby is rapidly expanding its range and dominates fish communities in many littoral and benthic habitats. Its ecological impact has been extensively investigated in the Great Lakes proper; however, less work has been done to characterize their impact in Great Lakes tributaries. We surveyed the Grand River (Ontario, Canada) as a model system to assess Round Goby impact on native benthic fishes in a flow-modified tributary. Sequential lowhead dams separate proximate uninvaded and invaded river reaches, and create upstream gradients of increasing water velocity. Round Goby abundance exponentially declined with increasing water velocity, whereas native benthic fishes were at their lowest abundance at sites with high Round Goby densities, suggesting competitive exclusion. Substrate was less important for habitat selection than is reported in the literature. Ongoing work compares invaded and uninvaded reaches to detect impact on native fishes. *Keywords: Fish, Invasive species, Tributaries.*

RAJAKARUNA, H., DRAKE, D.A.R., and BAILEY, S.A., Great Lakes Laboratory for Fisheries and Aquatic Sciences, Burlington. **Performance of species richness estimators: implications for ballast water monitoring and management.**

Invasive species risk management requires measures of transported community compositions to inform initial population size. Communities transported by ballast exhibit, generally, low richness. Yet, estimators, widely used to measure species richness in ballast, have not been evaluated under such condition. Using MCMC simulations, we compared the performance of richness estimators; Chao1, Chao2, Jacknife1, Jacknife2 and ACE; by sampling individuals from log-normal species abundance distributions (SAD), which exhibited strong empirical support as the common statistical distribution. Performance was evaluated by Mean Squared Error (MSE: variance+bias^2), which incorporates both precision and accuracy. When richness is low compared to total abundance, Chao2 and Jacknife2 estimators (with two samples) yield lower MSE compared to Chao1 and Jacknife2 estimators (with one sample) respectively, given that the overall size of cumulative sampling effort is the same. These results are driven by high precision of both Chao2 and Jacknife2 estimators, and do not change with the proportion sampled from the population. Chao2 performs better than Jacknife2, while ACE exhibits slightly higher MSE. Results presented here provide guidance towards choosing among species richness estimators when monitoring and managing organisms contained in ballast. *Keywords: Ballast, Estimators, Biodiversity, Monitoring.*

REAVIE, E.D.[1], SGRO, G.V.[2], ALLINGER, L.E.[1], BRAMBURGER, A.J.[1], and SHAW CHRAÏBI, V.L.[2], [1]Natural Resources Research Institute, University of Minnesota Duluth, 5013 Miller Trunk Hwy, Duluth, MN, 55811; [2]John Carroll University, University Heights, OH; [3]University of Nebraska-Lincoln, Lincoln, NE. **Great Lakes Phytoplankton are being Reorganized by Climate Change.**

Long-term monitoring of the Laurentian Great Lakes microflora has revealed changes in whole-lake conditions in each of the lakes. Trends indicate impacts from invasive species and nutrients, and many impacts are revealed in a longer-term context in paleolimnology studies. Sedimentary analyses have further revealed changes in phytoplankton driven by climate change. It was first recognized that rapid warming of Lake

Superior has resulted in a complete reorganization of the algal community. The increase in the diatom *Cyclotella* in sedimentary profiles is obvious in recent decades, as has been recognized in lakes worldwide. Similar changes are now being observed in sedimentary profiles from Lakes Ontario, Erie, Michigan and Huron, despite the fact these lakes are notoriously influenced by other stressors including nutrients and invasive species. Not surprisingly, those responsible for tracking and maintaining ecosystem services on the Great Lakes are concerned about the ecological trajectories of the lakes. As a significant freshwater resource, it is worth considering the implications of this ongoing change at the base of the food web. Future concerns and areas of study will be discussed. *Keywords: Phytoplankton, Diatoms, Paleolimnology, Climate change, Algae, Sediments.*

REDDER, T.M., RUCINSKI, D.K., VERHAMME, E.M., and DEPINTO, J.V., LimnoTech, 501 Avis Drive, Ann Arbor, MI, 48108. **What We Need is an Operational Integrated Model for Lake Ontario.**

Several different management issues are important in Lake Ontario, including the impact of water levels on coastal ecosystems, eutrophication (Cladophora and cyanobacteria blooms) in embayments and nearshore ecosystems, the impact offshore trophic status on the Lake Ontario salmonid fishery, contaminant bioaccumulation in the food web, and the health of the benthic community. All of these management issues are impacted by multiple natural and anthropogenic drivers/stressors, including climate, nutrient loads, contaminant loads, invasive species, fishery management, shoreline land use, water level regulation. Also, perturbations to any of these stressors will have an effect on all of the other management issues (i.e., they interact). We have developed models for an individual management concern in Lake Ontario (e.g., the Integrated Ecological Response Model, the Lake Ontario PCB Mass Balance model); however, they all assumed that all other Lake Ontario issue remained constant in assessing management options. This talk will offer a conceptualization of an operational integrated model that affords an opportunity to quantify the impacts of multiple stressors on multiple endpoints by accounting for those interactions. *Keywords: Ecosystem modeling, Integrated Modeling, Lake Ontario.*

REID, A.H. and SPRULES, W.G., University of Toronto Mississauga, 3349 Mississauga Road, Mississauga, ON, L5L 1J7. **Measuring the "Ins and Outs" of Daphnia pulex Foraging Energetics and Their Food Web Implications.**

Predator production in pelagic ecosystems has often been calculated as higher than possible given the observed prey production. We hypothesize that this mismatch is in part due to more efficient than predicted foraging by predators in regions of higher than average prey concentrations. To test this, we measured the energetic cost of behaviors associated with foraging, including prey search, consumption, digestion, and swimming, along a gradient of prey concentrations. Using a non-invasive oxygen sensor system, we measured the oxygen consumption of juvenile *Daphnia pulex* individuals under varying prey treatments to isolate the cost of foraging behaviors, and to test for a concentration effect. These data were compared to corresponding prey consumption rates to calculate the net benefit of foraging within a range of prey concentrations. This new information will allow for a greater understanding of how energy moves through the lower levels of aquatic food webs, and offer insight into how areas of higher than average prey concentrations lead to increased consumer production. *Keywords: Productivity, Food Webs, Spatial distribution, Daphnia, Zooplankton.*

REILLY, R. and CLARK, R.D., Quantitative Fisheries Center, Michigan State University, 293 Farm Lane, East Lansing, MI, 48824. **Evaluating changes in feeding behavior through movement patterns of Chinook salmon.**

Chinook salmon are a highly mobile top predator in the Great Lakes. Due to quick growth rates, by age 1+ they have very few natural predators and fairly large energy requirements. Limited food resources have led to the number of Chinook stocked in the Great Lakes being severely reduced, as stocking rates are designed to maintain a balanced predator-prey ratio. These rates have been evaluated within individual Great Lakes, making the assumption that there is no movement among basins. Recent observations through mass marking of hatchery-reared fish suggest this assumption may not be valid. Given the surge in natural reproduction of Chinook in Lake Huron (LH) in the early 2000s and subsequent alewife collapse, we hypothesized that the number of fish moving from LH into Lake Michigan (LM) to feed may be significant enough to warrant consideration in stocking rate determination. We analyzed the CWT data in LM and LH by fitting GLMs for fish recovered from each basin, using effort and the number of recoverable fish stocked as offsets. Year, region, and stocking source were significant factors for fish from both basins. LH-stocked fish showed significantly higher standardized recovery rates in the northernmost region of LM, supporting our hypothesis of movement between the basins. *Keywords: Salmon, Lake Michigan, Lake Huron.*

REZANEZHAD, F., PARSONS, C.T., SMEATON, C., KOVAC, R., MILOJEVIC, T., and VAN CAPPELLEN, P., Ecohydrology Research Group, University of Waterloo, 200

University Ave West, Waterloo, ON, N2L3G1. **Soil Biogeochemical Dynamics Under Freezing and Thawing Cycles.**

To investigate the role of freeze-thaw cycles on soil biogeochemical processes, a highly instrumented soil column experiment was designed to realistically simulate freeze-thaw dynamics under controlled conditions. This approach combines the acquisition of integrated soil-specific physical, chemical, microbial data to better understand the mechanisms that drive greenhouse gases emission and nutrient cycling in soils under freeze-thaw cycles. Pore waters collected periodically from different depths of the column and solid-phase analyses highlighted strikingly dynamic geochemical cycling. CO2, CH4 and N2O production at different depths within the column were quantified from dissolved gas concentrations in pore water. Pulsed CO2 emission to the headspace was observed at the onset of thawing, however, the magnitude of the pulse decreased with each subsequent freeze-thaw cycle indicating depletion of a "freeze-thaw accessible" carbon pool. Pulsed CO2 emission was due to a combination of physical release of gases dissolved in porewater and entrapped below the frozen zone and changing microbial respiration in response to electron acceptor variability. Our results show that both physical and biogeochemical processes regulate the belowground soil carbon and nitrogen and respiration during the alternating frost and thaw periods. *Keywords: Nutrients, Biogeochemistry, Carbon cycle.*

RICHARDS, E.A.[1], CHENG, V.[2], WONG, I.[1], KIM, D.K.[2], and ARHONDITSIS, G.B.[2], [1]Environment Canada, Burlington; [2]University of Toronto, Toronto. **Towards using spatial statistics in nutrient watershed models.**

Spatially Referenced Regression on Watershed Attributes (SPARROW) was used to provide empirical estimates of nutrient fate in the Bay of Quinte, Ontario, an Area of Concern. Nutrient loadings were examined for temporal and spatial autocorrelation to examine the degree of dispersion. Additional spatial structure and data sources are considered in their potential to assist the delineation of hot spots and propose locations where additional water quality data-collection efforts should be focused. These tools will be used to identify clusters of nutrient hotspots. *Keywords: Nutrients, Water quality, Spatial analysis.*

RIDDICK, N., NICKEL, M., GARNER, C., MCCARTHY, F.M.G., NOTTRODT, R., GUNTER, R., COCHRANE, D., AL-SILWADI, S., and ABOMRIGA, W., Brock University, St. Catharines, ON, L2S 3A1. **A Preliminary Paleolimnological Study of Lake George, NY, Using Microfossils.**

The fossil record of thecamoebians (testate amoebae) and palynomorphs was examined to assess anthropogenic impact on Lake George. Loss-on-ignition analysis supports visual observations of organic-rich dark brown sediments unconformably overlying barren light gray glacial clay below 79 cm in the 93cm-long sediment core from Warner Bay. A layer of coarse woody detritus between 24cm and 30cm on the core - below the rise in ragweed (*Ambrosia*) pollen in silty organic muds at ~14 cm in the core - is attributed to logging activities in the late 1700's to early 1800's. The transition from centropyxid to difflugiid thecamoebians upcore is evidence of eutrophication, but these organic-rich sediments contain few algal palynomorphs. A similar upcore trend in thecamoebians is seen in organic muds in the 115 cm-long core from Paradise Bay, but this core contains abundant algal palynomorphs, mainly *Botryococcus brauni*, *Pediastrum integrum*, *Cosmarium depressum* and dinoflagellate cysts of unknown affinity prior to human impact. The silty *Ambrosia*-rich sediments in the upper 8 cm of the Paradise Bay core, however, contain few algal palynomorphs. The decline in microfossil diversity observed in surface sediments may record the impact of road salt and chemical pollutants on the lake. *Keywords: Eutrophication, Bioindicators, Microfossils.*

RIESSEN, H.P., SUNY Buffalo State, 1300 Elmwood Avenue, Buffalo, NY, 14222. **Water Temperature Alters Predation Risk and the Adaptive Landscape of Zooplankton Defenses.**

Water temperature influences many biological processes in zooplankton, including those that affect interactions with predators. These relationships help shape the impact of predation and the development of prey defenses. Seasonal shifts in water temperature and long-term global climate change may therefore directly alter predator impacts in plankton communities. I develop a life history model to examine one aspect of this potential effect, the impact of water temperature on the interaction between predatory Chaoborus larvae and Daphnia, which includes the induction of defensive neck spines by the prey in response to predator kairomones. This model examines how water temperature affects the vulnerability of Daphnia to Chaoborus predation, and then applies this to the fitness consequences of developing neck spines. The model analyzes the influence of temperature on Daphnia instar development and body length, and on the encounter rate between Daphnia and Chaoborus, all of which affect the vulnerability of Daphnia to this ambush predator. It then assesses the costs and benefits of neck spine development in different temperature environments. Daphnia are more vulnerable to Chaoborus predation in warmer water and thus the enhanced induction of morphological defenses in this environment is an adaptive response. *Keywords: Life history studies, Daphnia, Zooplankton, Chaoborus, Predation.*

RIOS MENDOZA, L.M., University of Wisconsin Superior, Belknap and Catlin, Superior, WI, 54880. **Microsynthetic plastics in air, water, fish and sediments in the Great Lakes.**

Microplatics are considered a new emerging pollutant. It is increasing every day in the marine environment and the Great Lakes are no exception The pollution caused by the microscopic plastics is a potential hazard to aquatic life because of the known potential to adsorb persistent organic pollutants, POPs, which can affect the human race. Lake Superior has visible plastic debris on remote and otherwise pristine beaches and shorelines. Little information is currently available on the composition, distribution, or fate of plastic materials in freshwater ecosystems. An alarm has emerged with the discovery of plastic not visible by the naked eye on the Great Lakes waters. The research on Great Lakes about plastic pollution needs to be addresses before the impacts and consequences are disastrous on aquatic organisms. This research is designed to progress knowledge of quantification of microscopic plastic particles suspended in water, in air, accumulation of POPs onto these particles, and ingestion by fish in the Great Lakes. The results showed that microplasitc fibers were present on fish stomachs in average sizes from 0.3 to 5.7 mm and in the air 0.01 to 7.5mm. The main synthetic polymer plastic was PE and PP. POPs range concentration 77 to 800 ng/g of plastic debris. *Keywords: Lake Superior, Microplastics fish ingestion, Environmental contaminants, Plastic fibers, Microplastics, PAHs.*

RISCH, M.R.[1], LEPAK, R.L.[2], and KRABBENHOFT, D.P.[3], [1]U.S. Geological Survey Indiana Water Science Center, 5957 Lakeside Blvd, Indianapolis, IN, 46278; [2]University of Wisconsin Department of Civil and Environmental Engineering, 1415 Engineering Drive, Madison, WI, 53706; [3]U.S. Geological Survey Wisconsin Mercury Research Laboratory, 8505 Research Way, Middleton, WI, 53562. **Mercury Concentrations and Stable Isotopes in Litterfall for Understanding Loads to Forests.**

Autumn litterfall mercury (Hg) monitoring at 28 forest sites in 16 states in the eastern USA, 2007-2012, quantified the lower bound of annual Hg dry deposition loads to forests. Hg concentrations in litterfall samples had low intra-site variability. Approximately half of the annual Hg deposition was attributed to litterfall, when combined with Hg wet deposition at the sites. Modeled estimates of gaseous elemental Hg deposition based on measured atmospheric concentrations were consistent with litterfall Hg deposition.

Calculations of atmospheric Hg deposition resulting from changes in Hg emissions can have improved accuracy when litterfall Hg monitoring data are used. Hg stable isotope analysis of litterfall samples adds capacity for understanding Hg source apportionment and environmental processes. Results from isotope analyses of litterfall revealed natural variability in mass dependent fractionation; δ202Hg was mean -1.34 ± -0.33 ‰ ranging from -0.63 to -2.04 ‰. Mass independent fractionation Δ199Hg values were a mean -0.22 ± -0.13 ‰ ranging from -0.40 to 0.00 ‰, which suggests preferential light isotope volatilization from litterfall. As a potential tracer for atmospheric Hg, Δ200Hg in litterfall was a mean -0.09 ± -0.11 ‰ ranging from -0.08 to 0.36 ‰ and indicates varied atmospheric sources. *Keywords: Ecosystem health, Atmospheric deposition, Mercury, Isotope studies.*

RISENG, C.M.[1], WEHRLY, K.E.[2], RUTHERFORD, E.S.[3], MASON, L.[1], WANG, L.[4], GOODSPEED, R.C.[1], ROBERTSON, M.[5], SPARKS-JACKSON, B.L.[1], MCKENNA, JR., J.E.[6], and SCHOENFELDT, B.[1], [1]Univeristy of Michigan, Ann Arbor, MI; [2]MDNR, Institutte of Fisheries Research, Ann Arbor, MI; [3]NOAA GLERL, Ann Arbor, MI; [4]International Joint Commission, Windsor, ON; [5]Ontario Ministryof Natural Resources and Forestry, Peterborough, ON; [6]U.S. Geological Services, Cortland, NY. **Developing Spatially Referenced Tools for Adaptive Management of Great Lakes Ecosystems.**

Great Lakes agencies, managers, and researchers require publicly accessible habitat data and decision support tools that can facilitate adaptive management of multiple stressor (climate and land use change, invasive species) impacts on aquatic ecosystems throughout the basin. Our project team has been developing a spatial database of aquatic habitat and biological data and maps across the entire Great Lakes basin that are georeferenced to a common spatial grid, the Great Lakes Aquatic Habitat Framework (GLAHF). GLAHF is a web-accessible database and mapping framework for use by managers, planners, researchers, and restoration specialists across the basin. The GLAHF project team has developed a number of tools to assist with habitat monitoring, modeling, assessment, and prioritization for protection and restoration including: a scalable habitat classification framework; a GIS data and map viewer and server; a web-based decision support system to facilitate research and management activities in the Great Lakes; and in preparation, a coastal condition assessment, an ecological habitat classification, and fish habitat suitability models. These tools have been developed based on feedback from Great Lakes managers and stakeholders and address their specific information needs. *Keywords: Spatial analysis, Geospatial tools, Lake management, Decision support, Coastal ecosystems.*

RITZENTHALER, A.A.[1], MIKULSKI, C.M.[2], DAVIS, T.W.[3], RUBERG, S.A.[3], and DOUCETTE, G.J.[2], [1]Cooperative Institute for Limnology and Ecosystem Research (CILER), University of Michigan, Ann Arbor, MI; [2]NOAA/National Ocean Service (NOS), Charleston, SC; [3]NOAA/Great Lakes Environmental Research Laboratory (GLERL), Ann Arbor, MI. **Development of an Immunoassay for Near Real-time Detection of Particulate Microcystins in Lake Erie.**

Detecting and monitoring harmful algal bloom (HAB) development and toxicity are of growing importance nationally and globally, especially for freshwater systems that supply drinking water to many municipalities. As highlighted by the recent 'do not drink' advisory issued for roughly 400,000 Toledo residents in August 2014, it is essential that we continue to advance our detection capabilities for microcystins and other cyanotoxins in drinking water sources. The Environmental Sample Processor (ESP) is an autonomous, in-water instrument designed to assess concentrations of potentially toxic harmful algal bloom species and the toxins they produce in near real-time. Although the ESP has been deployed numerous times in marine coastal waters, this technology has not been utilized in freshwater systems to monitor potentially toxic cyanobacteria and their toxins. In a collaborative effort to bring the *in situ* capabilities of ESP instruments to the Laurentian Great Lakes, development of an efficient extraction method and immunoassay (cELISA) for microcystins was initiated. Here we present our progress towards near real-time detection of particulate microcystins in Lake Erie on the ESP platform. *Keywords: Microcystin, Harmful algal blooms, Lake Erie.*

ROBERTS, V.A., YODER, J.S., BACKER, L.C., and BEACH, M.J., 1Centers for Disease Control and Prevention, Atlanta, GA. **Building Health Surveillance Capacity for Harmful Algal Blooms in the United States.**

Human outbreaks associated with exposure to harmful algal blooms (HABs) may be reported by health departments to the Centers for Disease Control and Prevention via the web-based National Outbreak Reporting System (NORS). However, these outbreaks are difficult to detect and outbreak data lack the detail of case reports to inform case definitions and future prevention efforts. No national surveillance system exists to collect information on single cases of illness or the occurrence of HABs. In 2013, CDC established a HAB working group, a collaboration of state and federal partners with expertise in harmful algal blooms and illness surveillance, to develop a HAB reporting system that will be accessible to local and state health agencies via NORS. The system will receive and link reports of single cases of human illness, animal illness, and HABs. Programming the system has begun; pilot

launch is anticipated in 2015, with a full launch following user testing and enhancements. A national HAB reporting system will provide data to understand this emerging issue. Launch and maintenance of the system will require collaboration with reporting partners, as well as ongoing efforts to support state activities and to demonstrate the value of the data through improved reporting definitions and data use. *Keywords: Monitoring, Harmful algal blooms, Human health.*

ROBINSON, K.W.[1] and CANTIN, J.F.[2], [1]U.S. Geological Survey, 331 Commerce Way, Pembroke, NH, 03275; [2]Environment Canada, 1550, avenue d'Estimauville, Quebec, Qu, G1J 0C3. **Developing the Next Generation of Flood Forecasting in the Lake Champlain-Richelieu River.**

The record water levels in Lake Champlain in 2011 along with damaging floods downstream in the Richelieu River highlighted the need for an improved coordinated flood forecasting and inundation mapping system for these trans-boundary waterways. With support from the United States and Canadian governments, a Plan of Study was produced in 2013 that outlines future steps for improved flood forecasting and preparedness. Now a number of specific actions are being undertaken under the auspices of the International Joint Commission. These actions include: coordinated and seam-less flood inundation mapping of the Lake and River, identification of future lake and river water level models and systems to use for forecasting, and creation of necessary data needed for future modeling work. Inherent in these new systems will be improved communication and interaction between agencies on both sides of the border; this is being fostered by a bi-national Working Group to oversee and direct activities in 2015. Results of work to date, including modeling solutions for new and enhanced lake and river water level forecasting will be presented. *Keywords: Flood forecsating, Regional analysis, Richelieu River, Water level, Lake Champlain, Hydrodynamic model.*

ROLFHUS, K.R., SANDHEINRICH, M.B., HARO, R.J., and WIENER, J.G., University of WIsconsin-La Crosse, 1725 State, La Crosse, WI, 54601. **Mercury in the Aquatic Food Webs of Six National Parks of the Western Great Lakes Region.**

The Great Lakes region contains several national park units that provide potential pathways for exposure of humans and wildlife to methylmercury (MeHg). The parks exhibit a wide variety of aquatic ecosystems, and relatively little is known about the extent of Hg contamination in resources within them. During 2010-12, we quantified total Hg and MeHg in aquatic food webs from 23 water bodies within six national park units, including samples of sediment, water, seston, zooplankton, larval dragonflies, prey fish, and predatory fish.

Results indicate that aqueous MeHg levels are largely driving trophic transfer through the food web. A screening-level risk assessment indicates that a significant proportion of predatory fish (51%) exceed the US Environmental Protection Agency criterion for MeHg in fish tissue, whereas 30% exceed the threshold concentration of adverse effects to fish health and reproduction. Our results indicate a regional trend where the parks in northern Michigan and Minnesota exhibit higher food web MeHg concentrations than the parks in lower Michigan and northern Indiana, which are closer to Hg point sources and urban centers. Despite recent regional decreases in Hg emissions, contemporary Hg continues to pose a threat to humans and wildlife in these mercury-sensitive landscapes. *Keywords: Mercury, Bioaccumulation, Food chains.*

ROOK, N.A.[1], MANDRAK, N.E.[1], and REID, S.M.[2], [1]University of Toronto, 1265 Military Trail, Toronto, ON, M1C 1A4; [2]Ontario Ministry of Natural Resources & Forestry, 2140 East Bank Drive, Peterborough, ON, K9J 7B8. **Recolonization Trends in Fish Communities Following the Restoration of a Great Lakes Coastal Wetland.**

The coastal wetlands of the Great Lakes are ecologically diverse and provide numerous functions for native species including recruitment and early survival of fishes. The wetlands of Long Point Crown Marsh, located on the north shore of Lake Erie, have experienced habitat degradation since 1999 as a result of the establishment of *Phragmites australis*. As part of an initiative to increase habitat heterogeneity and restore natural wetland function, physical dredging to re-create open-water habitat occurred 2008 to 2012. This study assesses the seasonal dynamics of fish recolonization and provides insight on how life history traits and habitat characteristics influence colonization. Fish species richness and abundance in relation to dredging treatment (newly dredged, formerly dredged, and reference sites) were quantified using data from semi-annual fish and habitat sampling conducted 2012 to 2014. Multivariate analyses will be used to investigate the relationship between habitat variables and fish community. The results of this study will have implications for managing fish communities in response to habitat restoration. *Keywords: Fish populations, Recolonization, Coastal wetlands.*

ROSAMOND, M.S.[1], MOHAMED, M.N.[2], and TAYLOR, W.D.[1], [1]Department of Biology, University of Waterloo, 200 University Ave W, Waterloo, ON, N2L 3G1; [2]Ontario Ministry of the Environment and Climate Change, 125 Resources Rd, Etobicoke, ON, M9P 3V6. **N Application, Catchment Geography and N Export in Small, Agricultural Catchments in the Great Lakes.**

Reactive nitrogen export from agricultural streams in the Laurentian Great Lakes (LGL) watersheds can be a significant source to downstream water bodies such as Lake Erie. Recent work suggests that reactive nitrogen input to lakes can help determine the species composition of algal blooms as toxic cyanobacteria tend to dominate in low-N, high-P systems. However, controls on N inputs to the LGL are under-studied. We examined 15 streams in southern Ontario, Canada, in highly agricultural catchments, comparing $NO_3^-$ export to agricultural N application, runoff, catchment and channel slope, baseflow index, tile drainage and sediment geochemistry. While nitrogen application was very well correlated to phosphorus application, $NO_3^-$ export was not predictable with variables that predict (runoff and slope, tile drains, suspended sediment export). This is likely due to differences in N and P pathways, storage and transformations within catchments and streams. If reducing P inputs to the Great Lakes while keeping $NO_3^-$ relatively constant is the goal, agricultural management should focus on reducing storm-based soil erosion and discouraging further tile drainage, both of which appear to influence TP but not $NO_3^-$ export. *Keywords: Watersheds, Water quality, Nutrients.*

ROSSMANN, R.[1], PFEIFFER, E.L.[2], FILKINS, J.C.[3], and KREIS, JR., R.G.[3], [1]Large Lakes Research Station, 9311 Groh Road, Grosse Ile, MI, 48138; [2]Z-Tech Corporation, ICF Company, 9311 Groh Road, Grosse Ile, MI, 48138; [3]USEPA/NHEERL/ORD Mid-Continent Ecology Division, Large Lakes Research Station, 9311 Groh Road, Grosse Ile, MI, 48138. **A Method for Estimation of Historic Contaminant Loads using Dated Sediment Cores.**

Dated sediment cores were used to assess the history of contaminant loads. The contaminant selected must be one that is not significantly remobilized by post depositional processes such as diagenesis. In addition, the core must be from an area with a high deposition rate and little sediment reworking by biota or wave action to provide a highly resolved profile. Finally there must be an independent estimate of the load to the lake that can be used to calibrate the profile. These criteria were met for Lake Michigan during the 1994 to 1996 Lake Michigan Mass Balance Project. Box cores from 54 stations collected between 1994 and 1996 were used to estimate both historic lead and mercury loads to Lake Michigan. 186 and 143,000 t of anthropogenic mercury and lead are stored in the lake's sediments, respectively. A core was calibrated to represent the entire load of each metal to the lake. The annual load for each dated interval of the core was then calculated. Anthropogenic mercury and lead loads for 1994 were 973 kg/y and 1170 t/y, respectively. Mercury and lead loads were last this low in 1892 and 1920, respectively. Anthropogenic loads for mercury and lead first appeared in 1858 and 1852 and peaked in 1946 and 1960, respectively. This abstract does not necessarily reflect EPA policy. *Keywords: Historic loads, Sediments, Lead, Paleolimnology, Mercury, Lake Michigan.*

ROUS, A.M.[1], MIDWOOD, J.D.[1], VEILLEUX, M.A.N.[1], LAPOINTE, N.W.R.[1], PORTISS, R.[2], SCISCIONE, T.[2], WELLS, M.G.[3], DOKA, S.E.[4], and COOKE, S.J.[1], [1]Fish Ecology and Conservation Lab, Carleton University, Ottawa; [2]Restoration Services, Toronto and Region Conservation Authority, Toronto; [3]Environmental Fluid Dynamics Lab, University of Toronto, Toronto; [4]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington. **Telemetry-Based Multispecies Space Use and Movement in Restored Habitat in the Toronto Harbour.**

Widespread development has led to impairment of freshwater coastal embayments, which provide critical and unique habitat for most fish species. In the Toronto Harbour Area of Concern (AOC), restoration efforts have been directed towards improving the amount and quality of fish habitat in the harbour. In order to evaluate the effectiveness of this restoration work, it is important to determine whether both target species (e.g., Northern Pike) and the fish community as a whole are using restored areas. From 2012 to 2014, eighty-five individuals from six species (Common Carp, Largemouth Bass, Northern Pike, Walleye, White Sucker, and Yellow Perch) were tagged and tracked using a large acoustic telemetry array in Toronto Harbour. We present results from this ongoing embayment-wide study evaluating: 1) the use of restored areas by these six species based on occupancy models and 2) species-specific movement patterns among coastal embayments and between the inner and outer harbour sections. Results from this study will help determine the success of past restoration efforts in the Toronto Harbour and inform the development of future restoration projects. *Keywords: Acoustic telemetry, Fish tagging, Habitats.*

ROWE, M.D.[1], ANDERSON, E.J.[2], VANDER WOUDE, A.J.[1], JOHENGEN, T.H.[1], and VANDERPLOEG, H.A.[2], [1]University of Michigan CILER, 4840 S. State Rd., Ann Arbor, MI, 48108; [2]NOAA Great Lakes Environmental Research Laboratory, 4840 S State Rd, Ann Arbor, MI, 48108. **Vertical Mixing and Buoyancy in a Model for Short-term Forecasts of Cyanobacterial HABs in Lake Erie.**

Cyanobacterial harmful algal blooms (CHABs), primarily *Microcystis*, are a recurring problem in western Lake Erie. Short-term forecasts of CHABs are important to water treatment plant operators, anglers, recreational boaters, and beach users. NOAA NCCOS and NOAA GLERL have developed experimental forecast products that indicate the

present location and extent of CHABs from satellite imagery, then predict the movement of the CHAB five days into the future using forecast meteorology. These products use Lagrangian particle tracking models to forecast CHAB transport, forced by currents from a hydrodynamic model. Vertical distribution of *Microcystis* colonies is a balance between buoyancy and turbulent mixing, mechanisms not represented in current models. We evaluated forecast skill using a Lagrangian particle model that included vertical mixing and buoyancy in addition to 3D currents. Turbulent diffusivity was provided by the FVCOM hydrodynamic model. We evaluated model skill in hindcast scenarios from 2008 to 2014, testing the ability of the model to predict subsequent satellite images and surface observations after initialization from a satellite image. Inclusion of vertical mixing with buoyancy enabled the model to simulate observed changes in surface chlorophyll concentration in response to variable wind speed. *Keywords: Lake Erie, Harmful algal blooms, Model testing.*

RUCINSKI, D.K.[1], DEPINTO, J.V.[1], BELETSKY, D.[2], and SCAVIA, D.[3], [1]LimnoTech, 501 Avis Dr., Ann Arbor, Mi, 48108; [2]Cooperative Institute for Limnology and Ecosystem Research, Ann Arbor, MI, 48104; [3]University of Michigan, Ann Arbor, MI, 48104. **Lake Erie Central Basin Hypoxia - Modeling Response to Phosphorus Load Reduction Scenarios.**

Annex 4 of the Great Lakes Water Quality Agreement calls for the United States and Canada to cooperatively establish a new target load of phosphorus to improve water quality of the Great Lakes, including the reduction or elimination of hypoxia. As part of a group of models intended to address this goal, a calibrated model for the Central Basin of Lake Erie was used to develop response curves relating hypoxia metrics to phosphorus loads. The model is driven by a 1D hydrodynamic model that provides temperature and vertical mixing profiles. The biological portion of the coupled model incorporates phosphorus and carbon loading, internal phosphorus cycling, carbon cycling (in the form of algal biomass and detritus), algal growth and decay, zooplankton grazing, oxygen consumption and production processes, and sediment interactions. Hypoxic severity is estimated over a range of hydrodynamic, climate, and loading scenarios. *Keywords: Lake Erie, Hypoxia, Model studies, Nutrients.*

RUDSTAM, L.G.[1], BARBIERO, R.P.[2], HOLECK, K.T.[1], WARREN, G.J.[3], WATKINS, J.M.[1], WEIDEL, B.C.[5], LANTRY, J.R.[4], KOOPS, M.[6], LUCKEY, F.J.[7], JOHNSON, T.B.[8], and DOVE, A.[9], [1]Cornell University, Bridgeport, NY, 13030; [2]CSC and Loyola University, Chicago, IL, 60660; [3]USEPA Great Lakes National Program Office, Chicago, IL, 60604; [4]New York State Department of Environmental Conservation, Cape Vincent, NY, 13618; [5]U.S. Geological Survey, Great Lakes Science Center, Oswego, NY, 13126; [6]Fisheries and Oceans Canada, Burlington, ON, L7R 4A6; [7]United States Environmental Protection Agency, Region 2, New York, NY, 10007-1866; [8]Ontario Ministry of Natural Resources, Picton, ON, K0K2T0; [9]Environment Canada, Burlington, ON, ON L7R 4A6. **Combining Long-Term Data Sets to Detect Changes in Lake Ontario's Lower Trophic Levels.**

Lower trophic level changes are continuing in several Great Lakes and are of concern to both water quality and fisheries managers. We assembled several data series on zooplankton, chlorophyll, and nutrients in Lake Ontario collected by a range of agencies around the lake (NYSDEC, USGS, USFWS, EPA-GLNPO, DFO-Canada, OMNRF, EC). All data series show a consistent decline in phosphorus concentrations, an increase in spring silica, and a decrease in epilimnetic zooplankton but not necessarily in whole water column zooplankton since the 1970s. Since the mid-1990s no further declines were detected in many trophic state variables, although marked shifts in crustacean zooplankton community composition and vertical distribution occurred, likely a result of increases in invertebrate predation by *Bythotrephes*. Multiagency data sharing allowed for this comparison of long-term data series and resulted in more robust conclusions than each data series analyzed separately.
*Keywords: Zooplankton, Lake Ontario, Nutrients.*

RUITER, S.N., U.S. Fish & Wildlife Serive, 3090 Wright St., Marquette, MI, 49862. **The Importance of Dams to Sea Lamprey in the Great Lakes.**

Invasive, parasitic sea lampreys (Petromyzon marinus) in the Great Lakes are controlled by implementing a Sea Lamprey Control Program. Currently, selective pesticides (lampricides) are the primary application method used to kill larval sea lamprey. Barriers are another important tool used to prevent adult sea lamprey from accessing thousands of miles of suitable spawning habitat within Great Lakes tributaries. A low-head barrier is the most effective type of barrier because it can be constructed to specifically block the sea lamprey migration and is operated year round. Seasonal barriers are also used to prevent the upstream migration of sea lampreys, but are less effective than permanent low-head barriers due to the reduced operation time. There are hundreds of other existing barriers that are critical to the success of the control program as they restrict the spawning success of sea lampreys. Removal of these barriers will (i) increase available spawning habitat, (ii) increase the risk of abundance of parasitic, juvenile sea lamprey in the Great Lakes, and (iii) cause increased demand and cost of lampricide treatments. Finding alternatives to lampricides remains a high

priority for the Sea Lamprey Control Program and may be realized through innovative barrier research in collaboration with partner agencies. *Keywords: Invasive species, Sea Lamprey, Barriers.*

RUSSO, A.D., NEFF, F.C., SPRAGUE, H.M., LOFTUS, S.E., SKUFCA, J.D., and TWISS, M.R., Clarkson University, Potsdam, NY, 13699. **High Resolution St Lawrence River Water Quality Monitoring Using Sensors in a Hydropower Dam.**

We seek to develop a method for acquiring meaningful nearshore river water quality data in a cost effective manner that provides high spatial and temporal system coverage. Water quality along the shorelines and the main channel of the Upper St. Lawrence River (discharge approx. 7,000 $m^3/s$) was measured using continuous sensing technology as well as a long-term remote sensing array installed on the Moses-Saunders hydropower dam. The two-meter isopleth marked the path for the near-shore transects, while the mid-channel transect followed the path of the greatest water velocity as determined by hydrodynamic model output. Results show that near-shore water quality varies significantly more than that of the mid-channel, thus revealing that the river is not a completely mixed system, despite high flow. The sensor array located in the turbine unit nearest the US shore is able to discern tributary inputs originating from the Oswegatchie River (discharge 15-120 $m^3/s$), located 67 km upstream. This research is an important proof-of-concept for installing similar arrays in dams throughout the Great Lakes region and is applicable to smaller rivers containing power dams. *Keywords: Water quality, Big data, St. Lawrence River, Emerging technology, Monitoring.*

RUTHERFORD, E.S.[1], ZHANG, H.[2], BARNES, M.A.[3], CHADDERTON, W.L.[4], FINNOFF, D.C.[5], SHAKOOR, A.[2], MASON, D.M.[1], WITTMANN, M.E.[6], LODGE, D.M.[7], APRIESNIG, J.[8], and WARZINIACK, T.[9], [1]NOAA GLERL, 4840 S. State Rd, Ann Arbor, MI, 48108; [2]Univ. Michigan CILER, 4840 S. State Rd, Ann Arbor, MI, 48108; [3]Texas Tech University, Goddard Building, Room 102, 15th and Detroit, Lubbock, TX, 79409; [4]The Nature Conservancy, Great Lakes Project, 1400 E. Angela Blvd., Unit #117, South Bend, IN, 46617; [5]University of Wyoming College of Business, 1000 E University Avenue, Laramie, WY, 82071; [6]Univ. Nevada-Reno, Dept. Biology, 1664 N. Virginia St./ MS 314, Reno, NV, 89557; [7]University of Notre Dame, Dept. Biol. Sci, P.O. Box 369, South Bend, IN, 46556; [8]Colorado State Univ., Dept. Agric. Resource Econ., 1200 Center Ave Mall, Fort Collins, CO, 80523; [9]US Forest Service, 240 West Prospect Road, Fort Collins, CO, 80526.
**Run DMC! Forecasting Ecological Impacts of Dreissenid Mussel Control on Great Lakes Food Webs.**

Dreissena mussels have impacted Great Lakes food webs by diverting energy from pelagic to benthic pathways, increasing light penetration, altering nutrient and carbon cycling, and reducing plankton biomass. We used the Ecopath with Ecosim food web model to forecast ecological impacts of Dreissena Mussel Control (DMC) on the Lake Erie (LE) and Lake Michigan (LM) food webs. We ran simulation scenarios of 50%, 75%, 90% and 99% reductions in Dreissena mussel biomass for 1, 10, 30 and 60 years. Compared to their current biomass levels, most changes in LE species biomass from DMC were minor (<25%) compared to biomass changes (>50%) in LM. In LE, DMC caused: 1) decreased energy flow to the benthos, and decreased biomass of most benthic groups and their predators; 2) increased biomass of edible algae, but with little change in zooplankton because of high predation from increased planktivore biomass; 3) decreased predation on Yellow Perch larvae resulting in increased adult Yellow Perch biomass. In LM, DMC decreased biomass of benthivorous Lake Whitefish and Round Goby. Walleye biomass decreased at DMC levels <90% but increased at DMC levels exceeding 90%. DMC treatments increased salmonid (up to 78%) and alewife biomass (up to 49%). Our results may inform future cost/benefit analyses for controlling dreissenid populations. *Keywords: Biological invasions, Food webs, Dreissena, Fisheries.*

RUTLEDGE, J.M. and CHOW-FRASER, P., McMaster University, 1280 Main St. W., Hamilton, ON, L5G 3M9. **Land-Use Effects on Water Quality in the Nottawasaga River and the Minesing Wetlands.**

The Nottawasaga Valley Watershed (NVW) drains 2,900 $km^2$ of the Lake Huron sub-basin into the Nottawasaga River, which eventually flows into Nottawasaga Bay in southeastern Georgian Bay. The primarily agricultural land-use in the NVW results in excess loading of nutrients and sediment into the river and eventually the bay. This has become an environmental concern because Nottawasaga Bay features one of the most popular stretch of beaches in Ontario, with many summer resorts and cottages. The river also bisects the Minesing Wetlands, a Ramsar site and the largest inland wetland in southern Ontario. We conducted monthly sampling (June - September 2014) at 15 stations along the river during baseflow conditions for physical and chemical parameters (pH, DO, TEMP, COND), primary nutrients (TP, TN, TNN, TAN), algae (CHL-α), and suspended solids (TURB, TSS). We assessed the relative contributions of these parameters from all land-uses in each subwatershed. We found the most degraded water quality conditions to be associated with areas draining high proportions of agricultural and urban land-uses. Our results provide a more detailed understanding of the river's ability to absorb excess nutrients and sediment from different land-uses during the growing season, and will help predict annual loading to Nottawasaga Bay. *Keywords: Georgian Bay, Land use, Watersheds, Water quality.*

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SAAVEDRA, N.E.[1], WATKINS, J.M.[1], O'MALLEY, B.P.[2], and RUDSTAM, L.G.[3], [1]Cornell University Biological Field Station, 900 Shackelton Point Rd., Bridgeport, NY, 13030; [2]University of Vermont, Rubenstein Ecosystem Science Laboratory, 3 College St., Burlington, VT, 05401; [3]Cornell University, Department of Natural Resources, Fernow Hall, Ithaca, NY, 14853. **Vertical Distribution of Crustacean Zooplankton in Lake Ontario: Advances in Long-Term Monitoring.**

Lake Ontario has undergone significant change documented by long-term monitoring efforts of the lower trophic levels. Intensive lake-wide sampling at routine stations was conducted in Lake Ontario during May, July, and September of 2003, 2008, and 2013 as part of the Cooperative Science and Monitoring Initiative (CSMI) program. Epilimnetic and whole water column zooplankton samples were collected in 2003 and 2008. Changes in sampling protocol were made in 2013 which included collecting depth stratified zooplankton samples during the day and night using a vertical closing net. Our results in 2013 track the vertical distribution of crustacean zooplankton at a higher resolution than that of 2003 and 2008. This is an important advancement in long-term monitoring efforts because it will allow for scientists to capture more detailed information on vertical distribution as food-web dynamics change within Lake Ontario. Future monitoring efforts in Lake Ontario, as well as throughout the Great Lakes, should continue to employ a similar sampling protocol to that in 2013. Furthermore, an emphasis on documenting diel changes in vertical distributions will also prove to be valuable. *Keywords: Distribution patterns, Lake Ontario, Zooplankton.*

SAMANTA, A. and KELLOGG, W.A., Cleveland State University, 2121 Euclid Avenue, UR 230, Cleveland, OH, 44115. **Collaborations as Deliberative Processes for Policy Implementation: The Case of Cuyahoga Watershed.**

The Cuyahoga River watershed is governed by a constellation of laws and regulations creating a highly formal institutional structure for policy implementation. Within this structure local actors collectively construct and interpret meaning of the policies through the process of dialogue and deliberation. The resultant collaborations are not the traditional hierarchies of structured behaviors and roles, but are instead emergent and based on practices to achieve shared goals. We argue that the deliberation, meaning making, and understanding of the phenomena by the actors shape the way policy is implemented. Over time, these processes create a shared understanding and transform the watershed. We draw upon a detailed analysis of preliminary in-depth interviews, document analysis, participant observations, and network diagrams. From our analysis four main areas of governance emerge and we demonstrate how actors within each of these areas create collaborations that shape policy implementation in the form of plans, programs, and initiatives. We illustrate this through the example of two networks emerging out of collaborations in two of the governance areas and the breadth, depth, and extent of the deliberative process in each. We also briefly discuss how over the years governance has evolved in the watershed. *Keywords: Environmental policy, Areas of Concern, Urban watersheds, Collaboration, Watersheds, Deliberation.*

SANO, L.[1], DUHAIME, M.B.[2], BURTON, G.A.[1], DALEY, J.[1], WELLS, D.[1], CHEN, Z.[3], SHEIK, C.[4], and HANKETT, J.[3], [1]School of Natural Resources University of Michigan, 440 Church Street, Ann Arbor, MI, 48109-1041; [2]Dept of Ecology and Evolutionary Biology University of Michigan, 2019 Kraus Nat Sci Bldg, Ann Arbor, MI, 48109-1048; [3]Dept of Chemistry, 930 North University Avenue, Ann Arbor, MI, 48109; [4]Earth and Enviornmental Sciences, University of Michigan, Ann Arbor, MI. **Presence and Characteristics of Microplastic Material in Great Lakes Fishes.**

Recent and preliminary surveys of microplastics in the Laurentian Great Lakes have indicated that this material is present in surface waters at varying concentrations. To better characterize the relevance of these findings, a cross-disciplinary and multiscale project is underway to define the ecological and environmental health risks of microplastics in the Great Lakes. To assess the potential ecological risks associated with microplastics consumption, a range of different fish species were collected from Lake Erie and Lake Huron. The stomach contents of the fish were extracted and digested in KOH solutions. The resulting contents were visually processed to identify microplastic material. Individual items were then removed and the source material was characterized. The results will be presented in the context of both trends in species with respect to microplastic consumption as well as the potential source of microplastic material. *Keywords: Microplastics, Fish populations, Ecosystem health.*

SAWTELL, R.[1], SAYERS, M.J.[1], SHUCHMAN, R.A.[1], LESHKEVICH, G.A.[2], BROOKS, C.N.[1], and HATT, C.[1], [1]Michigan Tech Research Institute, Ann Arbor, MI;

[2]NOAA/GLERL, Ann Arbor, MI. **Water Quality Observations in the Great Lakes Using an Optimized Satellite Bio-optical Algorithm.**

The Color Producing Agent Algorithm (CPA-A) is a semi-analytical inverse radiative transfer bio-optical model to retrieve water quality parameters from satellite observed reflectance. The CPA-A requires knowledge of the inherent optical properties of a given water body to produce accurate retrievals of the primary color producing agents (CPA) namely chlorophyll (CHL), suspended matter (SM), and CDOM. An optimized set of inherent optical properties, known as a hydro-optical (HO) model, has been generated for Lakes Michigan, Superior, and Huron that produce robust retrievals annually and intra-annually for the MODIS mission (2002-2013). The optimized HO model was used to generate long term time series estimates of several water quality parameters including CHL, SM, CDOM, DOC, attenuation, absorption, backscatter, and photic depth. The diffuse attenuation coefficient (Kd) and photic depth are functions of CPA concentration and are therefore inherently retrievable with the CPA-A. Retrieved concentrations of CPA-A derived water quality parameters compare favorably with in situ measurements in the upper three Lakes. This complete set of water quality parameters provides unique observations of the lower food web including primary production to help better understand ecological changes due to anthropogenic forcing and climate change. *Keywords: Remote sensing, Water quality, Monitoring.*

SAYERS, M.J.[1], GRIMM, A.G.[1], SHUCHMAN, R.A.[1], DEINES, A.M.[2], BUNNELL, D.B.[3], ROGERS, M.W.[3], WOELMER, W.M.[3], BENNION, D.[3], and WARNER, D.M.[3], [1]Michigan Technological University, Michigan Tech Research Institute, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [2]Department of Fisheries and Wildlife, Michigan State University, 13 Natural Resources, East Lansing, MI, 48824; [3]U.S. Geological Survey, Great Lakes Science Center, 1451 Green Rd., Ann Arbor, MI, 48105. **A New Method to Generate a High-Resolution Global Distribution Map of Lake Chlorophyll.**

A new method was developed, evaluated, and applied to generate a global dataset of growing-season chlorophyll-a (chl) concentrations in 2011 for freshwater lakes. Chl observations from freshwater lakes are valuable for estimating lake productivity as well as assessing the role that these lakes play in carbon budgets. The standard 4-km NASA OceanColor L3 chlorophyll concentration products generated from MODIS and MERIS sensor data are not sufficiently representative of global chl values because they can only resolve larger lakes, which generally have lower chl concentrations than lakes of smaller surface area. Our new methodology utilizes the 300-m-resolution MERIS Full Resolution

Full Swath (FRS) global data set as input and does not rely on the land mask used to generate standard NASA products, which masks many lakes that are otherwise resolvable in MERIS imagery. The new method produced chl concentration values for 78,938 and 1,074 lakes in the Northern and Southern Hemispheres, respectively. The accuracy of the MERIS-derived values was assessed by comparison with temporally near-coincident and globally distributed in situ measurements from the literature (n = 185, RMSE = 9.39, $R^2$ = 0.72). This represents the first global-scale dataset of satellite-derived chl estimates for medium to large lakes. *Keywords: Phytoplankton, Chlorophyll, Remote sensing, Productivity.*

SCHAROLD, J., YURISTA, P.M., and KELLY, J.R., US Environmental Protection Agency Mid-continent Ecology Division, 6201 Congdon Blvd., Duluth, MN, 55804. **Linkages Between Benthic Macroinvertebrate Assemblages and Landscape Stressors in the US Great Lakes.**

We used multiple linear regression analysis to investigate relationships between benthic macroinvertebrate assemblages in the nearshore region of the Laurentian Great Lakes and landscape characteristics in adjacent watersheds. Benthic invertebrate data were obtained from the 2010 National Coastal Condition Assessment, a probability-based survey of the Great Lakes US nearshore zone (0-30m depth and within 5km from shore). Ponar grabs were collected at 306 sites distributed across all 5 Lakes. Backward stepwise regressions across sites revealed significant correlations of several benthic invertebrate assemblage metrics with landscape measures of anthropogenic stress in adjacent coastal watersheds. At a basin-wide scale, taxa richness, the Shannon diversity index, the oligochaete trophic index, and densities of chironomids and *Diporeia* were significantly related to agricultural activity in basin watersheds. Other significant landscape-level explanatory variables included human population density, land cover/land use, point source inputs, and soils. Study results provide evidence that benthic macroinvertebrate assemblages in the nearshore zone of the Great Lakes are responsive to landscape-derived stressors emanating from the adjacent watersheds. [This abstract does not necessarily reflect US EPA policy]. *Keywords: Macroinvertebrates, Zoobenthos, Coastal ecosystems.*

SCHMIDT, B.S.[1], MAYER, C.M.[1], ROSEMAN, E.F.[2], and PRITT, J.J.[2], [1]University of Toledo, Dept. of Environmental Science, Lake Erie Center, 6200 Bayshore Rd., Oregon, OH, 43616; [2]USGS Great Lakes Science Center, Ann Arbor, MI. **Assessing walleye spawning habitat in the Maumee River.**

Habitat loss and degradation are the largest contributors to species decline and extinction. The Maumee River has undergone a long history of anthropogenic degradation, yet still provides critical spawning and nursery habitat for many potadromous fish including one of four major substocks of walleye (*Sander vitreus*) in Lake Erie. To determine if spawning habitat availability and quality could limit production of Maumee River walleye, we assessed longitudinal distribution and relative abundance of walleye eggs deposited in a 31 km stretch of the river downstream of an impassable low head dam. Sampling was focused on areas identified as preferred walleye spawning habitat based upon substrate, depth, and water velocity. Eggs were pumped from the bottom at ten sites from April 1st until May 7th, 2014. Eggs from the four downstream spawning sites were present in a higher proportion of samples and had greater relative abundances than the six upstream sites. Counts of walleye eggs per two minute sample had a mean of 240.2 ± 223.2 SD whereas the six upstream sites mean was 11.1 ± 27.4 SD. Walleye spawning in the Maumee River appears to be longitudinally restricted to the lower 10 km reach of the study segment, despite large areas of available habitat suitable for spawning in the upper reaches. *Keywords: Habitats, Lake Erie, Walleye.*

SCHMIDT, J.R. and BOYER, G.L., State University of New York - ESF, 1 Forestry Drive, Syracuse, NY, 13210. **The Occurrence of Microcystins and their Metabolites in Fish: Implications for Human Health.**

Microcystin toxins produced by cyanobacteria can accumulate in fish tissues, leading to an additional exposure pathway for humans. Five species of fish (n=130) collected from Grand Lake St. Marys, a eutrophic lake in Ohio, were analyzed for microcystin-LR in their fillets using a very sensitive and selective LC-MS/MS technique. Only black crappie (*Pomoxis nigromaculatus*) and common carp (*Cyprinus carpio*) tested positive for the toxin and the concentration of toxin in individual fish within these species was highly variable. To determine if this variation was due to differences in exposure, laboratory-reared channel catfish (*Ictalurus punctatus*) were fed a diet containing microcystin-LR. Even under controlled conditions, the fish-to-fish variation in microcystin content was extremely high, ranging from 0-600 µg toxin per kg after 14 days of exposure. The glutathione conjugate of MC-LR was not detected in these fish, but the cysteine conjugate of MC-LR was found in some fish. These results suggest that the uptake of microcystins into fish and its subsequent metabolism and elimination is highly variable between both fish of the same species and between different species. Human health guidelines based on the consumption of an average fish are therefore highly suspect. *Keywords: Cyanophyta, Toxin, Fish, Microcystin, Harmful algal blooms.*

SCHOCK, N.T., SCHUBERG, D.H., and UZARSKI, D.G., Central Michigan University, 2625 Denison Dr. Lab 123, Mt. Pleasant, Mi, 48858. **Chemical and Physical Habitat Gradients within Great Lakes Coastal Wetlands.**

Great Lakes coastal wetlands are dynamic transition zones located between aquatic and terrestrial habitats. Due to their unique nature, coastal wetlands are biologically productive and diverse habitats, which are vital to the success of many macroinvertebrate taxa, and more than 80 Great Lakes fish species. Coastal wetlands provide unique functions and values that are vitally important to the health of the Great Lakes ecosystem such as carbon and nutrient cycling. As a filter, coastal wetlands are the last line of defense to protect the Great Lakes from harmful materials that run off the landscape, while trapping sediments, toxicants and preventing shoreline erosion. Therefore, understanding how wetland functions and processes respond to seasonal and yearly variations in hydrology is important. While collecting data at sites with multiple dominant plant zones, we have found that certain years and coastal wetland types (fringing, riverine, barrier) exhibit an evident chemical/physical gradient within coastal wetlands from the shoreline toward open water habitats. The observed changes in habitat conditions are an important aspect in understanding the functions and services that specific wetland types provide and how these aspects are influenced by changes in Great Lakes water levels and other aspects of hydrology. *Keywords: Water level fluctuations, Coastal wetlands, Hydrology, Biomonitoring.*

SCHOEN, L.S.[1], HOFFMAN, J.C.[2], SIERSZEN, M.E.[2], and UZARSKI, D.G.[1], [1]Central Michigan University, Mount Pleasant, MI; [2]US EPA Mid-Continent Ecology Division, Duluth, MN. **Sources of Energy Supporting Food Webs of Two Wetland Types in Lakes Michigan and Huron.**

We examined stable isotope signatures of Great Lakes coastal wetland and nearshore food webs in an attempt to identify dominant sources of energy in wetland fish communities. Dissolved inorganic carbon (DIC), plankton, macroinvertebrates and fish were collected from wetland and nearshore zones for analysis. In general, wetland sources were more 13C-depleted than nearshore sources. Sources from riverine wetlands were more 13C-depleted than sources from embayment wetlands. Within wetlands, δ13C of DIC and benthos varied by vegetation type, suggesting a gradient between wetland and nearshore habitats. Using community averages, we determined that prey and sport fish from Lake Michigan drowned river mouth wetlands were supported entirely by wetland sources. However, the importance of planktonic and benthic sources varied by site; plankton was dominant within the Grand River and benthos was dominant within the Kalamazoo River.

Similarly, prey fish from embayment wetlands of Lake Huron appeared to be supported by wetland sources; however, isotopic ratios of adults and sport fish indicated a mix of wetland and nearshore carbon. These results suggest that wetland fish communities are supported strongly by wetland sources, although sport fish within fringing wetlands may be partially supported by nearshore sources. *Keywords: Stable isotopes, Fish diets, Coastal wetlands.*

SCHOFIELD, J.A.[1], KLONICKI, P.T.[1], HELGEN, H.[2], ARON, J.L.[1], ALSUP, A.H.[1], PRANCKEVICIUS, P.[3], OSANTOWSKI, E.[3], MAY, J.[3], and KLEWIN, K.[3], [1]CSC, 6361 Walker Lane, Suite 300, Alexandria, VA, 22310; [2]CSC, 6201 Congdon Boulevard, Duluth, MN, 55804; [3]US EPA Great Lakes National Program Office, 77 West Jackson Blvd, Chicago, IL, 60604. **Approaches to Manage & Integrate Data-rich Sensor Technology into Long Term Monitoring Projects.**

GLNPO has primary responsibility within the US for conducting surveillance monitoring of the offshore waters of the Great Lakes. In addition, GLNPO now surveys the nearshore waters using the Triaxus towed sensor array which generates large volumes of *in situ* sensor data. While the long-term monitoring effort in offshore waters continues to focus on whole lake responses to changes in loading of anthropogenic substances and documenting patterns in water quality variables, the interpretation of nearshore data characterizes their relationship to landscape characteristics, such as tributaries, to discern shifts indicative of significant environmental change. To develop and maintain the long-term monitoring record of both the off- and nearshore regions of the Great Lakes, the data management system must be based on a large amount of sensor-generated data and associated sample data. An approach is needed to integrate the nearshore data with existing data management systems supporting the WQS, while continuing to pursue opportunities to improve the discoverability, accessibility and usability of monitoring data in the GLNPO program overall. We will discuss the approaches being considered to capture, store, integrate, analyze and visualize the offshore and nearshore monitoring data. *Keywords: Data storage and retrieval, Nearshore, Monitoring.*

SCHROTH, A.[1], GILES, C.D.[2], ISLES, P.[2], DRUSCHEL, G.[3], XU, Y.[2], and PERZAN, Z.[4], [1]UVM: Dept. of Geology, Burlington, VT; [2]Vermont EPSCoR/UVM, Burlington, VT; [3]Indiana University-Purdue University Indianapolis, Indianapolis, IN; [4]Middlebury College: Dept. of Geology, Middlebury, VT. **Dynamic coupling of trace metal and phosphorous behavior underneath the ice of Missisquoi Bay.**

Decreasing duration and occurrence of northern hemisphere ice cover due to recent climate warming is well-documented; however, biogeochemical dynamics underneath the ice are poorly-understood. We couple time-series analyses of water column and sediment water interface (SWI) geochemistry with hydrodynamic data to examine the drivers of trace metal and phosphorus behavior underneath the ice of a shallow eutrophic bay in Lake Champlain. During periods of persistent subfreezing temperatures, a pool of trace metals and phosphorus is established in bottom waters due to reductive dissolution of redox sensitive minerals near the SWI. During thaw events, the concentration, distribution and size partitioning of all species is dramatically different, with the highest concentrations of some species in the surface of the water column. This is due to the influx of geochemically distinct river water. The partitioning of trace metals and phosphorus beneath the ice is dynamic, and heavily influenced by climate-dependent physical processes that vary in time and space.
*Keywords: Biogeochemistry, Eutrophication, Phosphorus.*

SCHWAB, D.J.[1], RISENG, C.M.[2], GIBBONS, E.[3], GRONEWOLD, A.D.[4], BAULE, W.B.[3], and BROWN, D.[3], [1]University of Michigan Water Center, 625 E Liberty St, Ann Arbor, MI, 48104; [2]University of Michigan School of Natural Resources, 440 Church Street, Ann Arbor, MI, 48104; [3]University of Michigan Climate Center / GLISA, 717 E. Huron Street, Ann Arbor, Mi, 48104; [4]Great Lakes Environmental Research Lab, 4840 S. State Rd, Ann Arbor, MI, 48108. **Building a Great Lakes Adaptation Data Suite (GLADS) for Informed Decision Making in the Great Lakes.**

Climate change poses significant risks and impacts to communities across the Great Lakes region. Inherent in preparing for existing and anticipated changes in our climate is a need for locally relevant, highly credible, and distilled data/information. The University of Michigan Climate Center, with support from the Great Lakes Observing System (GLOS) is developing a data suite which integrates over-land observational data from the eight Great Lakes states and the province of Ontario with over-lake and coastal observations from the Great Lakes. These data sets include both gridded and in-situ observations. The Great Lakes Adaptation Data Suite (GLADS) seeks to standardize the characteristics of these data (i.e. time step, variables, and data structure) over a uniform period of analysis. GLADS will be primarily targeted at climate information providers and researchers across the region. This effort will allow access to high-quality, easily implementable data to inform their decision making processes with regard to lake, nearshore, and coastal interactions for climate adaptation efforts. Additionally, development of a standardized data suite will reduce data acquisition and standardization time for future researchers, creating more opportunities for applying lessons from these data sets to policy decisions across the region. *Keywords: Climate change, Coupled data, Data acquisition, Climate change adaptation, Great Lakes basin, Decision support.*

SCOFIELD, A.E.[1], WATKINS, J.M.[1], JOHENGEN, T.H.[2], MILLER, R.J.[2], WEIDEL, B.C.[3], COLLINGSWORTH, P.[4], and RUDSTAM, L.G.[1], [1]Cornell Biological Field Station, Department of Natural Resources, Cornell University, 900 Shackelton Pt. Rd., Bridgeport, NY, 13030; [2]School of Natural Resources & Environment, University of Michigan, Ann Arbor, MI, 48109; [3]U.S. Geological Survey, Great Lakes Science Center, Lake Ontario Biological Station, 17 Lake St., Oswego, NY, 13126; [4]U.S. Environmental Protection Agency, Great Lakes National Program Office, 77 W Jackson Blvd, Chicago, IL, 60604.
**Mapping the deep chlorophyll layer in Lake Ontario: A comparison of profiling technologies.**

Accurately quantifying deep chlorophyll layer (DCL) magnitude and composition is an important step in assessing the ecological structure of Lake Ontario during thermal stratification. Most efforts to characterize DCL structure in the Great Lakes have relied upon ship-based profiling technologies deployed at stationary points across the lake. However, towed instruments and autonomous underwater vehicles (AUVs) are emerging as common sampling methods for the study of large-scale patterns in aquatic systems. These technologies capture data with excellent spatial resolution and allow for the detailed examination of both large- and fine-scale processes that cannot be readily studied using stationary profile data. During the 2013 intensive study year for Lake Ontario, both a Slocum electric glider and a Triaxus towed vehicle were deployed to characterize water column properties across the lake in greater detail. This study compares chlorophyll-a fluorescence and fluoroprobe data from these continuous profiling instruments with stationary profile data collected at similar times and locations. This investigation serves to elucidate some of the benefits and challenges to employing these various technologies for *in situ* fluorescence measurements, in the context of accurately assessing DCL magnitude and composition. *Keywords: Lake Ontario, Deep chlorophyll maxima, Phytoplankton, Autonomous technologies, Spatial analysis.*

SCOTT, T.M.[1], PHILLIPS, P.J.[1], KOLPIN, D.W.[2], FURLONG, E.T.[3], FOREMAN, W.T.[3], GRAY, J.L.[3], and IWANOWICZ, L.R.[4], [1]US Geological Survey, 425 Jordan Road, Troy, NY, 12180; [2]US Geological Survey, 400 S. Clinton Street, Iowa City, IA, 52244; [3]US Geological Survey, Box 25046, Lakewood, CO, 80225; [4]US Geological Survey, 11649 Leetown Road,

Kearneysville, WV, 25430. **Pharmaceutical manufacturing facilities as sources of pharmaceuticals to municipal WWTP effluents.**

Little information is currently available on pharmaceutical manufacturing facilities (PMFs) as a source of pharmaceuticals to the environment. In the United States, current PMF-related data is limited to two small WWTPs receiving PMF discharge in New York State. For this study, the scope was expanded from the original study of the two small New York WWTPs to a national scale in order to encompass a broader: 1) spatial scale, 2) range of WWTP size, and 3) suite of pharmaceuticals formulated at the PMF sites. Samples were collected from 2012 - 2014 from twenty WWTPs located in nine states and Puerto Rico. Seven target pharmaceuticals (bupropion, carbamazapine, ethinyl estradiol, oxycodone, prednisone, sulfamethoxazole, and tamoxifen) were selected based on factors including potential for adverse environmental impacts, widespread documented occurrence in wastewater treatment plant effluent, high consumer usage, and the availability of methods to analyze for the compound. The results of this study document that some individual pharmaceutical concentrations were significantly higher in PMF-impacted effluent compared to the non PMF-impacted effluent. Individual pharmaceutical concentrations up to 1,000 ug/L were observed in PMF sites, compared to generally less than 200 ug/L in non-PMF sites. *Keywords: Organic compounds, Wastewater, Endocrine disruption, Pharmaceuticals, Water quality, Effluent.*

SHERMAN, J.J.[1], BOSSENBROEK, J.M.[1], MAYER, C.M.[4], BOASE, J.[2], CHIOTTI, J.[2], and VANDERGOOT, C.[3], [1]University of Toledo, Dept. of Environmental Sciences Bowman-Oddy 3043, Toledo, OH, 43606; [2]U.S. Fish and Wildlife Service, Waterford Sub-station, 7806 Gale Rd., Waterford, MI, 44870; [3]Ohio Department of Natural Resources, Sandusky Fisheries Research Station, 305 E. Shoreline Dr., Sandusky, OH, 44870; [4]University of Toledo Lake Erie Center, 6200 Bay Shore Road, Oregon, OH, 43616. **A Habitat Suitability Model for Lake Sturgeon (*Acipenser fulvescens*) in the Maumee River.**

Habitat suitability models are valuable tools to assist ecological and species rehabilitation. Lake sturgeon, *Acipenser fulvescens*, were historically abundant in the Maumee River. Over-exploitation in Lake Erie along with habitat destruction in the Maumee River has extirpated the species from this waterway; published accounts of lake sturgeon spawning in the river have not been documented in the last century and they were recorded being absent from the Maumee River as early as 1885. Restoration efforts are underway throughout the Great Lakes basin to improve habitat conditions and rebuild lake sturgeon populations. An initial step in this process is to determine the quality and quantity of lake sturgeon habitat in target systems. We constructed a spatially explicit habitat suitability index for multiple lake sturgeon life stages (e.g., adult and juvenile) in the Maumee River. Preliminary results demonstrate there are sections of the Maumee River containing optimal spawning habitat for lake sturgeon. This model will aid the development of a restoration plan for potential reintroduction of the species into this system. While lake sturgeon will be the target species for this model, the outcomes will have implications for monitoring other lithophilic spawning fish in the Maumee River. *Keywords: Spatial analysis, Suitability, Model testing, Sturgeon, Spawning.*

SHIMODA, Y.[1], WATSON, S.B.[2], YERUBANDI, R.[2], and ARHONDITSIS, G.B.[1], [1]University of Toronto, 1265 Military Trail, Toronto, ON, M1C1A4; [2]Environment Canada, 867 Lakeshore Road, Burlington, ON, L7S 1A1. **Phytoplankton functional type modeling: A critical assessment of the current state of knowledge.**

We evaluate the capacity of the current generation of aquatic biogeochemical models to reproduce the dynamics of phytoplankton functional groups, by reviewing 125 studies published in the international literature over the past three decades. Our analysis reinforces earlier findings that aquatic ecosystem modellers do not seem to consistently apply conventional methodological steps during the development of their models. We also found significant inconsistency with respect to the mathematical representation of key physiological processes (growth strategies, nutrient kinetics, settling velocities) as well as the group-specific characterization typically considered in the pertinent literature. Our study suggests that the derivation of distinct functional groups from fairly heterogeneous planktonic assemblages poses challenging problems. Because of the still poorly understood ecology, we do not have robust group-specific parameterizations that can support predictions in a wide array of spatiotemporal domains. In this context, we argue that the gradual incorporation of complexity, where possible and relevant, along with an open dialogue on how we can mathematically depict the interconnections among the different phytoplankton subunits or even how we can frame the suitable data collection efforts are the most prudent strategies. *Keywords: Eutrophication, Functional grouping, Ecosystem forecasting, Cyanobacteria, Ecosystem modeling, Uncertainty analysis.*

SHUCHMAN, R.A.[1], SAYERS, M.J.[1], GRIMM, A.G.[1], WEBER, S.[2], BROOKS, C.N.[1], and STONE, H.[2], [1]Michigan Technological University, Michigan Tech Research Institute, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [2]Battelle Memorial Institute, 505 King Avenue,

Columbus, OH, 43201. **Extending the Satellite-based Time Series of Harmful Algal Bloom Extents in the Great Lakes.**

The ability to generate maps of harmful algal blooms (HABs) in the Great Lakes using predictive HAB algorithms with ocean color satellite imagery has advanced significantly in recent years. However, these algorithms have mostly been developed for use with the MODIS and MERIS instruments, both of which were launched in 2002. To extend the time series of HAB extent data further back in time, the MTRI HAB algorithm was adapted for use with imagery collected by the SeaWiFS instrument launched in mid-1997. The combination of the SeaWiFS-based HAB product with MTRI's previous MODIS-based HAB product provides a continuous HAB extent dataset from mid-1997 to the present that provides improved historical context for the recent large algal blooms in the Western Basin of Lake Erie. The MODIS and SeaWiFS products will be compared and the longer-term trends in HAB occurrence in the Western Basin as well as Saginaw Bay and Green Bay discussed. *Keywords: Remote sensing, Harmful algal blooms, Monitoring.*

SIBRELL, P.L.[1] and WATTEN, B.J.[2], [1]USGS - Leetown Science Center, 11649 Leetown Road, Kearneysville, WV, 25430; [2]USGS - Conte Anadromous Fish Branch, One Migratory Way, Turners Falls, MA, 01376. **Chemical Characterization of Ballast Water and Precipitates Generated by Elevated pH Treatment.**

The U.S. Geological Survey has developed a ballast water treatment method based on short-term elevation of the water pH with sodium hydroxide or hydrated lime. Characterization of the reaction products of the treatment method are required in order to ensure that the impact on the environment is benign. The method was therefore tested by computer modeling of the neutralization process, which was then confirmed and supplemented by laboratory experiments. Computer modeling was done using the PHREEQC geochemical modeling program. Both the computer model and the laboratory studies were conducted using four different levels of salinity and through the application of either sodium hydroxide or hydrated lime to elevate the pH of the treated water to levels of 11.5 and 12.0. Reaction products of the treatment were also characterized through the analytical techniques of Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES) and X-ray diffraction. The high-pH water must then be neutralized to a safe pH before being released into the environment, so samples of the treated waters were then neutralized either with CO2 or by dilution, and the reagent requirements for these steps were also measured. This presentation describes the results of these investigations. *Keywords: Ballast, Chemical analysis, Model testing.*

SIERSZEN, M.E.[1] and VINSON, M.R.[2], [1]U.S. EPA, 6201 Congdon Blvd, Duluth, MN, 55804; [2]USGS, 2800 Lakeshore Drive East, Ashland, WI, 54806. **Examining Indirect Effects of Lake Trout Recovery.**

With the recovery of lake trout populations in Lake Superior, there are indications of decreased forage fish abundance and density-dependence in lake trout. In Lake Superior, lean lake trout historically occupied depths < 60 m, and siscowet lake trout occupied depths > 60 m. Siscowets have been known for their high lipid content (in excess of 65% in filets) which affords buoyancy that assists in diel vertical migration, an important adaptation to life in profundal habitats. However, in recent years several lines of evidence suggest that lipid concentrations in Great Lakes lake trout have declined. To explore changes in lipids and their energetic consequences, we compared lipid content and swimming costs among siscowet lake trout collected in 1953-1963, 2005, and 2011, and trends in lean and siscowet depth occurrences. We found ca. 40% declines in filet lipid content of similarly-sized siscowet between 1953 and 2011, a concomitant doubling of swimming costs, and a trend for siscowet to occur in shallower waters over the past decades. Mechanisms behind these trends would be clarified through further investigations in Lake Superior and other recovering systems. *Keywords: Food chains, Lake Superior, Lake trout.*

SIMONIN, P.W.[1], RIHA, M.[2], RUDSTAM, L.G.[1], SULLIVAN, P.J.[3], PARRISH, D.L.[4], and PIENTKA, B.[5], [1]Cornell Biological Field Station, Cornell University, Bridgeport, NY; [2]Biology Centre CAS, Institute of Hydrobiology, Ceske Budejovice, CZECH REPUBLIC; [3]Cornell University, Ithaca, NY; [4]U.S. Geological Survey, Vermont Cooperative Fish and Wildlife Research Unit, Burlington, VT; [5]Vermont Department of Fish and Wildlife, Essex Junction, VT. **Comparing and Predicting Spatial Ecology of Lake Champlain vs Lake Ontario Rainbow Smelt and Alewife.**

Rainbow smelt (Osmerus mordax) and alewife (Alosa pseudoharengus) are pelagic fish species native to coastal regions of northeastern North America. Rainbow smelt are native to Lake Champlain, but alewife were first found in the lake in 2003. Both species are also present in the Laurentian Great Lakes. Spatial dynamics of these species are particularly important because both are cannibalistic, with cannibalism rate a function of spatial overlap and fish density. Using data collected over both diel and seasonal cycles in Lake Champlain we determined what abiotic conditions influenced fish spatial distributions and created models predicting age-0 and adult rainbow smelt and alewife distribution. We then compared alewife distribution patterns in Lake Champlain, where they are found in the upper part of the epilimnion, with those in Lake Ontario. Distribution predictions were

coupled with previously-created predation models to simulate predation and cannibalism patterns. Using current Lake Champlain distribution patterns, our work predicts, due to the importance of cannibalism, that neither species will extirpate the other. Adult alewife are distributed closer to the thermocline in Lake Ontario, though, and we predict age-0 rainbow smelt mortality rate will increase in Lake Champlain if alewife adopt similar behavior in this system. *Keywords: Distribution patterns, Cannibalism, Alewife, Smelt.*

SLAWECKI, T.A.D.[1], PAIGE, K.R.[2], and KOCH, K.R.[1], [1]LimnoTech, 501 Avis Dr, Ann Arbor, MI, 48108; [2]Great Lakes Observing System, 229 Nickels Arcade, Ann Arbor, MI, 48104. **GLOS as an On-Ramp to the Information Superhighway.**

The federated data management system implemented at the Great Lakes Observing System (GLOS) has sometimes been described through the metaphor of the national highway system. GLOS sees itself and its Federal partners as stewards of a data management "interstate highway," but there are other critical players such as academic institutions, state and local government, and other research/policy/advocacy organizations that are responsible for the local "roads" that connect to this system. These partners already collect and/or manage data but need to develop the capacity and infrastructure to help make their data available to a wider audience of data users and stakeholders. There may also be larger policy or management efforts being planned by a consortium of partners that need to design or develop a framework to manage and widely share the relevant data.

In 2014, GLOS issued a request for proposals to help connect the "local roads" to the "interstates highway" by supporting the data management piece of a larger management or policy effort or development of the local infrastructure required to help make data more widely available. This presentation will provide an overview of the highway metaphor for data management and explain how selected projects improve access to useful data *Keywords: Data storage and retrieval, Observing systems, Data acquisition, Decision making.*

SMITH, J.P.[1] and SLAWECKI, T.A.D.[2], [1]Cooperative Institute for Limnology and Ecosystems Research, G110 Dana Building, 440 Church St., Ann Arbor, MI, 48109-1041; [2]Limnotech, 501 Avis Drive, Ann Arbor, MI, 48108. **State of Environmental Big Data Processing, Analysis, Management, and Distribution on the Web.**

Since its conception and invention by Sir Tim Berners-Lee, the World Wide Web, or just the Web, has been a platform for information exchange and collaboration. The Web's precursor was, in fact, applied at the European Organization for Nuclear Research (CERN) for precisely such a purpose before being reconfigured and implemented globally. As computing technology has evolved, so have uses for the Web, especially in the realm of data processing and curation. The number of tools available to process, manage, and analyze data have increased alongside their capabilities. This presentation will serve as a summary of, and mini-forum for, discussing *Web Technologies for Environmental Big Data* by Vitolo et al., a 2015 open access review paper in Environmental Modeling and Software, with additional notes from the presenters. Covered points of interest with example applications and/or clients will include web services and architectures, data storage and processing, modeling, visualization and interfaces, web catalogues, and workflow orchestration. We end with a few examples of how these tools have been implemented in past projects. *Keywords: Data acquisition, Data analysis, Data storage and retrieval, Data dissemination, Decision making.*

SMITH, S.D.P.[1], BUNNELL, D.B.[2], BURTON, G.A.[1], CIBOROWSKI, J.J.H.[3], DAVIDSON, A.[4], DICKINSON, C.[1], ESSELMAN, P.[2], EVANS, M.A.[2], KASHIAN, D.R.[4], MANNING, N.F.[1], MCINTYRE, P.B.[5], NALEPA, T.F.[6], PÉREZ-FUENTETAJA, A.[7], STEINMAN, A.D.[8], UZARSKI, D.G.[9], and ALLAN, J.D.[1], [1]University of Michigan, School of Natural Resources and Environment, Ann Arbor, MI; [2]U.S. Geological Survey, Great Lakes Science Center, Ann Arbor, MI; [3]University of Windsor, Dept. of Biological Sciences, Windsor, ON, N9J 3P4; [4]Wayne State University, Detroit, MI; [5]University of Wisconsin, Center for Limnology, Madison, WI; [6]University of Michigan Water Center, Ann Arbor, MI; [7]SUNY - Buffalo State, Buffalo, NY; [8]Grand Valley State University, Muskegon, MI; [9]Central Michigan University, Mount Pleasant, MI. **Synthesizing and Modeling Interactions among Environmental Stressors in the Laurentian Great Lakes.**

Many environmental stressors can occur simultaneously in an ecosystem. However, their cumulative effects on ecosystem condition are difficult to predict, since stressors' effects can be amplified or mitigated when they co-occur. We synthesized the incidence of stressor interactions in the Laurentian Great Lakes with a systematic literature review and structured expert elicitation. In the review, we searched pairs of stressors and related keywords with location. We found that authors discussed synergies in the majority of relevant studies, such as interactions of invasive mussels and climate change with other stressors, but individual and joint effects were seldom fully quantified. In the elicitation, researchers particularly implicated nutrient loading in interactions, expecting synergies with invasive mussels, hypoxia, wetland loss, and climate change. We are using conceptual models to explore key interactions and identify knowledge gaps. To study effects on the ecosystem holistically, we modified a spatial model of cumulative impact. In conservative scenarios, we found that antagonisms strongly affected maps of relative stress. Currently, we are incorporating the specific interactions from the review and elicitation into a new best-estimate map of cumulative stress to inform management and restoration efforts. *Keywords: Environmental effects, GIS, Spatial analysis.*

SNYDER, M.R.[1] and STEPIEN, C.A.[1], [1]Lake Erie Center, 6200 Bayshore Rd., Oregon, OH, 43606; [2]Lake Erie Center, 6200 Bayshore Rd., Oregon, OH, 43606. **Invasion genetics of the Eurasian round goby in North America: patterns across time and space.**

The Laurentian Great Lakes have experienced at least 186 successful biological invasions, causing large environmental and economic damages. The Eurasian round goby, Neogobius melanostomus, arrived via ballast water in ~1990, and has had large impacts on economically important native species like walleye and yellow perch. This study compares genetic structure in 7 round goby population sites across the Great Lakes and invasion source population at the approximate time of establishment and over 20 years later using 14 nuclear microsatellite loci and the mtDNA cytochrome b to analyze whether changes in round goby genetic population structure have occured across time and space. Preliminary results show the site of initial invasion (St. Clair R.) has always had the highest diversity. All 7 sites show significant spatial divergence, which is greater than the temporal variation within sites. Populations closer to the leading edge show signs of genetic bottlenecks early in the invasion that are less pronounced in later years. All populations except the site of initial establishment show evidence that the gene pool early in the invasion was supplemented by later arriving genotypes. *Keywords: Invasive species, Genetics.*

SNYDER, R., PÉREZ-FUENTETAJA, A., CLAPSADL, M.D., COCHRAN, J., OSBORNE, C., and LANG, J., SUNY Buffalo State, 1300 Elmwood Ave., Buffalo, NY, 14222. **Growth and Mortality of Emerald Shiners (*Notropis atherinoides*) in the Niagara River, NY.**

The emerald shiner (*Notropis atherinoides*) is a small, native cyprinid found in many of the large rivers and lakes of North America, including the Great Lakes and its connecting channels. Although the emerald shiner is an important prey species for piscivorous fishes and birds throughout its range, many aspects of its ecology and life history are poorly understood. In this study we use data obtained from extensive electroshocking surveys carried out in the upper Niagara River during spring, summer, and fall 2014 to determine growth rates via length-frequency analysis. We also use these data to estimate mortality rates using length-based models, including length-converted catch curves. A better understanding of population dynamics of the emerald shiner will help to guide future management actions in the upper Niagara River designed to improve recruitment and survival of this key species. *Keywords: Fish populations, Niagara River, Fisheries.*

SOKOL, E.C., URBAN, N.R., and PERLINGER, J.A., Michigan Technological University, 1400 Townsend Drive, Houghton, MI, 49931. **Trends and Predictions of Polychlorinated Biphenyl Contamination in Michigan's Upper Peninsula Fish.**

Fish consumption is an important economic, social and cultural component of Michigan's Upper Peninsula. Safe human consumption is threatened due to polychlorinated biphenyl (PCB) contamination caused by atmospheric deposition and past industrial use. This project focuses on small inland lakes which tend to have higher PCB concentrations than the Great Lakes. The Michigan Department of Environmental Quality has sampled lakes for PCB contamination across the peninsula. These samples, along with model predictions of fish PCB concentrations, were used to determine important environmental factors that affect PCB concentrations in inland lakes. Factors considered include the source of contamination, physical characteristics of the lake and watershed, and food web structure. Six of the 18 sampled lakes were determined to have local, industrial sources using Principal Component Analysis. Stepwise multiple linear regression predicted mean depth as the best predictor of total PCB concentration ($r^2 = 0.76$). Using EPA's bioaccumulation model (BASS), food web structure was altered to determine if significant effects to piscivore contamination occurred. Using future modeled scenarios of PCB air concentrations, future fish contamination was predicted to determine when desired fish consumption rates will pose acceptable risk. *Keywords: Fish, Atmosphere-lake interaction, PCBs, Bioaccumulation.*

SOOD, S. and DELAVAN, S.K., The State University of New York at Buffalo, Buffalo, NY, 14260. **Turbulence and Velocity Barriers for Upstream Shiner Movement: A Field Study at Broderick Park.**

Physical modifications to the upper Niagara River in the form of river dredging and shoreline alterations have presumably lead to artificially high flow rates in the river. This has impacted the emerald shiner, a small pelagic minnow known to traverse sections of the Niagara River. The objective of this study is to quantify the existing flow and turbulence conditions at Broderick Park, where shiners are observed to congregate downstream of a shoreline recess. Using Acoustic Doppler Velocimeters and Acoustic Doppler Current Profilers, it was determined that water velocities upstream of the recess, within 0.5 m from the seawall are on the order of 0.9 - 1.5 m/s, which is beyond the known swimming capability of emerald shiners. Also, the region upstream of the recess has eddy sizes on the order of 0.1 - 0.6 m, which are potentially problematic for shiners due to fish overturn and imbalance. In contrast, downstream of the recess, water velocity is on the order of 0.01 - 0.5 m/s and the eddy sizes are in excess of several meters, which is less problematic for the shiners. The high flow and problematic eddy sizes observed upstream may be evidence of barriers to shiner movement, necessitating possible remedial measures. *Keywords: Niagara River, Turbulence, Fish behavior.*

SOWA, S.P.[1], KHOURY, M.[1], SEELBACH, P.W.[2], DORAN, P.[1], POTTER, B.[3], ROGNER, J.[3], YACOBSON, E.[1], DATTA, A.[1], WEIS, S.[1], CARTER, S.[1], and EDER, T.[4], [1]The Nature Conservancy, 101 East Grand River Ave, Lansing, MI, 48906; [2]USGS Great Lakes Science Center, 1451 Green Rd, Ann Arbor, MI, 48105; [3]USFWS Upper Midwest-Great Lakes LCC, 2651 Coolidge Road, East Lansing, MI, 48823; [4]Great Lakes Commission, 2805 S. Industrial Hwy Suite 100, Ann Arbor, MI, 48104. **The Great Lakes IMDS: Helping Advance Landscape-scale Collaboration and Adaptive Management.**

Adaptive management provides the necessary framework and principles to guide any restoration effort. However, implementing adaptive management at landscape scales requires unprecedented levels of collaboration. But how can dozens of agencies, hundreds of organizations, and thousands of people collaborate when it is impossible for them to directly communicate and coordinate? Global business enterprises like General Motors or McDonald's® face this same problem and use information supply chains to foster independent collaboration. Over the past four years we have worked to develop the Great Lakes Information Management and Delivery System (IMDS), an online platform designed to support the entire adaptive management process and foster landscape-scale, independent, collaboration. The six modules of the IMDS provide a home for all outputs from each step in the adaptive management process and therefore demands a comprehensive adaptive management strategy. The site also allows you to manage content in a strategic manner, placing each piece of knowledge, data, decision tool, etc. into the proper context of how it helps support the particular component of the overall collaborative adaptive management strategy. This presentation will provide an overview of the IMDS and case studies of how it is being used in the Great Lakes. *Keywords: Decision making, Information Management and Delivery, Observing systems, Collaborative Conservation, Great Lakes basin, Adaptive Management.*

SPENCE, C.[1], LENTERS, J.D.[2], BLANKEN, P.D.[3], GRONEWOLD, A.D.[4], KERKEZ, B.[5], FROELICH, N.J.[6], and LEGER, W.P.[7], [1]Environment Canada, Saskatoon, SK; [2]LimnoTech, Ann Arbor, MI; [3]University of Colorado-Boulder, Boulder, CO; [4]NOAA Great

Lakes Environmental Research Laboratory, Ann Arbor, MI; [5]University of Michigan, Ann Arbor, MI; [6]Northern Michigan University, Marquette, MI; [7]Environment Canada, Burlington, ON. **The Great Lakes Evaporation Network (GLEN): More than just evaporation.**

Around 1998, the Laurentian Great Lakes underwent a regime shift toward higher summer evaporation rates and lower water levels, in conjunction with warmer summer water temperatures and reduced winter ice cover. More recently, cold, high-ice winters such as 2013-14 remind us of the large interannual variability in the Great Lakes system and the continued need for long-term monitoring. A growing ensemble of observations, including offshore eddy flux towers, buoy-based sensors, and vessel-based platforms are being deployed through a bi-national collaboration to reduce uncertainties in the Great Lakes water balance, provide a more robust basis for short- and long-term projections, and fill a significant gap in over-lake flux measurements and related meteorological data. Here, we provide an overview of this initiative, known as the Great Lakes Evaporation Network (GLEN). Although the network was initiated to provide improved estimates of evaporation, it is also intended to meet a broad range of applied and basic research needs. We provide an overview of the data collection efforts, the array of instrumentation and platforms, and the network of flux measurements and meteorological observations available to research scientists, operational forecasters, commercial shipping, recreational boaters, and other Great Lakes stakeholders. *Keywords: Hydrologic budget, Atmosphere-lake interaction, Climatic data.*

SPIESE, C.E.[1], BERRY, J.M.[1], BOWLING, M.N.[1], THAYER, A.G.[1], and BOULANGER, B.O.[2], [1]Department of Chemistry & Biochemistry, Ohio Northern University, 525 South Main St, Ada, OH, 45810; [2]Department of Civil Engineering, Ohio Northern University, 525 South Main St, Ada, OH, 45810. **Human Waste Markers and Nutrient inputs From Waste-treatment Systems in an Agricultural Watershed.**

Markers offer interesting insight into the complexities of nutrient management in watersheds. This paper reports on the use of caffeine as a marker to track the contribution of human wastewater and groundwater to nutrient levels observed within tile drainage effluents in a rural, secondary tributary of Lake Erie in northwest Ohio. The study results revealed a strong, negative correlation between caffeine and total phosphorous (Pearson's product moment correlation = -0.9). However, no additional correlations were observed between caffeine and other nutrients. Caffeine was positively related to total coliform bacterial abundance as well as E. coli abundance. Mean ± standard deviation caffeine concentrations ranged from non-detect at the control site to 1.2 ± 0.4 μg/L in tile drainage

effluents from sites having on-site wastewater systems. Mean ± standard deviation concentrations observed for total nitrogen and phosphorous concentrations in tile drains were 3.5 ± 1.8 mg/L and 0.4 ± 0.07 mg/L, respectively. Bacterial abundances ranged from non-detect to 60 cfu/mL. Commonalities in nutrient fingerprints (total and speciated phosphorus and nitrogen) in groundwater and tile drainage highlight the complex relationships for nutrient and water quality management in irrigation drainage networks. *Keywords: Water quality, Nutrients, Environmental health.*

ST PIERRE, J.I.[1], CIBOROWSKI, J.J.H.[1], AXLER, R.[2], BROWN, T.N.[2], BRADY, V.J.[2], DANZ, N.[5], GATHMAN, J.P.[4], KOVALENKO, K.E.[2], HOST, G.E.[2], HOWE, R.W.[3], NIEMI, G.L.[2], REAVIE, E.D.[2], and JOHNSON, L.B.[2], [1]University of Windsor, 401 Sunset Ave, Windsor, ON, N9B 3P4; [2]Natural Resources Research Institute, 5013 Trunk Miller Highway, Duluth, MN, 55811; [3]University of Wisconsin, Green Bay, 2420 Nicolet Drive, Green Bay, WI, 54311; [4]University of Wisconsin- River Falls, 410 S. 3rd Street, River Falls, WI, 54022; [5]University of Wisconsin- Superior, Belknap & Catlin P.O. Box. 2000, Superior, WI, 54880. **Cumulative effects of human land-use on benthic community condition at Great Lakes coastal margins.**

The ecological services provided by Great Lakes coastal ecosystems are threatened by diverse anthropogenic stressors. Although cumulative anthropogenic stress indices have been proposed, how biological communities relate to the risk of cumulative stress is largely unresolved. Using existing data, we assessed variation in benthic macroinvertebrate community composition (BMI) at coastal margins relative to watershed-scale agricultural (AG) and development-associated (DEV) stress. "GLEI" stressor scores were scaled to TITAN-derived 'threshold units'-the AG or DEV-induced stress at which abundances of sensitive taxa abruptly change (Kovalenko et al 2014). Sites draining watersheds with <50% AG and <10% DEV stress were designated 'reference sites.' Their biota described BMI reference condition. Using multivariate analyses, BMI of test sites were compared to the reference condition and classified as either Reference or Nonreference. Site positions were then plotted on an AG vs. DEV stress graph. Discriminant analysis identified the isopleth separating reference from nonreference sites using AG and DEV stress scores and their interaction term (IT) as classification variables. The magnitude and sign of the IT coefficient indicated if stress effects were independent, synergistic or antagonistic. *Keywords: Macroinvertebrates, Agriculture, Coastal wetlands, Development, Multiple stressors.*

STADIG, E.R.[1], GILLESPIE, R.B.[1], ALI, S.M.[2], and MCKINNEY, E.N.[1], [1]Indiana University-Purdue University Fort Wayne, Fort Wayne, IN; [2]International Islamic University, Islamabad, PAKISTAN. **Monitoring Long Term Trends in the St Joseph River Watershed.**

The St. Joseph River drains about 700,000 acres of primarily agricultural lands comprising seven counties in northeastern Indiana, southern Michigan and northwest Ohio. The St. Joseph is a major contributor to the Maumee River Basin which is the largest drainage basin to the Great Lakes. The St. Joseph River Watershed Initiative has monitored physicochemical measurements, herbicides, and nutrients at 24 sites since 1996. We evaluated spatial and temporal trends in atrazine, total phosphorous (TP), total nitrogen (TN), conductivity (Cond), turbidity (TB), and dissolved oxygen (DO) from 2000-2013 at 13 tributary sites. We selected an 11-week period (April-July) during each year and used Time Series-Trend Analysis to detect trends over the past 14 years. Preliminary results indicate significant decreasing trends in atrazine across the watershed. Decreasing trends in TN and TB were also detected along with increasing trends in DO and Cond at a majority of the sampling sites. There are several possible causes for the trends found in this analysis. Our results are currently being compared to data on discharge and metrics associated with land-use and conservation practices to identify important variables that might explain the variation in water quality parameters. *Keywords: Nutrients, Monitoring, Atrazine.*

STANISLAWCZYK, K. and MACISAAC, H.J., GLIER, University of Windsor, 401 Sunset Avenue, Windsor, ON, N9B 3P4. **Comparison of Multiple Techniques for Identifying Rare Species in Hamilton Harbour.**

Aquatic-invasive species (AIS) including zebra mussel, round goby, and fishhook waterflea, among others, have changed the dynamics of the Great Lakes since their introductions. Many of these AIS were introduced and moved throughout the Great Lakes via ballast water discharged from both domestic and international ships. When a species is first introduced, the population size will generally be very small. This is the best time to eradicate AIS; however, it is difficult to detect rare species in aquatic systems. I will spike different densities of non-indigenous Cladocera species into zooplankton samples collected from Hamilton Harbour, Ontario to simulate rarity and assess the return rate when using traditional taxonomy, genomics (454 pyrosequencing), and automated imaging flow cytometry (FlowCAM) technologies. Additionally, water samples from Hamilton Harbour will be analyzed using these techniques to discover rarity in situ. This study will provide insight regarding the use of each technique for the early detection of introduced invasive species, and will help scientists choose the most appropriate method for their studies. *Keywords: Zooplankton, Rarity, Invasive species.*

STEDMAN, R.C.[1], HECK, N.[1], and GADEN, M.[1], [1]Cornell University, Ithaca, NY; [2]UC Santa Cruz, Santa Cruz, CA; [3]Great Lakes Fishery Commission, Ann Arbor, MI. **Human Dimensions of Great Lakes Fisheries: Managers' Information Needs.**

Our study investigates Great Lakes fishery managers' information needs around social dimensions crucial to effective fishery management. Understanding and responding to social issues is crucial for effective management, but fishery managers face a number of barriers that impede them from doing so. We interviewed a broad array of Great Lakes fishery managers to identify barriers and opportunities for better use of social science information in decision-making. Such barriers include limited training in social science; incomplete and skewed understandings of the nature of social science information; and logistical difficulties in integration. Subsequently, fishery managers identify multiple information needs that would allow them to manage social dimensions aspects of the fishery better. Most of the cited information needs focus on the resolution of existing pressing management issues. Fishery managers seem less interested in information on long-term changes or social-ecological relationships that would allow building adaptive capacity to cope with future changes. This finding demonstrates an emphasis on dealing with short term, day-to-day management issues for social dimensions of the fishery in the Great Lakes rather than long-term planning. *Keywords: Environmental policy, Human dimensions, Public participation.*

STEGER, C.E.[1], OBENOUR, D.R.[2], BERTANI, I.[1], BRIDGEMAN, T.B.[3], JOHENGEN, T.H.[4], SAYERS, M.J.[5], SHUCHMAN, R.A.[5], FAHNENSTIEL, G.L.[1], and SCAVIA, D.[1], [1]Water Center, Graham Sustainability Institute, University of Michigan, 625 E. Liberty, Suite 300, Ann Arbor, MI, 48104; [2]Department of Civil, Construction, and Environmental Engineering, North Carolina State University, 311 Mann Hall, Campus Box 7908, Raleigh, NC, 27695; [3]Department of Environmental Sciences, University of Toledo, Lake Erie Center, 6200 Bayshore Rd., Oregon, OH, 43616; [4]Cooperative Institute for Limnology and Ecosystem Research, University of Michigan, 4840 S. State Street, Ann Arbor, MI, 48108; [5]Michigan Tech Research Institute, Michigan Technological University, 3600 Green Ct., Suite 100, Ann Arbor, MI, 48105. **Intra-seasonal Cyanobacteria Bloom Dynamics in Lake Erie in Relation to Environmental Drivers.**

Over the last decade, harmful algal blooms (HABs) have increased in frequency and intensity in western Lake Erie, causing water quality impairment threatening public health, fisheries, and tourism. Despite recent improvements in bloom forecasting, quantifying the role of environmental drivers in regulating intra-seasonal HAB dynamics remains a significant challenge. This is partly due to the limitations in accuracy and spatio-temporal coverage that affect *in situ* and remotely sensed bloom estimates. As a result, discrepancies in the characterization of seasonal bloom dynamics may emerge among different sets of observations, highlighting the need to include multiple data sources in modeling efforts. We compiled multiple long-term ('98-'14), high-frequency (daily to bi-weekly) datasets of HAB estimates in western Lake Erie, and we applied machine learning techniques to quantify interactive, non-linear relationships between environmental drivers (e.g. wind stress and direction, water temperature, irradiance, and nutrient loads) and short-term HAB dynamics. We identified critical thresholds of environmental factors that are likely to promote HAB development, and discuss them in relation to current knowledge on cyanobacteria requirements and results from existing models relating nutrient loads to HAB size in Lake Erie. *Keywords: Harmful algal blooms, Lake Erie, Mathematical models.*

STEIN, J.A.[1], LANDSMAN, S.J.[2], and WHITLEDGE, G.W.[3], [1]Illinois Natural History Survey, 1816 S. Oak St., Champaign, IL, 61820; [2]University of Prince Edward Island, 550 University Avenue, Charlottetown, PE, C1A4P3; [3]Southern Illinois University, 175 Life Science II, Carbondale, IL, 62901. **Detection of Natural Reproduction and Successful Recruitment of Lake Trout in Southern Lake Michigan.**

Overfishing and sea lamprey mortality drove Lake Michigan Lake Trout populations to near collapse in the mid-20th century. A massive stocking program began in 1965 with the goal of increasing spawner abundance and restoring Lake Trout populations. Beginning in 2009, nearly 20% of adult Lake Trout captured in fall spawning surveys lacked fin clips that normally indicate a hatchery-reared fish, and in 2012 and 2013 nearly 50% of all captured adults were unmarked. Stable isotope signatures were determined using otolith core material, which are indicative of the location of hatching and early life, and otolith edge material, which is indicative of locations recently occupied by the fish. Signatures from these two regions of the otolith enable the determination of the origin of unmarked fish by comparing otolith cores of unmarked adults with otolith cores of recently produced hatchery yearlings and otolith edge material of adults captured in L. Michigan and L. Huron. Otolith core signatures for unmarked adult Lake Trout collected from Julian's Reef in 2012 and 2013 were consistent with the open lake signatures found in otolith edge material of L. Michigan and L. Huron fish, and distinct from the hatchery signatures found in the core of hatchery-reared juveniles, suggesting natural recruitment to the adult life stage. *Keywords: Lake trout, Recruitment, Management.*

STEIN, S.R.[1], BOWEN, G.J.[2], TROY, C.D.[3], and HÖÖK, T.O.[1], [1]Purdue University, Department of Forestry and Natural Resources, West Lafayette, IN, 47907; [2]University of Utah, Department of Geology and Geophysics, Salt Lake City, UT; [3]Purdue University, Department of Civil Engineering, West Lafayette, IN. **Early Life Habitat Utilization of Fishes in Southern Lake Michigan Rivermouths.**

Fish habitat occupancy during early-life is one important determinant of population scale recruitment. Larval mortality rates are incredibly high; therefore, if certain habitats promote survival, these areas may contribute more fish to the adult population. In southern Lake Michigan, tributaries deliver seasonally warmer, nutrient enriched water into the relatively cool, oligotrophic lake. Through their unique physical and chemical processes, rivermouth mixing zones may promote growth and enhance recruitment of Great Lakes fishes; however, habitat utilization of rivermouths by young fish remains relatively unknown. To determine nursery and juvenile habitat occupancy, we analyzed the stable isotopes of carbon and oxygen from the core and outer edge from otoliths of round goby, yellow perch, and alewife. We compared otolith isotope chemistry to stable isotopes of water samples and Dreissenid shells to establish environmental baselines. Our results indicate that these fishes tend to spend early-life in similar habitats as where they were captured. Preliminarily, rivermouth fishes do not appear to subsidize Lake Michigan populations. Our investigation likely has broader implications for the recruitment of these ecologically and economically important fishes throughout the Laurentian Great Lakes. *Keywords: Stable isotopes, Coastal ecosystems, Fisheries.*

STELZER, E.A., FRANCY, D.S., and ECKER, C.D., U.S. Geological Survey, 6480 Doubletree Ave, Columbus, OH, 43229. **Predicting Harmful Cyanobacterial Algal Blooms at Lake Erie and Ohio Inland Lake Waters.**

Predicting when and where a harmful cyanobacteria bloom (cyanoHAB) may occur is important to protect the public that uses and consumes a water source; however, because of the many factors affecting toxin production, predictions are complicated and likely site specific. Monitoring for cyanobacteria genes including the microcystin synthetase gene (*mcy*), which can be detected by molecular methods, and for chlorophyll or phycocyanin using optical sensors may be able to provide an early warning system for cyanoHABs. Data were collected at Lake Erie and inland lake beaches weekly to monthly from May-November in

2013 and 2014 to better understand the links among cyanobacteria community structure, toxin production, and environmental and water-quality factors. Composite samples were preserved and analyzed for dissolved and total nutrients, cyanotoxins, phytoplankton abundance, and cyanobacteria and *mcy* genes by molecular assays. The molecular assay results that were good predictors of microcystin concentrations were different among the sampling locations. Phycocyanin, nutrient concentrations, and wind direction were significantly related to microcystin concentrations at most sites. Data from molecular assays, sensor measurements, and other variables are being used to develop site specific predictive models for cyanoHABs. *Keywords: Model studies, Lake Erie, Cyanophyta.*

STEPIEN, C.A., University of Toledo Lake Erie Center, 6200 Bayshore Rd., Toledo, OH, 43616. **A University's Response to the Toledo Water Crisis and ongoing HABs.**

In early August 2014, the Toledo area community awoke to the news that our water was unsafe to drink due to microcystin toxin concentrations over the WHO 1 ppb limit, which lasted for 3 days. Researchers had been documenting increasing concentrations of Microcystis blooms, sometimes accompanied by the toxin. A large bloom was concentrated at the Toledo Water Intake Crib, where University of Toledo researchers have real-time gear. Winds pushed the normally buoyant algal cells into the 17ft deep intakes, and overwhelmed the treatment plant. Within an hour, no bottled water was to be had within 100 miles. The UT Hospital had to postpone surgeries, and the football team had water donated by their rival BGSU team. This talk explores what the exact conditions were, with video footage through the bloom at the intake. UT quickly formed a Task Group, focused on the science behind the blooms, including phosphorous nutrients, land use, water treatment, diagnosis of algal species and toxins, and the short and long term health effects of microcystin. The status of these efforts is detailed, along with the growing community of networked scientists and specialists who are addressing this challenge to our water supplies, not only in the Great Lakes, but worldwide. *Keywords: Harmful algal blooms, Water quality, Drinking water.*

STERNER, R.W. and AUSTIN, J.A., Large Lakes Observatory, 2205 East 5th St., Duluth, MN, 55812. **Primary producers during the Big Chill.**

The winter of 2014-15 was unusually cold in the Laurentian Great Lakes region. In Lake Superior, ice cover was extensive and lake temperatures remained well below average for most of the 2015 ice-free season. Year-to-year variability in climate is one tool we can use to understand how large lakes are affected by changing climate. In late winter, when it was clear that 2015 would be an unusually cold ice-free period, a web survey was created and hypotheses were accepted from Great Lakes researchers about what influence the cold winter would have during the following season. There was little consensus in expert opinion about how temperature variation affects primary productivity in large lakes. Observations made during four offshore station occupations through 2015 found that primary productivity and chlorophyll in 2015 fell well within the range observed in previous years, with the exception of the late-season when both production and chlorophyll were noticeably higher in the shallow depths of the mixed layer than typically observed, effectively eliminating the Deep Chlorophyll Max. However, there were pronounced differences is size structure, with a much higher complement of algae >2 um in the cold year. These results indicate that indirect climate effects override direct temperature effects on growth. *Keywords: Algae, Climate change, Productivity.*

STEVACK, K.M.[1], POIRIER, D.[2], and SIBLEY, P.K.[1], [1]University of Guelph, 50 Stone Road East, Guelph, ON, N1G 2W1; [2]Ontario Ministry of Environment & Climate Change, 125 Resources Rd, Toronto, ON, M9P 3V6. **PCB Bioaccumulation and Toxicity of Lyons Creek Sediments in Comparison to Historical Trends.**

Lyons Creek East (Welland, Ontario) is a tributary of the Niagara River, and part of the Niagara River Area of Concern. Pollutants of potential concern for this site are mainly Polychlorinated biphenyls (PCBs), with historical contamination being monitored since the 1990's. Beneficial Use Impairments highlighted as result of this contamination include degradation of benthos, and fish consumption restrictions. In this study a sediment quality tetrad approach (including toxicity tests, bulk sediment chemistry, benthic community structure, and bioaccumulation tests) was utilized to investigate changes in sediment quality in Lyons Creek. The upper region of Lyons Creek, stretching from the Welland Canal to Highway 140 had the highest levels of total PCBs in sediment, and these sediments were acutely toxic to benthos during laboratory experiments. The data generated will contribute to the many line of evidence utilized as part of Monitored Natural Recovery sediment management option designated for this area under the Remedial Action Plan. *Keywords: PCBs, Lake Ontario, Bioaccumulation.*

STOMMEL, E.W.[1], ANDREW, A.S.[2], HENEGAN, P.L.[1], GRIGEL, H.[1], TANDAN, R.[3], LUCY, S.[3], HANEY, J.F.[4], TORBICK, N.M.[5], BULLERJAHN, G.S.[6], MURBY, A.L.[4], SHI, X.[7], CHEN, C.Y.[8], CALLER, T.A.[1], MULHOLLAND, M.R.[9], COX, P.A.[10], BANACK, S.A.[10], METCALF, J.S.[10], and BRADLEY, W.G.[11], [1]Department of Neurology, Dartmouth-Hitchcock Medical Center, Lebanon, NH, 03756; [2]Geisel School of Medicine at Dartmouth, Lebanon, NH, 03756; [3]Department of Neurological Sciences, University of Vermont, College of Medicine, Burlington, VT, 05405; [4]Zoology Department, University of New Hampshire, Durham, NH, 03824; [5]Applied GeoSolutions, New Market, NH, 03857; [6]Bowling Green State University, Bowling Green, OH, 43403; [7]Department of Geography, Dartmouth College, Hanover, NH, 03755; [8]Department of Biological Sciences, Dartmouth College, Hanover, NH, 03655; [9]Department of Ocean, Earth & Atmospheric Science, Old Dominion University, Norfolk, VI, 23529; [10]Institute for Ethnomedicine, Jackson Hole, WY, 83001; [11]Department of Neurology, University of Miami, Miami, FL. **Risk Factors for ALS: A Comprehensive Evaluation of Toxins and Toxicants from Field to Patients.**

Amyotrophic lateral sclerosis (ALS) is a devastating neurodegenerative disease and occurs sporadically (sALS) in 90% of cases. Exposure to the cyanobacteria produced neurotoxin beta-N-methylamino-L-alanine (BMAA) has been linked to sALS and the previously increased ALS rates in Guam. BMAA is found in waterbodies, can accumulate in fish, shellfish and crustacean, can be aerosolized, and has been found in the brains of ALS patients. We have demonstrated several ALS clusters in northern New England (NNE) close to waterbodies with a history of cyanobacterial blooms. We are conducting an individual-level biomarker-based case-control study to evaluate hypothesized exposure pathways for BMAA and the synergistic toxin methylmercury (MeHg). Questionnaire data has been collected on more than 105 controls and 155 ALS patients in NNE. Sampling of fish tissues, water, and aerosol is being performed on high vs. a low historic ALS-rate lakes, and in-situ field data will be correlated with remote sensing data. Cerebrospinal fluid (CSF), blood, hair, nail clippings, and postmortem tissues are being collected from incident ALS cases and controls for toxins analysis, histological analysis and future genetic testing. Ultimately this research may provide insight into pathological mechanisms of sALS, Alzheimer's and Parkinson's disease. *Keywords: Human health, Amyotrophic lateral sclerosis, Harmful algal blooms, Cyanobacteria, Environmental health, Beta-methylamino-L-alanine.*

STOW, C.A.[1], CHA, Y.[2], JOHNSON, L.T.[3], CONFESOR, R.B.[3], and RICHARDS, R.P.[3], [1]NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI; [2]University of Michigan, 4840 S. State Rd, Ann Arbor, Mi, 48108; [3]Heidelberg University, National Center for Water Quality Research, Tiffin, Oh, 44883. **Long-Term and Seasonal Trend Decomposition of Maumee River Nutrient Inputs to Western Lake Erie.**

We applied a seasonal trend decomposition technique to examine long-term and seasonal changes in Maumee River discharge, and nutrient concentrations and loads. Our results indicate similar long-term increases in both regional precipitation and Maumee River

discharge (1975-2013), though changes in the seasonal cycles are less pronounced. Total and dissolved phosphorus concentrations declined from the 1970s into the 1990s; since then total phosphorus concentrations have been relatively stable while dissolved phosphorus concentrations have increased. However, both total and dissolved phosphorus loads have increased since the 1990s because of the Maumee River discharge increases. Total nitrogen and nitrate concentrations and loads exhibited patterns that were almost the reverse of those of phosphorus, with increases into the 1990s and decreases since then. Seasonal changes in concentrations and loads were also apparent with increases since approximately 1990 in March phosphorus concentrations and loads. These documented long-term and seasonal changes in phosphorus, nitrogen, and suspended solids likely reflect changing land-use practices. *Keywords: Eutrophication, Nutrients, Pollution load.*

STRAYER, N.J.[1], O'MALLEY, B.P.[1], STOCKWELL, J.D.[1], and HANSSON, S.[2], [1]University of Vermont - Rubenstein Ecosystems Science Laboratory, 3 College Street, Burlington, VT, 05401; [2]Stockholm University, Stockholm, SWEDEN. **To Migrate or Not: Optimal Annual Routine Modeling to Evaluate Mysis Diluviana Migration Decisions.**

Recent work indicates that the macro-invertebrate *Mysis* exhibits partial diel vertical migration (DVM), whereby part of the population remains on the lake bottom at night as the rest migrates to the surface waters. The drivers underlying the decision to migrate remain unknown. We use concepts from optimal annual routine modeling to develop an agent-based model that simulates thousands of individual Mysids' decision-making processes at an hourly time step throughout a year. The model takes into account a daily and seasonally changing environment, including light, temperature, resources, and body condition to evaluate if multiple migration strategies can produce similar levels of fitness. In addition to testing hypotheses about migration drivers, the model will help facilitate more efficient field sampling and prediction of resource availability for mysivorous fishes by evaluating the potential for seasonality in *Mysis* migration patterns. *Keywords: Mathematical models, Macroinvertebrates, Migrations.*

STRYSZOWSKA, K.S., LANGEN, T.A., and TWISS, M.R., Clarkson University, Clarkson Avenue, Potsdam, NY. **Evaluation of Biodiversity and Water Quality Indicators in Wetlands of the Massena Area of Concern.**

The natural wetlands in the bi-national environmental Area of Concern (AOC) near Massena, New York and Cornwall, Ontario have been impacted by major habitat alteration and contamination that occurred as a consequence of historical industrial development. In recent years, various restoration and remediation projects have been implemented in the AOC; however, there is a recognized information gap as to whether these projects have been successful in restoring the beneficial use impairments (BUIs) identified for the Remedial Action Plan (RAP). We have been funded by the St. Lawrence River Research and Education Fund (SLRREF) to evaluate wetland habitat quality by surveying five biological indicators and fourteen indicators of water quality within a sample of wetlands in the Massena AOC and a comparable set of reference wetlands form outside the AOC. Results indicate that wetland habitat quality in the AOC does not differ from that of reference wetlands with respect to water quality and diversity of wildlife. However, we found that reference wetlands outside the AOC are larger while wetlands in the Massena AOC are covered by a higher percentage of invasive plant species. We concluded that the RAP implemented in Massena seems to have been successful at reducing the extent of wetland impairment and restoring wetland habitat. *Keywords: Bioindicators, Massena AOC, Wetlands, Ecosystem health.*

STUMPF, R.P.[1], JOHNSON, L.T.[2], BAKER, D.B.[2], and WYNNE, T.T.[1], [1]NOAA National Centers for Coastal Ocean Science, 1305 East West Highway`, Silver Spring, MD, 20910; [2]Heidelberg University, National Center for Water Quality Research, Tiffin, OH, 44883.
**Updating Heuristic Models for Predicting the Severity of Lake Erie Cyanobacterial Blooms.**

Lake Erie has experienced a reappearance of cyanobacterial blooms in this century, with severe blooms in six of the last seven years. Our previous work showed that spring (March to June) discharge and phosphorus load from the Maumee River can explain inter-annual variation in bloom severity between 2002 and 2011 (Stumpf et al., 2012, PLoSONE). The resulting regression models were used for predictions of seasonal bloom severity in the last three years. However in 2012 and 2013, the models underestimated the blooms. In addition, while a discharge based model has been a better estimator of severity, improved phosphorus load models are needed in order to provide guidance for reducing phosphorus loads. With data on severity now from 2002 to 2014, we have reexamined the model parameters, with the goal of improving prediction of load impacts on the blooms. A heuristic strategy uses ecological understanding of the cyanobacterial blooms to inform adjustments to the models. Bioavailable phosphorus provides better discrimination of bloom severity than total phosphorus. This result suggests that the reappearance of blooms may be associated with the increase in the load of dissolved reactive phosphorus relative to total phosphorus starting in the late 1990s. *Keywords: Cyanophyta, Phosphorus, Model testing.*

STUMPF, R.P.[1], TOMLINSON, M.C.[1], REICH, A.[2], SCHAEFFER, B.A.[3], and WYNNE, T.T.[1], [1]NOAA National Centers for Coastal Ocean Science, Division of, Silver Spring, MD, 20910; [2]Florida Department of Health, Bureau of Environmental Health, Tallahassee, FL, 32399; [3]U.S. Environmental Protection Agency, National Exposure Research Laboratory, Research Triangle Park, NC, 27711. **Routine Monitoring of Cyanobacterial blooms with Remote Sensing--Some Practical Considerations.**

State officials face a challenge of identifying when and where blooms of cyanobacteria, or other nuisance algae, occur. Advances in satellite-based sensors have allowed the potential for routine monitoring of larger lakes for cyanobacteria. Former satellites have provided information on the history of blooms in this century. In the next year, new launches should make routine monitoring a reality. We will discuss demonstration programs in Florida and Ohio's Lake Erie waters, the use and limitations of the data, and strategies to simplify access to data by drinking water managers in the future. *Keywords: Cyanophyta, Drinking water, Remote sensing.*

SUEDEL, B.C.[1], BIJHOUWER, P.[2], RUBY, R.[2], BANKS, C.J.[1], FRIONA, A.[2], HARRINGTON, H.[3], and ESSELMAN, P.[4], [1]US Army Corps of Engineers, 3909 Halls Ferry Road, Vicksburg, MS, 39180; [2]US Army Corps of Engineers, 1776 Niagara Street, Buffalo, NY, 14207; [3]US Army Corps of Engineers, 477 Michigan Avenue, Detroit, MI, 48226; [4]US Geological Survey, 1451 Green Road, Ann Arbor, MI, 48105. **Increasing Habitat Value on Great Lakes Coastal Structures through the Engineering With Nature Initi.**

The US Army Corps of Engineers, supported by the USEPA's Great Lakes Restoration Initiative, has initiated three demonstration projects to determine whether minor modifications to breakwater structure repairs can be used to increase habitat quality for aquatic and avian species. Existing structures are currently maintained to meet navigation safety objectives while minimizing adverse environmental impacts to the extent possible. The demonstration projects were initiated to determine whether minor modifications during the repair of breakwater structures would result in increased environmental benefits. In Cleveland Harbor, concrete toe blocks used to repair the breakwater were modified to create habitat at the base of the aquatic food chain. In Ashtabula Harbor, the concrete block repair was modified to create nesting habitat for the common tern, which had not been nesting in the area for decades. In Milwaukee Harbor, a rubble mound breakwater repair was modified to create fish spawning habitat. Field observations indicated that the modified toe block surfaces had more early colonizers and that the modified rubble mound is attracting fish to the newly formed structure. By applying these repair modifications long-term, there is tremendous potential to increase multiple benefits associated with built navigation infrastructure. *Keywords: Breakwaters, Restoration, Coastal ecosystems, Habitat Improvement, Macroinvertebrates.*

SUGIYAMA, N., KRAVTSOV, S., and ROEBBER, P.J., University of Wisconsin at Milwaukee, Milwaukee, WI, 53201. **The summertime warming trends in surface water temperature of the Great Lakes.**

Over the past 30 years, the Laurentian Great Lakes have exhibited summertime warming trends in surface water temperature greater than those in surrounding land air temperature by as much as an order of magnitude. For the years 1995-2012, Lake Superior exhibited the most dramatic warming trend in July-mean temperature, of 0.27±0.15 deg C/yr, based on the NOAA's GLSEA satellite observations. Shallower lakes, such as Lake Erie, exhibited smaller warming trends. In addition, within each lake, the warming was also the greatest in the regions of larger water depth; for example, some regions of Lake Superior deeper than 200m exhibited surface-water July-mean warming trends which exceeded 0.3 deg C/yr. We used a three-column lake model based on Hostetler and Barnstein (1990) coupled with a two-layer atmospheric energy balance model to explore the physics behind these warming trends. We found that, while as suggested by Austin and Colman (2007), the ice-albedo feedback plays an important role in amplifying the overlake warming trends, diffusion and light attenuation greatly affect how well the model reproduces the observed ice coverage of the deep lakes. *Keywords: Climate change, Atmosphere-lake interaction, Great Lakes basin.*

SUGLA, M.[1], ISLES, P.[2], and STOCKWELL, J.D.[2], [1]Rutgers- The State University of New Jersey, New Brunswick, NJ, 08901; [2]University of Vermont, Burlington, VT, 05401. **A Zooplankton Respiration Model to Evaluate Lake Metabolism Estimates from High-Frequency Data.**

High-frequency sensor data are increasingly being used to estimate lake metabolism (gross primary production, ecosystem respiration, and net ecosystem production) based on the diel oxygen technique. Validation of these lake metabolism estimates remains difficult because of inherent constraints with empirically-based techniques (e.g., container effects in bottle experiments). In this study, we use an empirically-derived zooplankton respiration ($R_{Zoop}$) model, based on body size and temperature, to evaluate lake respiration ($R_{Lake}$) estimates derived from high-frequency sensor data from Missisquoi Bay, Lake Champlain, a system prone to cyanobacteria blooms in late summer. We hypothesized that if both zooplankton and lake respiration models are realistic, then the ratio of $R_{Zoop}$:$R_{Lake}$ should be relatively low, and should be lower in late summer compared to early summer because cyanobacteria blooms likely negatively influence zooplankton through toxins, mechanical defenses, and decreased food quality. *Keywords: Lake Champlain, Metabolism, Respiration, Carbon cycle, Missisquoi Bay, Zooplankton.*

SUN, X.[1], JOHNSON, T.B.[2], and DROUILLARD, K.G.[1], [1]GLIER University of Windsor, 401 Sunset Ave, Windsor, ON, N9B 3P4; [2]Ontario Ministry of Natural Resources, 41 Hatchery Lane, Picton, ON, K0K 2T0. **Use of LC50 and LT50 testing to compare the acute thermal tolerance in two goby species.**

LC50 tests were used to determined the acute thermal tolerance in round gobies (*Neogobius melanostomus*) and tubenose gobies (*Proterorhinus semilunaris*). Both species were acclimated at their optimal temperature (22°C) prior to initiating trials. Triplicate batches of 10 fish per species were brought to the treatment temperature over a slow temperature ramp of 2°C/h and held at 31, 32, 33, 34 or 35°C for 12 h. For each fish, time to death was recorded and % mortality determined at the end of the trial. Temperature LC50's were computed by linear regression on probit-transformed mortality against the log of temperature. For round goby the LC50 was 33.3°C and was significantly higher ($p<0.05$; ANCOVA) than the LC50 of tubenose goby (32.1°C). Time to death analyses were also conducted at temperatures 32.5, 33.9 and 35.X°C (round goby only) by linear regression of log time to death measured for individual fish against probit transformed % mortality. LT50 (lethal time) of tubenose gobies was 248.3 min at 32.5°C and 127.7 min at 33.9°C, while that in round gobies it was 287.2 min and 527.6 min, respectively. The study demonstrates that round gobies have a higher physiological tolerance to acute temperature stress compared to tubenose goby. *Keywords: Invasive species, Round goby, Tubenose goby.*

SWINTON, M.W.[1], EICHLER, L.W.[1], NIERZWICKI-BAUER, S.[2], and BOYLEN, C.W.[2], [1]Darrin Fresh Water Institute, 5060 Lake Shore Drive, Bolton Landing, NY, 12814; [2]Rensselaer Polytechnic Institute, 110 8th Street, Troy, NY, 12180. **Stream temperature extremes attenuated by groundwater influence intrusion depth into Lake George, NY.**

East and West brooks, located at the south end of Lake George, experience attenuated temperature extremes compared to other major tributaries. Between late April and mid-October water temperature in these brooks was cooler than other major tributaries, reaching 4-5C cooler in mid-summer. From mid-October through April, water temperature in East and West Brooks was warmer than other major tributaries, reaching 3-4C warmer in mid-winter. The transition temperature in both the spring and fall were similar to groundwater temperature for the area (8-9C). A greater proportion of sand in the East and West brook watersheds resulted in greater hydraulic conductivity and likely aided groundwater transport to these streams. The cooler spring and summer temperatures in East and West brooks resulted in denser water than other major streams implying deeper lake intrusion depths. Comparing lake density profiles to the water density of East and West brooks indicated intrusion depths at or below the metalimnion (May-November) while other major tributaries generally inserted at or above the metalimnion. By mid-August/early September all streams inserted below the metalimnion. The deeper intrusion depth of East and West brooks may influence thermocline depth while potentially loading a greater proportion of nutrients to the hypolimnion. *Keywords: Tributaries, Monitoring, Hydrodynamics.*

# T

TESSIER, L.R. and WILKIE, M.P., Wilfrid Laurier University, 75 University Ave W, Waterloo, ON, N2L3C5. **Factors affecting lampricide uptake rates in the sea lamprey (Petromyzon marinus).**

The lampricide TFM (3-trifluoromethyl-4-nitrophenol) has been used to suppress invasive sea lamprey populations in the Great Lakes since the 1960's, by applying the chemical to streams containing high densities of larval sea lampreys. Although mortality rates are usually greater than 90%, treatment effectiveness can be underminded by residuals that survive treatments and undergo metamorphosis into parasitic sea lampreys. These parasitic sea lampreys migrate to the Great Lakes where they feed on the blood of sport and commercial, often killing their host. The present study tested the hypothesis that larger larval sea lampreys could be a source of residuals due to lower rates of TFM uptake during lampricide treatments. Accordingly, rates of TFM uptake were measured using $^{14}$C-TFM, along with oxygen consumption ($M_{O2}$) in larval sea lamprey ranging in size from 0.4-3.7g. Body size was negatively correlated with both MO2 ($P<0.001$; $R2=0.44$), and TFM uptake rates ($P<0.001$; $R2=0.77$). The rates of TFM uptake were 2X greater in the smallest vs the largest lampreys examined. Surprisingly, no differences in TFM uptake rates or MO2 were found between size-matched larval and parasitic sea lampreys. These findings indicate that larger sea lampreys are a potential source of residual lampreys following TFM treatments. *Keywords: Fish, Sea lamprey, Invasive species, Toxic substances.*

TETREAULT, G.R.[1], KLEYWEGT, S.[2], MARJAN, P.[3], BRAGG, L.[3], FUZZEN, M.[3], SMITH, B.[3], FLETCHER, T.[2], MOON, T.[4], MASSARKY, A.[4], MELTCALFE, C.[5], OAKES, K.[6], MCMASTER, M.E.[1], and SERVOS, M.R.[2], [1]Environment Canada, Burlington, ON; [2]University of Waterloo, Waterloo, ON; [3]Ontario Ministry of the Environment and Climate Change, Toronto, ON; [4]University of Ottawa, Ottawa, ON; [5]Trent University, Peterborough, ON; [6]Cape Breton University, Sydney, NS. **Response of fish to remedial actions at select sewage treatment plants in the Grand River.**

This study assessed contaminants and biological responses in fish during pre- (2010) and during- upgrades (2012) at a municipal wastewater facility which has been linked with adverse outcomes in wild fish. This was done by: 1) validating the relationship between exposure and responses in fish (Rainbow trout (Oncorhynchus mykiss), Fathead minnow (Pimephales promelas) using in vivo exposures in the river and, 2) assess the responses to infrastructure upgrades that have improved effluent quality. In 2010 the estrogenicity of the effluent ( YES assay) was considered to be high (~ 17 ng/L EEQ). In 2010, male minnows caged at the exposures sites did not demonstrate significant induction of vitellogenin (VTG). In 2012, effluent estrogenicity decreased to 7.5 ng/L EEQ. Caged fish after 14 d of exposure to the effluent had lower levels of VTG relative those fish caged at the reference locations. Fish caged at both a reference and exposed site injected with EE2 responded with significant induction of VTG. The lack of inducting of VTG in caged fish does not support the established adverse outcome pathway (AOP) of VTG induction of exposed fish leading to the intersex condition observed in wild fish. This would when suggests that there is another potential of mechanism or site of action by which oogenesis is initiated in exposed fish. *Keywords: Endocrine disruption, Environmental contaminants, Fish.*

THARP, R.[1] and HOWE, E.[2], [1]Lake Champlain Sea Grant, 705 Spear Street, South Burlington, VT, 05405; [2]Lake Champlain Basin Program, 54 West Shore Road, Grand Isle, VT, 05458. **Land Use Planning and Water Quality Educator.**

Realtors often serve as the only certified professional liaison present for property transfers - offering objectivity, experience, and perspective. They are in a unique position to educate the public and impact land use decisions that can influence the health of the environment and the investments of their clients. Ongoing state licensing requirements for

this group include continuing education (CE) classes but a survey of the offerings reveal that they rarely include important issues germane to flooding risk and natural resource protection - such as wetland and lake science or basic river dynamics. Working with partners at the Lake Champlain Basin Program, Lake Champlain Sea Grant developed a workshop in the Spring of 2014 approved for CE credits for Vermont licensed Realtors. Covering lake, river, and wetland science and regulations, as well as mapping tools and flood risk prediction methods, the 2-hour workshop was offered in the spring and fall of 2014 throughout the state of Vermont. In six course offerings, 137 Realtors completed the class and received CE credits. In course evaluations, 96% of respondents rated the course as "excellent" or "good." Realtors represent an important target audience for additional environmental education offerings. As a result, LCSG is expanding content of courses offered to this group. *Keywords: Environmental education, Public education, Urban areas.*

TILLOTSON, N.A.[1], MARSDEN, J.E.[2], and MCCABE, D.J.[3], [1]Murray State University, Murray, KY, 42071; [2]University of Vermont, Burlington, VT, 05405; [3]Saint Michael's College, Colchester, VT, 05439. **Zebra Mussels in Lake Champlain Prior to Quagga Mussel Invasion.**

Zebra mussels (*Dreissena polymorpha*) are a highly invasive species that can have severe ecological impacts on the systems they invade. By selective filter feeding, they compete with larval fishes and other native planktivorous species for resources, increase light penetration into the water column, and can increase the frequency of toxic cyanobacteria blooms. They invaded the south end of Lake Champlain in 1993, and have since spread throughout the lake. Quagga mussels (*Dreissena rostriformis bugensis*) are closely related to zebra mussels and are expected to invade the lake soon. Whenever quagga mussels are introduced into a system dominated by zebra mussels, they tend to replace zebra mussels as the dominant species. Zebra mussel veligers and newly settled mussels have been monitored in Lake Champlain since 1993, but very few data are available on adult populations. To establish baseline data in Lake Champlain prior to a quagga mussel invasion, we collected data on length frequency, population density, and percent coverage of adult zebra mussels at sites and depths throughout the lake. If quagga mussels invade the lake, data from this project will be used to document how rapidly and to what extent quagga mussels displace zebra mussels as the dominant species. *Keywords: Dreissena, Invasive species, Populations.*

TISUE, G.T., Muskegon Community College, 221 Quarterline Road, Muskegon, MI, 49442.
**Perfect Pitch: Simple Map Tools for Estimating Stream Gradients.**

The density and diversity of macroinvertebrate communities are commonly used metrics for assessing the health of stream ecosystems. These indicators depend on water quality, of course, but also on the abundance and variety of in-stream habitats. Stream gradient is a major determinant of hydraulic diversity and therefore also of habitat diversity. Volunteer monitoring programs often lack the resources and know-how to employ sophisticated methods for determining stream gradients, leaving them without the means for selecting sampling sites that are representative with respect to the range of gradients exhibited by the stream under study. This presentation demonstrates two simple open-source software tools that effectively solve this problem using Google Maps data. Applications to wadeable streams in Lake Michigan's watershed confirm the method's validity. *Keywords: Hydrogeomorphology, Gradients, Tributaries, Watersheds.*

TITZE, D.J. and AUSTIN, J.A., Large Lakes Observatory, University of Minnesota Duluth, 2205 E. 5th St, Duluth, MN, 55812. **Below-ice Observations in Lake Superior During the Cold 2013-2014 Winter.**

During the 2013-2014 winter, Lake Superior experienced record low air temperatures and record high ice cover, based on time-series dating back to 1985 and 1973, respectively. We analyze the sensitivity of Lake Superior ice cover to regional air temperatures over the past 30 years, and present observations from three subsurface moorings, which were deployed over the extreme 2013-2014 winter in deep offshore eastern, western, and central locations of the lake. Each mooring was equipped with an ADCP and a set of thermistors, providing a rare glimpse into the subsurface characteristics and behavior of an ice-covered large lake, including thermal structure, ice drift velocity, and the currents below the ice. Passing ice keels displaced the western mooring's top subsurface float to depths of up to 11 meters during the winter season, and frequently to depths greater than 6 meters. Ice occurred much later into the season than average during 2014, and this late-season ice inhibited surface heat flux and led to a delay in the onset of spring warming. Additionally, the direction of currents in the upper water column, and specifically the relationship between water velocities and wind velocities, was observed to shift dramatically in the presence of ice cover. *Keywords: Lake Superior, Ice, Climatology.*

TONINGER, R., MCDONALD, K., DIROCCO, J., and MACPHERSON, G., Toronto and Region Conservation Authority, 5 Shoreham Drive, Downsview, On, M3N1S4.
**Turning an accidental wilderness into meaningful habitat and park space in Canada's largest city.**

Tommy Thompson Park (Leslie Street Spit) was never intended to be a public urban park, but through natural succession and strategic habitat enhancement and creation projects it has turned into the most significant natural area on Toronto's waterfront. Once it was determined the reclaimed land was not required for "port related facilities", Toronto and Region Conservation (TRCA) developed a Master Plan to help guide park development and management, and set out to restore some of the habitats that have been historically lost from the Toronto waterfront. The restoration and enhancement of more than 22 hectares of wetland and terrestrial habitat, plus over two kilometres of shoreline as well as deep water enhancements, have created a biological centre of organization in a highly urbanized environment, benefiting not only fish and wildlife, but the people who visit as well. The restoration and management of the site are not without challenges, which include invasive species, colonial waterbirds, fisheries and people. With over 250,000 visitors each year, human management is essential to ensure the ecological integrity of the site is maintained. Well planned infrastructure, 18 kilometers of trails and nature-driven special events help the public understand, appreciate and steward Toronto's urban wilderness. *Keywords: Habitats, Restoration, Urban areas.*

TORBICK, N.M.[1], CORBIERE, M.M.[1], and STOMMEL, E.W.[2], [1]Dartmouth, Newmarket, NH, 03857; [2]Dartmouth, Hanover, NH. **Mapping Lake Champlain spatiotemporal water quality to support human health.**

Research has shown a potential linkage between lake water quality, cyanotoxins and clusters of Amyotrophic lateral sclerosis (ALS) in New England. Clusters are found along Lake Champlain and across the northeast adjacent to Bays and lakes that undergo chronic HAB events and suffer from poor water quality. The objectives of this research are to assess spatiotemporal trends in Champlain and lakes across northern New England to improve our understanding of public health risks. We obtained multiscale imagery including Rapid Eye, Proba, Landsat, and EO-1 and assessed parameters in St Alban's and Mallet's Bays. A suite of data mining approaches and empirical models were used to map the spatial distribution of chlorophyll-a, cyanobacteria concentration, and lake attributes measured with in situ instruments. Results show moderate to strong ability across the sensors with R2 ranging from 0.62- 0.88. Complementing efforts used historical Landsat archives to extrapolate the models across time and space to assess the spatiotemporal trends of lake water quality. Geostatistical techniques show varying clusters and trends across the northeast associated with the risk of belonging to an ALS cluster. Generally poorer water quality was significantly associated with increased odds of belonging to a cluster in the region. *Keywords: Climate change, Water quality, Remote sensing.*

TORBICK, N.M.[1], STOMMEL, E.W.[2], and CORBIERE, M.M.[1], [1]Applied Geosolutions, Newmarket, NH, 03857; [2]Dartmouth, Hanover, NH. **Mapping amyotrophic lateral sclerosis lake risk factors across northern New England.**

Amyotrophic lateral sclerosis (ALS) is a progressive, fatal neurodegenerative disease with a lifetime risk of developing as 1 in 700. Water quality and the toxin beta methyl-amino-alanine produced by cyanobacteria are suspected environmental triggers. Our objective was to develop an eco-epidemiological modeling approach to characterize the spatial relationships between areas of higher than expected ALS incidence and lake water quality risk factors derived from satellite remote sensing as a surrogate marker of exposure. We implemented spatial clustering analysis, remote sensing tools, and geostatistical modeling to explore these patterns in northern New England. Broadly, we found that poorer lake water quality was significantly associated with increased odds of belonging to an ALS cluster in the region.Geographic scale needs to be diligently considered when evaluating relationships among ecological processes, risk factors, and human health outcomes. *Keywords: Harmful algal blooms, Monitoring, Remote sensing.*

TREBITZ, A.S.[1], HOFFMAN, J.C.[1], PILGRIM, E.[2], PETERSON, G.S.[1], and LIETZ, J.[1], [1]U.S. EPA Mid-Continent Ecology Division, 6201 Congdon Blvd., Duluth, MN, 55804; [2]U.S. EPA Ecological Exposure Research Division, 26 W. Martin Luther King Dr., Cincinnati, OH, 45268. **Capacity for DNA-Barcode Based Taxonomy in Support of Great Lakes Biological Monitoring.**

Enumerating organisms collected via nets and sediment grabs is a mainstay of aquatic ecology. Since morphological taxonomy can require considerable resources and expertise, DNA-based identification of mixed-organism samples offers a valuable tool in support of biological monitoring. We recently compiled inventories for Great Lakes aquatic fauna (>1600 taxa) and examined the availability of reference mitochondrial COI DNA barcodes for them. We found barcode libraries to be largely complete for vertebrate species both extant and on threatening-to-invade lists. In contrast, roughly half of aquatic invertebrates lacked reference DNA barcodes or were not resolved to species such that barcodes could be looked up - a situation which calls for a concerted effort of voucher collection and barcode library building among Great Lakes researchers. We are also actively testing DNA-based taxonomy in the context of monitoring for invasive species. While there remain issues to explore and procedures to resolve, DNA processing of mixed-organism samples has the potential to bypass the laboratory effort of sample sorting and microscopy. [This abstract does not necessarily reflect U.S. EPA policy]. *Keywords: Species diversity, Bioindicators, Genetics.*

TUCKER, A.J.[1], MAHON, A.M.[2], CHADDERTON, W.L.[1], and WEGLEITNER, B.[2], [1]The Nature Conservancy, 1400 E. Angela Blvd., South Bend, IN, 46617; [2]Central Michigan University, Brooks Hall 214, Mount Pleasant, MI, 48859. **The Erie Canal Corridor as a Pathway for Biological Invasion.**

The Erie Canal Corridor (ECC) is the second largest artificial canal system in the Great Lakes Basin (GLB) and provides a continuous connection between the Great Lakes and the Lake Champlain and Mohawk-Hudson River basins. The ECC has been implicated in the spread of sea lamprey, alewife, water chestnut, zebra mussel, and white perch into or out of the GLB. Whereas significant management attention is focused on the threat posed by Asian Carp and other aquatic invasive species (AIS) at headwater connections that link the GLB to the Mississippi River basin, the ECC has the potential to undermine efforts to prevent future introductions into the GLB by providing a back door invasion pathway that directly links the basin to New York City -- one of North America's largest international shipping ports and an important entry point of imports for the commercial trade in live organisms. Here we examine the current and future invasion risk posed by the ECC and we present results from genomic surveillance efforts targeted at the early detection of AIS in the ECC. *Keywords: Biological invasions, Invasive species, Risk assessment.*

TUTTLE, T.[1], BULLERJAHN, G.S.[1], ROZMARYNOWYCZ, M.[1], MCKAY, R.M.[1], DAVIS, T.W.[2], and WATSON, S.B.[3], [1]Bowling Green State University, Life Sciences Building, Bowling Green, OH, 43403; [2]NOAA-GLERL, Ann Arbor, MI, 48108; [3]Environment Canada, Canadian Centre for Inland Waters, Burlington, ON, L7R 4A6.
**Evaluation of Increasing N and P Concentrations on Planktothrix in Sandusky Bay.**

Much of the cyanobacterial harmful algal bloom (CHAB) research in Lake Erie over the past two decades has focused almost exclusively on *Microcystis*. However, dense blooms of toxic *Planktothrix* occur annually in Sandusky Bay. The goal of our study was to assess the physiological response of Planktothrix to increases in inorganic and organic forms of nitrogen (N) and phosphorus (P) over the growing season and compare these data to bloom toxicity. We conducted 13 nutrient amendment experiments in 2013 and found that *Planktothrix* growth and bloom toxicity were primarily limited by N but did respond to N+P dual additions in experiments conducted after increased precipitation brought higher N inputs. Additionally, nutrient analyses indicate that dissolved inorganic N concentrations are far more variable than soluble reactive P, suggesting dynamic N cycling in the Bay. These data indicate that N is more important than P for controlling CHAB density and toxicity in Sandusky Bay. These findings will be integrated with metagenomic and metatranscriptomic data of the planktonic community to elucidate why this non-nitrogen fixing cyanobacterium thrives in an N deplete environment. *Keywords: Microcystin, Nutrients, Nitrogen, Cyanophyta, Lake Erie.*

TWISS, M.R.[1], JOHNSON, T.A.[2], DOVE, A.[3], CRIMMINS, B.S.[2], and HOLSEN, T.M.[2], [1]Clarkson University, Department of Biology, Potsdam, NY, 13699; [2]Environment Canada, Water Quality Monitoring and Surveillance, Burlington, ON, L7S 1A1; [3]Clarkson University, Department of Civil and Environmental Engineering, Potsdam, NY, 13699. **Thallium bioaccumulation by lake trout related to changes in lake water chemistry.**

Thallium (Tl) is a highly toxic non-essential redox sensitive trace metal. In the Great Lakes, most thallium enters as a result of anthropogenic activity, primarily from the combustion of coal and sulfidic metal ore smelting processes. Most Tl enters Great Lakes waters as Tl(I), but exists as Tl(III). Tl(I) is oxidized to Tl(III) by biota and as a result Tl(III) is significantly less bioavailable than Tl(I). Tl(I) uptake by organisms is strongly inhibited by potassium (K). We glean data from Environment Canada's Water Surveillance and fish contaminant levels from the USEPA Great Lakes Fish Monitoring and Surveillance Program (GLFMSP) to investigate temporal trends of Tl in game fish (lake trout; Salvelinus namaycush) in relation to water quality. Trends in Tl and K burdens in lake trout from the Great Lakes over a current time scale (2004-2012) are related to the concentrations of these metals (total Tl collected using trace metal clean technique and dissolved K) from the water column over the same time period. We suggest that changes in concentration of a base ion such as K will have significant impacts on accumulation by lake trout of a potentially harmful metal such as Tl. *Keywords: Fish, Biomonitoring, Metals, Bioaccumulation.*

TYLER, J.A.[1], RUTHERFORD, E.S.[2], WILEY, M.J.[3], HYNDMAN, D.W.[4], and PIJANOWSKI, B.C.[5], [1]Fisheries Projections, Farmington, CT; [2]NOAA - Great Lakes Environmental Research Lab, Ann Arbor, MI; [3]University of Michigan, School of Natural Resources and the Environment, Ann Arbor, MI; [4]Michigan State University, Department of Geological Sciences, East Lansing, MI; [5]Purdue University, Department of Forestry and

Natural Resources, West Lafayette, IN. **Physical Model Resolution and Predictive Power for Fish Populations: The Value of Detailed Data.**

As computing power has increased, models of fish populations have progressively operated with finer spatial resolutions, yet the costs and benefits of this trend that have gone under-examined. We compare predictions of two Individual Based Models (IBMs) of salmonid populations in the Muskegon River to assess the effect of spatial resolution on the predictive power of IBMs. FP-RAS operates with cell sizes of about 40 $m^2$ and includes a GIS based depiction of the substrate, characterized by 19 classes, and of benthic invertebrates, separated into 4 size classes. Its predecessor, FP-MesoRiver, operates with cell sizes of about 2000 $m^2$, describes substrate with a single variable (%gravel), and includes a spatially homogeneous function for drifting invertebrates. We ran simulations with Steelhead and Chinook Salmon populations varying water temperature and river discharge in isolation and in combination. Results show some important similarities in the predicted effects of temperature and flow on the fish populations, however, FP-RAS allowed for a more detailed analysis and understanding of these effects. We discuss the costs and benefits high- and low-resolution physical models for a fish population IBM and situations in which each may be more appropriate. *Keywords: Model studies, Fish populations, Salmon.*

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URBAN, N.R.[1], PERLINGER, J.A.[1], GORMAN, H.S.[1], GAGNON, V.S.[1], GIANG, A.[2], SELIN, N.[2], and NORMAN, E.S.[3], [1]Michigan Technological University, 1400 Townsend Dr., Houghton, MI, 49931; [2]Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA, 02139; [3]Norwest Indian College, Bellingham, WA, 98225. **When Can We Eat the Fish? An Approach towards an Answer.**

Most predictions that have been made regarding a timeline for reaching "safe" contaminant concentrations in fish are based on extrapolation of time trends from the recent past. Such extrapolation assumes, however, that the trajectory of atmospheric concentrations and deposition will remain the same, that the trajectory of delivery of contaminants from the catchment will remain the same, that the in-lake processing of the contaminants will remain similar, and that the endpoint (edible fish) has been correctly identified. Given the ongoing changes in policy that affect contaminant emissions, changes in climate, in lake food webs, and in catchment processes the first three assumptions may not be met. Current fish consumption advisories and "safe concentrations" in fish are not based on fish consumption rates desired by many indigenous communities, and therefore the fourth assumption also is typically not met. In this talk, we will present an alternative approach towards estimating the time required to reach safe contaminant concentrations in fish for the most sensitive individuals of high-fish consuming communities. *Keywords: Environmental contaminants, Biogeochemistry, Policy making.*

UZARSKI, D.G., SCHOCK, N.T., SCHUBERG, D.H., CLEMENT, T.A., and COOPER, M.J., Central Michigan University, Mount Pleasant, MI, 48858. **Interpreting Multiple Organism-Based IBIs and Disturbance Gradients: Basin Wide Monitoring.**

The Great Lakes Coastal Wetlands Consortium formed in 2000 with the intention of developing a basin wide monitoring plan to determine status and trends of ecosystem health. In 2010, implementation of the plan began and after visiting nearly 800 sites over four years and collecting data on chemical/physical parameters and biotic communities across the basin, it became apparent that individual wetlands do not experience stress uniformly nor do organism-based IBIs function at uniform scales. Therefore, IBIs often provide conflicting results within a given wetland. We used multivariate ordination techniques and correlations to relate IBIs to stressor gradients organized by hydrologic gradients while evaluating the use of land use/cover as a surrogate for stress. Vegetation-based IBIs represented upper portions of coastal wetlands and were driven by measures of invasive species, while invertebrate and fish-based IBIs better represented water quality in the lower portions. Monodominant stands of Phragmites may be improving water quality in the lower portions since very little material can penetrate the expansive stands while pelagic water may simultaneously be diluting stressors. Therefore a given wetland can be both extremely degraded (upper) and have reference conditions (lower), which must be accounted for in monitoring programs. *Keywords: Wetlands, Ecosystem health, Hydrodynamics.*

# V

VAN METRE, P.C.[1], FREY, J.W.[2], MAHLER, B.J.[1], NOWELL, L.H.[3], GILLIOM, R.W.[3], and CARLISLE, D.[4], [1]U.S. Geological Survey, Austin, TX, 78754; [2]U.S. Geological Survey, Indianapolis, IN; [3]U.S. Geological Survey, Sacramento, CA; [4]U.S. Geological Survey, Reston, VA. **Evaluating Relations Between Stressors and Ecological Endpoints in Streams at the Regional Scale.**

The U.S. Geological Survey assessed stream quality in the Midwestern United States in 2013 in cooperation with the U.S. Environmental Protection Agency. The goals were to characterize water-quality stressors--contaminants, nutrients, stream flow, temperature, and sediment--and ecological conditions in streams across the Midwest and to determine the relative effects of these stressors on aquatic organisms in the streams. One-hundred wadeable streams were sampled 12 times over 14 weeks during the spring and summer across parts of 11 states. Water samples were analyzed for major ions, nutrients, isotopes of nitrogen and oxygen, and about 230 pesticides and pesticide degradates. The sampling period concluded with an assessment of habitat, ecology (fish, benthic invertebrates, and algal communities), and bed sediment chemistry and toxicity at all 100 sampling sites, making this one of the most intensive characterizations of stressors and ecology in U.S. streams at the regional scale. The spatial and temporal distributions of nutrients and pesticides and some initial observations on ecological condition will be presented. *Keywords: Water quality, Multiple stressors, Watersheds, Pesticides, Ecosystem health, Nutrients.*

VANDERWESTHUYSEN, A.[1], ANDERSON, E.J.[2], MANN, G.[3], ALVES, H.[4], KELLEY, J.G.W.[5], MYERS, E.[6], FUJISAKI, A.[2], and SCHWAB, D.J.[7], [1]IMSG at NOAA/NWS/NCEP Environmental Modeling Center, College Park, MD; [2]NOAA/OAR Great Lakes Atmospheric Research Lab, Ann Arbor, MI; [3]NOAA/NWS Weather Forecast Office, White Lake, MI; [4]SRG at NOAA/NWS/NCEP/Environmental Modeling Center, College Park, MD; [5]NOAA/NOS/OCS/Coastal Survey Development Lab, Silver Spring, MD; [6]NOAA/NOS/CO-OPS, Silver Spring, MD; [7]University of Michigan, Ann Arbor, MI.

**A High-Resolution Atmospheric, Wave and Circulation Forecast System for the Great Lakes Region.**

The Great Lakes region contains many shallow coastal areas that are vulnerable to flooding and poor water quality (e.g., Saginaw Bay, Green Bay, Grand Traverse Bay). These regions feature complicated atmospheric conditions and irregular bathymetric characteristics, which are not well resolved by NOAA's current structured grid operational models WAVEWATCH III and the POM-based Great Lakes Operational Forecast System (GLOFS). Atmospheric models over the Great Lakes also require high resolution (e.g. < 2 km) to adequately resolve various physical phenomena. This paper presents the development of a next-generation, coupled wave and circulation operational model to address these needs, which is based on FVCOM and an unstructured version of WAVEWATCH III. As part of the initial system development presented here, WRF model runs were conducted at various spatial (1-12 km) and temporal (10-60 min) resolutions for a series of significant storms. These were subsequently used to force FVCOM and WAVEWATCH III simulations at resolutions down to 200-500 m. The results show the significant impact of the WRF model resolution on capturing atmospheric structures over the lakes, as well as the critical role of the higher nearshore resolution in reproducing waves and surge at vulnerable coastal locations. *Keywords: Hydrodynamics.*

VATOVEC, C.M.[1], PHILLIPS, P.J.[2], and VAN WAGONER, E.A.[1], [1]University of Vermont, 81 Carrigan Drive, Burlington, VT, 05405; [2]USGS, 425 Jordan Road, Troy, NY, 12180. **Pharmaceuticals in Lake Champlain: Investigating Levels, Sources, Effects and Points of Intervention.**

Pharmaceuticals are receiving increasing attention as chemicals of emerging concern in the aquatic environment. This research employs multidisciplinary mixed methods to understand the role of pharmaceutical contaminants in the Lake Champlain ecosystem. To determine levels of pharmaceuticals entering the lake, effluent samples were collected from the Burlington, Vermont wastewater treatment facility for ten consecutive days in May 2014 which coincided with the local university student move-out period. Of the 101 pharmaceutical compounds tested for, 54 compounds were present in the effluent. Analyses indicate that concentrations of several compounds increased over the ten day sampling period, suggesting that the student population may be diluting the pharmaceutical load. To identify sources of pharmaceutical contamination, we implemented a survey among students regarding drug waste disposal behaviors (n=419). Results indicate that 44% of respondents reported having leftover over-the-counter medications in the past year, and 31% had leftover prescription drugs. Fewer than 1% of respondents flushed drug waste during the past year, while 17% disposed of medications as municipal waste. Further research is needed to identify points of intervention for minimizing pharmaceutical waste entering the Lake Champlain ecosystem. *Keywords: Social-ecological systems, Pharmaceutical contamination, Lake Champlain.*

VERHAMME, E.M., DEPINTO, J.V., and REDDER, T.M., LimnoTech, 501 Avis Dr., Ann Arbor, MI, 48108. **Western Lake Erie Ecosystem Model - Connecting Phosphorus Loads to HAB Biomass.**

The Great Lakes Water Quality Agreement calls for the United States and Canada to work cooperatively to establish a new target load of phosphorus that reduces or eliminates the occurrence of harmful algal blooms (HABs) in Western Basin of Lake Erie. The challenge in setting the new targets is to quantify the relationship between external loads of phosphorus and the occurrence and severity of HABs. Statistical models can present correlations between the two, but have limited ability to describe the transport and cycling of phosphorus within the system and the dynamic nature of blooms throughout the season and from year to year. Presented here are results from the Western Lake Erie Ecosystem Model (WLEEM) that not only quantify the load-response relationship, but investigate the cause-effect pathways between phosphorus loads and HABs in Western Lake Erie. Model output was used to compare the relative contribution of phosphorus from the Detroit River and the Maumee River to HABs occurrence and severity. *Keywords: Harmful algal blooms, Model studies, Lake Erie.*

VERHAMME, E.M.[1], PETERSON, G.W.[1], MCCLURE, A.[2], and SNYDER, B.[2], [1]LimnoTech, 501 Avis Dr, Ann Arbor, MI, 48108; [2]City of Toledo, 3040 York St, Toledo, OH, 43605. **A real-time HABs monitoring system to support the Toledo Water Treatment Plant.**

In contrast to water treatment plants that withdraw groundwater, plants that withdraw surface waters must contend with relatively large fluctuations in source water quality on seasonal, daily, and even hourly time scales. The typical monitoring point for source water is at the plant prior to the beginning of treatment. Recent advances in remote telemetry and the low maintenance requirements of optical continuous monitoring sensors have enabled utilities to cost effectively monitor source water quality further from the treatment plant and closer to the source water body. This has proven particularly useful for water treatment plants that are located a considerable distance from their source water inlet. Within days after the Toledo Water Crisis, the City of Toledo installed a network of real-time water quality sensors as well as monitoring buoy in Lake Erie. The sensors measured a range of environmental parameters in real-time on the lake, inside the intake crib, and within the intake service tunnel on land. The buoy monitored wind speeds, waves heights, and provided a real-time video image of surface water conditions. This new monitoring system has vastly improved the City's ability to detect changes in environmental and source water quality hours before water reaches the plant and will help inform treatment decision *Keywords: Lake Erie, Drinking water, Harmful algal blooms.*

# W

WALLER, D.L.[1], LUOMA, J.A.[1], WEBER, K.L.[1], SEVERSON, T.J.[1], WISE, J.A.[1], and MAYER, D.A.[2], [1]USGS-UMESC, 2630 Fanta Reed Road, La Crosse, WI, 54603; [2]New York

State Museum's Field Research Laboratory, 51 Fish Hatchery Road, Cambridge, NY, 12816.
**Evaluation of the Impacts of Zequanox® to Nontarget Organisms.**

Non-target testing of Zequanox® was undertaken in conjunction with field studies to determine its safety and efficacy for control of dreissenid mussels in limited, high-value waters. We conducted toxicity trials in outdoor mesocosms and in a stream-side mobile laboratory at expected field application concentrations (50 and 100 mg/L AI Zequanox) and duration (8 h). Separate studies were conducted to evaluate effects of Zequanox exposure on: (1) survival of seven species of unionid mussels, (2) survival of amphipods (*Gammarus* sp) and hexagenid mayfly nymphs and (3) reproduction and early life development of fathead minnows. Results of these trials will be presented along with discussion of future research needs for evaluating impacts of Zequanox on nontarget organisms. *Keywords: Invasive species, Zequanox®, Macroinvertebrates, Unionids.*

WALLER, M.E.[1], CUMMING, B.F.[1], and BRAMBURGER, A.J.[2], [1]Queen's University, Kingston, ON; [2]St. Lawrence River Institute, Cornwall, ON. **Understanding the algal communities of the Lake St. Francis area with the help of citizen scientists.**

In recent years, occurrences of nuisance algae have been reported in the watershed and nearshore area of Lake St. Francis, a fluvial portion of the St. Lawrence River near Cornwall, Ontario. These nuisance algae blooms have been known to include potentially hazardous cyanobacteria (blue-green algae). There is a concern that algal blooms are occurring more frequently and that adverse impacts to wildlife, human activities and public health could occur. However, there is a general lack of information on the location, frequency and types of algal occurrences in this part of Eastern Ontario. This research seeks to address this lack of information through intensive sampling and citizen science in order to create the information that is necessary to document the occurrence of harmful algal blooms and the associated environmental conditions in and around Lake St. Francis. Analysis of these data will allow possible causative factors (e.g., land use, river/lake characteristics and water quality measurements) associated with algal blooms to be identified. This research will help local agencies and organizations manage harmful algal bloom occurrences responsibly and support the ongoing effort to reduce eutrophication (plant and algal growth) in the Cornwall area as well as meet provincial guidelines. *Keywords: Algae, Water quality, Citizen science.*

WALSH, M.G.[1], WEIDEL, B.C.[1], SCHULZE, P.M.[1], and BUNNELL, D.B.[2], [1]USGS Great Lakes Science Center Lake Ontario Biological Station, 17 Lake Street, Oswego, NY, 13126;

[2]USGS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105. **Effects of Trawling Depth and Area Swept on Benthic Fish Density Estimates.**

Uncertainty with respect to area swept by bottom trawls used by the USGS GLSC Lake Ontario Biological Station has historically resulted in reporting indices rather than specific density estimates.Time series of these indices have been critical for fisheries management and for insight into a changing fish community, but are less applicable for analyses requiring prey fish densities, such as quantifying behavioral changes with respect to depth and ecosystem mass balance modeling. Converting bottom trawl catches to fish density requires an understanding of how trawl geometry and trawl bottom contact behavior vary with fishing depth. We used trawl mensuration sensors to collect data on the actual amount of time the 11.8-m headrope Yankee bottom trawl is fishing on the lake bottom (versus an intended fishing time of 10 minutes), and verified touchdown and haulback times observed with mensuration gear using underwater cameras. We applied the relationships to estimate densities of important benthic fishes (e.g., native sculpins and invasive round goby). Relationships between time on bottom and depth were simililar in Lakes Ontario and Michigan and indicate that particularly at deeper trawling depths, using intended trawl time rather than actual time on bottom could markedly underestimate area swept and therefore benthic fish density. *Keywords: Fish populations, Bottom trawl, Lake Ontario, Underwater camera.*

WANG, J.[1] and BAI, X.[2], [1]NOAA Great Lakes Environmental Research Laboratory, 4840 S State Rd, Ann Arbor, MI, 48108; [2]CILER University of Michigan, 4840 S State Rd, Ann Arbor, MI, 48108. **Seasonal Prediction of Great Lakes Ice cover using indices of interannual & decadal teleconnections.**

This research investigates the relationship of the Great Lakes ice cover with not only the NAO and ENSO on internnual time scales, but also with AMO and PDO on decadal time scales. It was found that both NAO and AMO have a linear impact on lake ice, while ENSO and PDO have nonlinear (quadratic) impacts on lake ice, but none of them solely dominates the Great Lakes regional climate and lake ice cover. The combined effects of NAO, ENSO, AMO, and PDO on lake ice provide high predictability skills. We develop comprehensive statistical regression models to project medium-range lake ice cover only using projected indices of NAO, Nino3.4, AMO, and PDO one to several months ahead of time. *Keywords: Atmosphere-lake interaction, Ice, Air-water interfaces.*

WANG, L.L.[1], FLANAGAN, C.D.[2], and CHERKAUER, A.K.[1], [1]Purdue University, 225 South University street, West Lafayette, IN, 47907; [2]National Soil Erosion Research

Labratory, 275 Russell Street, West Lafayette, IN, 47907. **Climate change impacts on water quality in Great Lakes Region.**

Agricultural chemical pollutants of non-point sources (NPS) are one of major reasons for the degradation of water quality of Great Lakes, which is of critical importance as the Great Lakes supports millions of residents living in the states surrounding Great Lakes. Climate change in the future has impacts on the water quality in both direct and indirect ways through influencing hydrological cycle, nutrient transportation and transformation processes. But few studied the impact of climate change on the chemical pollutants coming from NPS in the Great Lakes region. This study will focus on studying impacts of climate change on the nutrients (Nitrogen and Phosphorus) of NPS in the Great Lakes region within 100 years. Effects of precipitation intensity and amount, and air temperature change on nitrogen and phosphorus losses were studied for six small watersheds to clarify the pollutant quantity lost from agricultural area under three special report emission scenarios (A2, A1B, B1). A newly developed water quality model Water Erosion Prediction Project-Water Quality (WEPP-WQ) model was utilized to predict nutrient load with ressembled climate datasets of three General Climate Models after validation and calibration with observed runoff,sediments, and nutrient dataset for each selected watershed located in the Great Lakes Region. *Keywords: Model studies, Climates, Water quality.*

WARNER, D.M.[1], O'BRIEN, T.P.[1], CLARAMUNT, R.M.[2], HANSON, D.[3], LENART, S.[4], and YULE, D.L.[5], [1]USGS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48103; [2]Michigan Department of Natural Resources, 96 Grant Street, Charlevoix, MI, 49720; [3]USFWS Green Bay Fish and Wildlife Conservation Office, 2661 Scott Tower Road, New Franken, WI, 54229; [4]USFWS Alpena Fish and Wildlife Conservation Office, 480 West Fletcher Street, Alpena, MI, 49707; [5]USGS Great Lakes Science Center Lake Superior Biological Station, 2800 Lakeshore Drive East, Ashland, WI, 54806. **Pattern and Process in Pelagic Fish Communities of the Great Lakes.**

Historically, the three upper Laurentian Great Lakes (Superior, Huron, and Michigan) were believed to have similar food webs in spite of a gradient in productivity (from Lake Superior at the low end and Lake Michigan at the high end). However, until recently, no data collected at the lake scale with the same techniques existed to allow for modern evaluation of this belief or how a gradient in productivity (if any) might influence the fish communities. We used data from lakewide hydroacoustic surveys, satellites, and published studies to compare and contrast the pelagic fish communities of these lakes in the context of system productivity and environmental stress. We compared fish community composition, community variation along environmental gradients, and productivity of both primary producers and pelagic fish communities at a scale that was previously not possible. *Keywords: Comparison studies, Fish, Acoustics.*

WARREN, G.J.[1], LESHT, B.M.[2], BARBIERO, R.P.[2], and HORVATIN, P.J.[1], [1]U.S. EPA, Great Lakes National Program Office, 77 W. Jackson Blvd., Chicago, IL, 60604; [2]CSC, Chicago, IL, 60660. **Toward a definition of the nearshore based on surface water properties.**

There are a number of definitions of the nearshore area for the Great Lakes, based largely on either physical (bathymetry, epilimnion depth) or biological attributes. We are attempting to provide an alternative approach to defining the nearshore based on observable surface water properties using nearshore:offshore transects derived from satellite imagery from Lake Michigan. While measurable through remote sensing, these also match surface water properties observed by citizens living on or using nearshore water. Surface temperature, reflectance at 555 nm (for turbidity) and chlorophyll from ten transects on each of the east and west sides of the lake were extracted from images that were sufficiently cloud-free to provide complete coverage along the transect. These transects were analyzed to find the distance from shore (width) at which sufficient change occurred to provide a quantitative estimate of the local nearshore. That width appears to vary over time and between the east and west coasts of the lake. In this talk we will discuss the estimates of the nearshore width based on each of the image based parameters, with particular reference to the differences observed east versus west. Techniques used to determine the nearshore width will also be presented. *Keywords: Remote sensing, Nearshore, Water quality.*

WATKINS, J.M.[1], COLLINGSWORTH, P.[2], RUDSTAM, L.G.[1], SAAVEDRA, N.E.[1], O'MALLEY, B.P.[3], SCOFIELD, A.E.[1], and HOLDA, T.J.[1], [1]Cornell Biological Field Station, 900 Shackelton Pt Rd, Bridgeport, NY, 13030; [2]US EPA GLNPO, 77 W Jackson Blvd, Chicago, IL, 60604; [3]University of Vermont, 3 College Street, Burlington, VT, 05401.
**Tracking diel vertical migration using advanced technology and net tows in Lake Ontario.**

Advanced technology such as the Laser Optical Plankton Counter (LOPC) and hydroacoustics provide high-resolution measurements of the distribution of zooplankton, mysids, and fish over space and time. In September 2013, the crew of the EPA GLNPO R/V Lake Guardian deployed an LOPC mounted on a Triaxus array along three 16 km north-south transects in support of the CSMI Lake Ontario sampling program. Multifrequency (120 and 430 kHz) hydroacoustic data were collected at the same time. These transects were conducted near midday and midnight in order to track diel vertical migration of organisms. Zooplankton counts from closing net tows (63 micron mesh) sampled three depth strata on either end of each transect and validate the in situ observations. *Keywords: Zooplankton, Lake Ontario, Hydroacoustics.*

WATSON, N.M.[1], HUMMEL, S.M.[1], JONAS, J.L.[2], STUDENT, J.J.[1], and PANGLE, K.L.[1], [1]Central Michigan University, Mount Pleasant, MI; [2]Michigan Department of Natural Resources, Traverse City, MI. **Lake Michigan Steelhead: Where were you hatched?**

Lake Michigan steelhead, *Oncorhynchus mykiss*, are a mix of hatchery-produced and wild fish, the latter originating from many different natal tributaries within the lake basin. Mixed stock populations can complicate conservation and management due to unequal contributions from various stocks, thus making it necessary to understand the natal origins of such populations. We evaluated the use of otolith chemistry as an approach to identify the natal origin of Lake Michigan steelhead. Using laser-ablation inductively coupled plasma mass spectrometry, we analyzed the otoliths of juvenile steelhead collected in 2013 and 2014 from 46 Michigan and Wisconsin tributaries of Lake Michigan. We found distinct chemical signatures occurring between fish from different natal streams and hatcheries that could be used to predict natal origin with a high degree of accuracy. Strontium was found to be the most important trace element for discrimination, with highest natural values occurring in the Manistee River. Our results clearly demonstrate the utility of otolith chemistry and pave the way for future studies to determine the natal origins of adult steelhead, thus benefiting the management of both steelhead and their natal habitats. *Keywords: Fisheries, Otolith chemical analysis, Steelhead.*

WATSON, S.B.[1], MATISOFF, G.[2], GUO, J.[1], and DUEWIGER, A.[2], [1]Watershed Hydrology and Ecology Research Division, Environment Canada, Burlington, ON, L7S 1A1; [2]Dept. Earth, Environmental and Planetary Sciences, Case Western Reserve University, Cleveland, OH, 44106-7216. **Sediment Resuspension and Accumulation Rates in Lake Winnipeg.**

There has been a dramatic rise in severe algal blooms in Lake Winnipeg, attributed to increased nutrient inputs from the watershed. Much of this external loading is associated with suspended particles but the transport and fate of this nutrient fraction within the lake and the importance of internal loading via resuspension is unknown. We employed $^{7}Be$,

$^{210}Pb$, and $^{137}Cs$ activities of suspended matter in tributaries and in the lake water column, in sediment traps and in bottom sediments to estimate sediment resuspension and mass accumulation rates. Comparing long term sedimentation rates in $^{137}Cs$ and $^{210}Pb$ dated cores with the seasonal sediment accumulation in the sediment traps indicated that 95-98% of suspended matter in the water column was resuspended bottom sediment in agreement with a 2-component mixing model using the $^{7}Be/^{210}Pb$ ratio in each potential sediment source that indicated that resuspension of bottom sediment accounted for 78-95% of the suspended material in the water column. The $^{137}Cs$ profiles indicate a 15-16 year system time integration constant and surface mixed layers of 3.7-7.3 cm to explain the uniform activities of the surface bottom sediments. *Keywords: Sediment transport, Internal loading, Sediment resuspension, Lake Winnipeg.*

WATSON, S.B.[1], STAINTON, M.[2], ZASTEPA, A.[1], VOGT, R.[3], and BOURBONNIERE, R.[1], [1]Environment Canada, Canadian Centre for Inland Waters, Burlington, ON, L7S 1A1; [2]Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, MB, R3T 2N6; [3]Department of Biology Trent University, Peterborough, ON, K9J 7B8. **Development of a Semicontinuous Ship-board Autonomous Plankton Metabolic Monitor (APPM).**

The purpose of this work was to develop a semi continuous ship-board Autonomous Plankton Metabolic Monitor (APMM) to measure primary productivity (P) and respiration (R), and evaluate this system in two major waterbodies with gradients in productivity and water quality, Lakes Erie (August 2014) and Winnipeg (Sept-Oct 2013 and 2014). During these cruises, the APMM incubation chambers were filled with subsurface water from an in-hull sampling line at regular (hourly) intervals, exposed to variable light levels (light and dark), and monitored for $O_2$ using an AAnderaa optode. This generated some 100 estimates of Gross P, Net P, and R for each cruise. In Lake Erie, APMM data at select stations were compared with concurrent estimates of productivity made using $^{14}C$ uptake rates from light/dark incubated bottles, and light response curves measured using a Walz®PhytoPAM. We will present these data, showing instances of severe $CO_2$ limitation in both lakes, and major spatial differences in Net P and respiration rates, for example with areas in Lake Erie near the Detroit R. dominated by heterotrophic activity, near Maumee Bay, and the Grand R with strong PP rates and deep offshore areas showing extremely low metabolic rates *Keywords: Metabolism, Respiration, Lake Winnipeg, Productivity, Lake Erie, Autonomous Plankton Metabolic Monitor.*

WATTEN, B.J.[1], ADAMS, N.[2], REYNOLDS, K.[3], SIBRELL, P.L.[4], MOFFITT, C.M.[5], STARLIPER, C.[6], GREEN, P.A.[7], BASSETT, N.L.[8], and HENQUINET, J.W.[8], [1]USGS Conte Anadromous Fish Research Branch, P.O. Box 796-One Migratory Way, Turners Falls, MA, 01376; [2]USGS Columbia River Research Laboratory, 5501A Cook - Underwood Road, Cook, WA, 98605; [3]The Gloston Associates, 1201 Western Avenue, Suite 200, Seattle, WA, 98101; [4]USGS Leetown Science Center, 11649 Leetown Road, Kearneysville, WV, 25430; [5]USGS Idaho Coop Fish and Wildlife Research Unit, Department of Fish and Wildlife, Moscow, ID, 83844; [6]USGS Leetown Science Center, 11649 Leetown Road, Kearneysville, WV, 25430; [7]NPS Isle Royale national Park, 800 East Lakeshore Drive, Houghton, MI, 49931; [8]Henquinet Consulting, P.O. Box 808, Houghton, MI, 49931. **Evolution of a NaOH / CO2 based Ballast Treatment Process for the Great Lakes Fleet.**

Ballast can contain high numbers of bacteria, algae and invertebrates which combined represent a significant threat to receiving waters. Stabilization of biologically active water has been achieved through use of hydroxide treatment. Here alkalinity is elevated through reagent addition (NaOH) so as to establish a killing effect that is easily controlled by regulation of the target pH (11-12.5). Exposure requirements are short and pH can be readily returned to neutral levels through use of a re-carbonation step - - the transfer into the bulk fluid of CO2 recovered from combustion sources or through application of commercial CO2. Hydroxide stabilization appears attractive given (1), the ease of applying the relatively inexpensive base through existing ballasting/deballasting plumbing and (2), the avoidance of ship corrosion concerns, associated with pH depression, that are linked to certain alternative acid/oxidant addition treatments. In this presentation we review the steps taken by our team to evaluate the feasibility of applying the hydroxide stabilization process on a large bulk carrier plying the Great Lakes. Our testing included use of computational fluid dynamic simulations, physical scale model testing, application of chemical reactor theory and full scale design/performance evaluations at sea. *Keywords: Ballast, Treatment, Invasive species.*

WEATHERS, K.C.[1], EWING, H.A.[2], KLUG, J.L.[3], and BORRE, M.A.[1], [1]Cary Institute of Ecosystem Studies, Millbrook, NY, 12545; [2]Bates College, Lewiston, ME, 04240; [3]Fairfield University, Fairfield, CT, 06824. **Embracing the role of citizen science in the Global Lake Ecological Observatory Network.**

Many of the 500+ members of the Global Lake Ecological Observatory Network (GLEON) work in close partnership with local lake associations and citizen science volunteers to leverage GLEON's three networks: lakes, data, and people. Many GLEON research sites rely on local citizen partners for sample collection and maintenance of data

buoys. Likewise, lake managers and citizen scientists recognize the value of sharing and interpreting high-resolution data and are eager to participate in the broader GLEON network. GLEON is working to bring research questions and data about lakes into the public sphere. Further, GLEON members are developing tools, such as a mobile app, to create opportunities for citizens to participate in scientific research. Partnerships between volunteers and researchers have advanced science about, for example, the impact of large storm events on lakes and their watersheds and the impact of cyanobacterial blooms within lakes that are public water supplies. Case Studies from Lake Sunapee (New Hampshire), Lake Auburn (Maine), and Lake Lillinonah (Connecticut) demonstrate how citizens contribute to the formulation of new research questions as well as how research scientists embrace citizen science to help understand, predict, and communicate the role and response of lakes in a changing global environment. *Keywords: Citizen science, Network science, Observing systems, Regional analysis.*

WEIDEL, B.C.[1], WALSH, M.G.[1], DIETERLE, C.[1], KARBOSKI, C.T.[1], PAUFVE, M.[1], LANTRY, J.R.[2], and MUMBY, J.[3], [1]USGS Lake Ontario Biological Station, 17 Lake St., Oswego, NY, 13126; [2]New York State Department of Environmental Conservation, 541 East Broadway, Cape Vincent, NY, 13618; [3]University of Windsor, GLIER, 401 Sunset Avenue, Windsor, ON, N9B 3P4. **Turning *Dreissena* Into Sport Fish: Round Goby's Role in the Lake Ontario Food Web.**

Round Goby play an important role in moving energy from *Dreissena* mussels throughout the Lake Ontario food web. We use fish and benthic invertebrate time series data to illustrate how Round Goby have influenced many of the changes that have taken place in Lake Ontario over the last decade. Within the benthic prey fish community Round Goby have replaced native Slimy Sculpin and are now the second most abundant prey fish in Lake Ontario behind Alewife. Round Goby diets are dominated by *Dreissena* mussels year-round with benthic invertebrates and *Mysis diluviana* making up the remaining portions. Seasonal trawling data illustrate an annual Round Goby migration from deeper habitats (60-120 m) into near shore areas (<20 m depth) in May and back to deeper habitats in early fall. Piscivore diet time series and mass balance food web models indicate Round Goby link *Dreissena* energy to higher trophic levels, supporting both near shore piscivores (Smallmouth Bass, Yellow Perch) and salmonids (Brown Trout, Lake Trout). We discuss our results in the context of future changes to the Lake Ontario ecosystem. *Keywords: Round goby, Food webs, Dreissena.*

WEINKE, A.D. and BIDDANDA, B.A., Grand Valley State University - Annis Water Resources Institute, 740 W. Shoreline Dr., Muskegon, MI, 49441. **Time-Series Productivity and Hypoxia Dynamics Linked to Storms and Runoff in a Great Lakes Estuary.**

Conditions in Muskegon Lake, a highly productive drowned river-mouth estuary, have improved since its initial placement on the list of Great Lake Areas of Concern. However, it is still suffering from issues such as Microcystis blooms and hypoxia. Using advanced observing technology to collect large quantities of quality time-series data, the Muskegon Lake buoy Observatory (MLO) is able to remotely monitor the conditions in and over Muskegon Lake. Since spring 2011, MLO has collected meteorological, biological, chemical, and physical data, which has revealed many details about how the lake operates daily, monthly, seasonally, and yearly (www.gvsu.edu/buoy), and enabled us to hone in on some key suspects causing the lake's hypoxia and eutrophication. MLO has alerted us to summer bottom water hypoxia and the status of potentially harmful cyanobacterial blooms (HABs) in Muskegon Lake during four years of deployment, and shed light on the response of hypoxia and HAB's to storm events and increased river runoff. Matching weather data collected in close proximity to the lake surface with the biological and physio-chemical parameters through the water column, has allowed us to learn about the intimate relationship between the weather and the inner workings of Muskegon Lake. *Keywords: Observing systems, Hydrodynamics, Eutrophication, Hypoxia, Estuaries, Time-series lake-weather interactions.*

WHITE, B., KOLBE, T., and STOCKWELL, J.D., University of Vermont, 538 Waterman 85 S. Prospect Street, Burlington, VT, 05405. **Lake Champlain REU: Evaluating and Improving Our Summer Undergraduate Research Program.**

In its inaugural summer in 2014, the Lake Champlain Research Experience for Undergraduates (REU) program, funded by NSF, provided ten students the opportunity to conduct research on the ecological and socioeconomic impacts of humans in the Lake Champlain ecosystem. We outlined benchmarks we used to identify progress toward the program's overall objectives, including the summative evaluation. We articulated plans for longitudinal data on (1) the importance and effectiveness of specific project components, and (2) the degree to which participant career trajectories were positively mediated by our summer experience. Our initial short-term results indicate that students gained significant research experience and unequivocally recommend this program to others interested in interdisciplinary research. We will report on student demography and our plans to incorporate more students from underrepresented groups. We will highlight areas for improvement based on participant and mentor feedback. *Keywords: Interdisciplinary, Evaluation, Undergraduate Research Experiences.*

WHITE, J.D.[1], HAMILTON, S.K.[2], and SARNELLE, O.[1], [1]Dept. of Fisheries and Wildlife, Michigan State University, East Lansing, MI, 48824; [2]Kellogg Biological Station, Michigan State University, Hickory Corners, MI, 49060. **Mass Mortality of Zebra Mussels at Sublethal Temperatures: Implications for a Complex Interaction.**

Microcystis, a toxic cyanobacterium, is forecast to increase with climate warming. It has also increased in oligotrophic lakes, an uncharacteristic niche, due to zebra mussel (Dreissena polymorpha) invasion, where it is strongly dependent on Dreissena for success. Therefore, in order to understand the effects of climate change on Microcystis, we need to know how warming affects both interacting species. We observed a mass die-off of Dreissena in oligotrophic Gull Lake during the warm summer of 2010, although water temperatures were below widely-reported lethal temperatures (≥ 30 °C). Using a combination of in situ monitoring of caged mussels and lab experiments, we demonstrate that zebra mussels are susceptible in nature to prolonged exposure to sublethal temperatures (>1,100 degree hours > 26 °C, as during the die-off), indicating a lower thermal tolerance than has been assumed. These temperatures were lethal to zebra mussels, but were within the optimal range for Microcystis growth. A complex interaction between zebra mussels, Microcystis, and temperature may lead to non-monotonic responses of Microcystis to a warming climate in oligotrophic lakes, demonstrating the need to understand how interacting species respond to climate change when forecasting the response of a focal species. *Keywords: Zebra mussels, Harmful algal blooms, Climate change.*

WHITTEN, A.L.[1] and MCNAUGHT, A.S.[2], [1]Annis Water Resources Institute, 740 W. Shoreline Dr., Muskegon, MI, 49441; [2]Central Michigan University, 153 Brooks Hall, Mount Pleasant, MI, 48859. **A Mesocosm Investigation of the Direct Effects of Quagga Mussels on Lake Michigan Zooplankton.**

Quagga mussels in the Great Lakes have increased and surpassed zebra mussels within the past decade. These dreissenid mussels are known to disrupt the base of the food web by filter feeding on phytoplankton; however, they can also directly ingest zooplankton. The objective of this study was to assess the direct effects of dreissenid feeding on the composition and size structure of Lake Michigan zooplankton assemblages. We conducted 2 mesocosm experiments in summer 2013 using quagga mussels and zooplankton collected near Beaver Island, MI. Mesocosms were sampled daily and zooplankton taxa were enumerated and sized using microscopy and FlowCAM® imaging. In experiment 1, quagga mussels had an immediate negative effect on veligers and copepod nauplii and a delayed effect on rotifers and copepods. In experiment 2, multivariate analysis revealed a change in zooplankton community composition with increasing mussel density. The abundance and frequency of 10 zooplankton taxa decreased as mussel density increased, but the opposite was true for the rotifer *Trichocerca*. High mussel densities had the greatest negative effect on small-bodied zooplankton (<128 μm). This study shows that quagga mussels can alter zooplankton communities directly, and reflects changes seen in Lake Michigan zooplankton assemblages during the past decade. *Keywords: Dreissena, Zooplankton, Predation.*

WHITTIER MULANAPHY, N., SONTAG, S., and MENTON, A., RPS ASA, 55 Village Square Drive, South Kingstown, RI, 02879. **Oil Spill Trajectory Forecasting Tool: Integrate and Disseminate Data to Decision Makers.**

Recent headlines have highlighted potential concerns for pipeline ruptures from the Mackinac Pipeline. This paper discusses improvements to oil spill trajectory forecasting that integrates and disseminates data to decision makers to improve response to an oil incident. New technologies, including mobile and tablet devices, public GIS sites, and the dramatic increase in accessibility of environmental data such as data from GLCFS, is changing the way oil spill responders can leverage tools to integrate and disseminate a wide variety of data for decision makers. OILMAP has been used for oil spill modeling by industry and governments for over 20 years. The latest generation of OILMAP tools includes mobile and tablet accessibility, the use of web services to publish results to ArcGIS Online, and direct access to environmental data via the Environmental Data Server (EDS) to support deterministic and ensemble spill trajectory modeling. EDS can also provide environmental conditions such as ice coverage, wave height, water temperature and others to bring better situational awareness to the way we prepare and react to oil spills. It is essential that we bring the best technologies and 'on-demand' data services to decision makers so that we have accurate and prompt information for operational response. *Keywords: GIS, Oil spill modeling, Planning, Web services, Decision making, Emergency response.*

WILCOX, E.M. and SMUDDE, J., NEW Water, 2231 N. Quincy Street, Green Bay, WI, 54302. **Is technology always better? Innovative watershed approach to improved water quality.**

NEW Water, the brand of Green Bay Metropolitan Sewerage District, is faced with a dilemma. With the issuance of a new Wisconsin Pollutant Discharge Elimination System

(WPDES) permit, NEW Water is required to meet new total phosphorus (TP) and suspended solids limits determined by the state and the Lower Fox River Basin Total Maximum Daily Load. Given the options of, Water Quality Trading, Adaptive Management (AM), plant upgrades, and permit variance, NEW Water selected to improve water quality in its receiving water through an AM approach. A five year pilot project in a Fox/Wolf sub watershed, Silver Creek, is underway. Silver Creek spans Brown and Outagamie counties and flows through parts of the Oneida Reservation. From the first water year, non-event baseline concentrations were monitored and high concentration sites identified. Event sampling showed loading of TP and sediment during times of high flow due to rain, snow melt and runoff, primarily in the spring and fall. To demonstrate compliance with NEW Water's WPDES permit, a reduction of Silver Creek TP to 0.075mg/L must be shown. The goal of AM is to implement restoration and best management practices to maximize water quality. NEW Water will leverage its existing water quality monitoring program to measure long term improvement in the local rivers and Green Bay. *Keywords: Water quality, Watersheds, Phosphorus.*

WILLIAMS, J.R., Inland Seas Education Association, PO Box 218, Suttons Bay, MI, 49682.
**Teacher collaboration leads to innovative shipboard programming.**

Inland Seas Education Association (ISEA) has been delivering Great Lakes environmental education aboard its tall ship schooner for 25 years. When it came time to expand our program offerings we looked to our audience for guidance - the teachers and students who benefit from our programs. We collaborated with 11 high school teachers and regional education experts to create classroom lessons and an ISEA shipboard program that delivers involvement in Great Lake research, stewardship education, and an enhanced sailing adventure for more advanced students. This was an involved undertaking that included grant writing, teacher recruitment, professional development days, online collaboration, program development, volunteer training, program implementation, and evaluation. The investment in time and funds was extensive, but well worth it. ISEA now has a strong program offering that meets real needs of teachers and schools. By using this process we also developed and strengthened relationships with regional teachers and schools who will advocate for ISEA and support our programming in the future. This talk will share the new program and the process that led to its inception. *Keywords: Citizen science, Lake Michigan, Education, Monitoring.*

WILLINK, P.W.[1], JACOBS, G.R.[3], WOIAK, Z.[3], GORSKY, D.[4], and BEISINGER, Z.[4], [1]Shedd Aquarium, 1200 South Lake Shore Drive, Chicago, IL, 60605; [2]University of Georgia, Odum School of Ecology, Athens, GA, 30601; [3]U.S. Fish and Wildlife Service, Northeast Fishery Center, Lamar, PA, 16848; [4]U.S. Fish and Wildlife Service, Lower Great Lakes Fish and Wildlife Conservation Office, Basom, NY, 14013. **Activity Patterns of Lake Sturgeon in Lakes Erie and Ontario using Pop-off Archival Satellite Tags.**

Little is known about lake sturgeon (*Acipenser fulvescens*) movement and migration behavior in Lakes Erie and Ontario. In contrast to conventional survey methods, archival tags allow the ability to record habitat variables, movement, and location throughout the year. The objective of this study was to characterize movement behavior of lake sturgeon in response to time and habitat variables during and after the spring spawning period. Pop-off Archival Satellite Tags (PSAT tags) were attached to 23 lake sturgeon in Buffalo Harbor, Lake Erie and 22 lake sturgeon in the Lower Niagara River, Lake Ontario during spring, 2014. PSAT tags measure location, depth, temperature, and activity until a programmed release date. After release, tags float to the surface where they communicate their data via satellite or may be recovered and their data downloaded directly. We evaluated migration behavior and positional accuracy of tag data on a daily time step. We then evaluated variation in tag acceleration and orientation across depth, temperature, and time to infer movement patterns. Migration patterns were difficult to assess as lake sturgeon tended to migrate relatively short distances during tag deployment. However, we do find patterns in the variation of lake sturgeon activity across environmental covariates. *Keywords: Niagara River, Lake Erie, Lake Ontario.*

WINSLOW, M.J.[1], SHAMBAUGH, A.[2], and CHEVREFILS, A.[3], [1]Lake Champlain Committee, 208 Flynn Ave., Bldg. 3, STE 3-F, Burlington, VT, 05401; [2]Vermont Department of Environmental Conservation, 1 National Life Drive, Main 2, Montpelier, VT, 05620; [3]Vermont Department of Health, 108 Cherry St., Burlington, VT, 05401.
**Establishing a Volunteer Cyanobacteria Bloom Monitoring Network.**

Cyanobacteria blooms are a subject of concern on Lake Champlain. The non-profit Lake Champlain Committee has run a volunteer cyanobacteria monitoring program in collaboration with the Vermont Departments of Health (VDH) and Environmental Conservation (VTDEC). Volunteer monitors' reports were used to update citizens, guide public health decisions about when to close beaches and to populate the publicly available web-based VDH status maps of conditions on the lake. Since 2011 monitors have provided qualitative assessments of conditions, a methodology that allows broad geographic scope by avoiding lab analysis costs. We train lay citizens in identifying and assessing the risk of cyanobacteria, hold training sessions throughout the region, collect and vet reports from

volunteers, and share results with a broad network. From June 15 to September 13, 2014 we received routine observations from 87 sites generating 939 reports. An additional 226 supplemental reports represented extra reports from regular sites, extra sites that did not report regularly, or reports from outside the thirteen-week monitoring season. Regular reports indicated no cyanobacteria blooms present 95.5% of the time, low level blooms 2.6% of the time and extensive blooms 1.9% of the time. Blooms were most extensive in northeastern bays. *Keywords: Cyanophyta, Monitoring, Citizen science, Harmful algal blooms.*

WITUSZYNSKI, D., SIKON, K., HU, C., BRILAND, R.B., RIEDL, K., LEE, J., LUDSIN, S.A., and MARTIN, J.F., Ohio State University, 590 Woody Haze Dr, Columbus, OH, 43210. **Fate and Concentration of Microcystin in Lake Erie Game Fish.**

Lake Erie is an economic and cultural resource that is threatened by recurring blooms of toxin-producing cyanobacteria. Microcystin, a potent liver toxin linked to human and animal illness and death, has been found in fish from Lake Erie, sometimes in excess of World Health Organization guidelines. Despite this, few studies have analyzed microcystin concentrations and forms in Lake Erie fish, and these past studies have derived conflicting results as to the risk posed to public health. To address this gap in knowledge, in the summer and fall of 2013 and 2014 we gathered samples of three commonly harvested fish in Lake Erie: Walleye, Yellow Perch, and White Perch. By analyzing the toxin content of these fish, we are able to determine if fish size, species, location at harvest, and harvest time significantly affect the concentration of toxin in fish fillets. We were also able to differentiate between microcystin and metabolites of this compound using HPLC-MS methodology. These results help determine the fate of microcystin in Lake Erie game fish, and whether levels of microcystin in these fish exceed thresholds for safe consumption. *Keywords: Microcystis, Lake Erie, Walleye.*

WOELMER, W.M., ARMENIO, P.M., WATSON, N.M., BUNNELL, D.B., KEELER, K.M., and ADAMS, J.V., US Geological Survey, Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105. **Do *Bythotrephes* and *Cercopagis* wear their sunglasses at night?**

Large, invasive predatory cladocerans, *Bythotrephes longimanus* and *Cercopagis pengoi*, can have disproportionately large impacts on the Great Lakes zooplankton community. Most studies estimating their density sample without regard to time of day, yet our preliminary 2010 and 2011 data suggest higher densities at night than during the day. To better understand whether these animals avoid the net in daylight, we surveyed northern Lake

Huron in August and November 2013 and July 2014, at night and day, using three nets of different mesh size (64, 153, and 285 μm) and diameter (0.5, 0.5, and 0.75 m, respectively). We sampled whole water column and layered depths based on light intensity. Using a mixed effects model, we found densities in the whole water column to be significantly higher at night than during the day consistently for *Cercopagis* (3.9 fold higher) and for *Bythotrephes* (1.4 fold higher)at one location. Within layered samples, *Bythotrephes* and *Cercopagis* densities were higher in the 64 than the 285 μm net, with this effect increasing with layer depth. Preliminary results indicate that *Bythotrephes* and *Cercopagis* may exhibit net avoidance, requiring development of a more efficient sampling technique to better estimate their true densities in the Great Lakes food web. *Keywords: Zooplankton, Bythotrephes longimanus, Cercopagis pengoi, Invasive species.*

WOO, K.H., HAMPTON, S., and GALLOWAY, A.W.E., Washington State University, Pullman, WA, 99164. **Data Management and Building Community in a Global Synthesis of Under-Ice Productivity.**

Interest in winter limnology has increased in recent years, yet still relatively little is known about ecological dynamics under ice in seasonally frozen lakes. A synthesis project is underway to examine these dynamics using data collected from global researchers. Challenges for syntheses involving geographically distributed colleagues include integrating heterogeneous data, managing communications from inception to conclusion, and building a sense of community. We describe techniques we used to integrate and manage data throughout each stage of the project, beginning with the early step of gauging interest from 120 researchers using an online survey. We used these survey results to tailor our subsequent request for ecological data, which was accompanied by policies on data sharing and collaboration for prospective collaborators. Our data entry template was designed to make data comparable across systems while both minimizing the effort of combining researchers' data into one data set and reducing potential anxiety about data sharing. Additionally we developed an R software package to automate data quality assurance. Project files and analyses are hosted on a website to which collaborators have access, with clear expectations for access and use, and the data will ultimately be published in an open access data repository. *Keywords: Data acquisition, Data management, Ice.*

WOOD, N.J., GEHRING, T.M., and UZARSKI, D.G., Central Michigan University, Mount Pleasant, MI. **The invasive mute swan's impact on plant, fish, and invertebrate communities of coastal wetlands.**

Mute swans (*Cygnus olor*) are a native species from Europe that have been introduced multiple times to North America (Ciaranca et al., 1997; Allin et al., 1987). Since those introductions, the mute swan population has steadily increased at a rate of 10-18% annually, resulting in a Michigan population estimated at 15,500 individuals in 2010 (Petrie & Francis, 2003; MDNR, 2012). Mute swans are tremendous consumers of submerged aquatic vegetation (SAV), their preferred food (Allin & Husband, 2003). A reduction in SAV impacts food resources for other bird species and diminishes habitat resources for small fish and invertebrates (SFI). SAV and SFI sampling occurred in September 2012 and 2013 in the drowned river mouth lakes along the eastern shore of Lake Michigan. Transects were drawn through each SAV bed and a throw trap was placed at three different depth intervals. The SAV in the trap was removed, identified, and a dry weight of each species was obtained. Fish were seined from the trap, identified, and measured. Abiotic data was also collected from each SAV bed. Lakes with large mute swan populations showed reductions in SAV height, a stunting of fish lengths, and an abiotic separation when compared to other sites. These analyses have shown that mute swans may be negatively impacting the coastal wetlands in Michigan. *Keywords: Avian ecology, Invasive species, Wetlands.*

WOOD, T.[1], WHERRY, S.[1], PICCOLROAZ, S.[2], and GIRDNER, S.[3], [1]US Geological Survey, 2130 SW 5th Ave., Portland, OR, 97201; [2]University of Trento, via Mesiano 77, Trento, 38123, ITALY; [3]Crater Lake National Park, P.O. Box 7, Crater Lake, OR, 97604.

**Changes in the Mixing Regime of Crater Lake in a Future Climate.**

We applied a 1-dimensional lake model developed to simulate deep mixing related to thermobaric instabilities in temperate lakes to Crater Lake, a 590-m deep caldera lake in Oregon's Cascade Range, in order to determine the frequency of deep water renewal in future climate conditions. The lake model was calibrated with 6 years of water temperature profiles, and then simulated 10 years of validation data with an RMSE of 0.81°C at 50 m depth and 0.04°C at 350-460 m depth. The simulated time series of heat content in the deep lake accurately captured extreme years characterized by weak and strong deep mixing. The lake model uses wind speed and lake surface temperature (LST) as boundary conditions. LST projections under six climate scenarios (2 representative concentration pathways x 3 general circulation models) were evaluated with *air2water*, a simple lumped model that only requires daily values of downscaled air temperature to calculate LST. *air2water* was calibrated with data from 1993-2011, obtaining a RMSE of 0.68°C. Preliminary results from the lake model indicate that the frequency of deep water renewal could change substantially in a warmer future climate as the entire water column warms and reverse stratification becomes rare, with potential implications for the clarity of Crater Lake. *Keywords: Model studies, Crater Lake, Atmosphere-lake interaction, Deep mixing, Climate change, Air2water.*

WRIGHT, D.A.[1] and HENQUINET, J.W.[2], [1]Environmental Research Services, Baltimore, MD; [2]Henquinet Consulting, LLC, Houghton, MI. **UV Ballast Water Treatment: The Viability Conundrum.**

Through Great Lakes Restoration Initiative (GLRI) funding, Isle Royale National Park installed the first permanent ballast water treatment system (BWTS) in the Great Lakes aboard its passenger vessel, Ranger III. After a thorough review of available technology, the Park selected an automated BWTS manufactured by Hyde Marine that relies on filtration and UV. In August 2014, we conducted shipboard trials of the Hyde BWTS and results indicated successful treatment of the ballast water for zooplankton (>50µm) and indicator bacteria according to U.S. Federal standards. Residual live phytoplankton concentrations as determined by the ETV double stain protocol indicated a decline relative to uptake samples, although live residuals (mean 85±20/mL) of phytoplankton exceeded the U.S. Federal standard of <10 live organisms/mL for this size group. However, additional testing suggests that any organisms living post-treatment were not viable. This presentation will discuss testing results and the underlying policies choices behind the U.S. Federal ballast water discharge standards. *Keywords: Ballast, Invasive species, Phytoplankton.*

WU, C.H.[1], LINARES, A.[1], ANDERSON, E.J.[2], and BECHLE, A.J.[1], [1]University of Wisconsin-Madison, Madison, WI, 53706; [2]NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI, 48108. **Meteorologically induced high-frequency water level flutuations in northern Lake Michigan.**

High-frequency water level oscillations (HFWLOs) driven by meteorological sources are frequently observed in Lake Michigan. Extreme HFWLOs can behave like meteotsunamis, causing tens of millions of dollars in damage in coastal structures and posing threat to human lives. To reveal the role of the meteorological sources (wind and pressure) on HFWLOs, we examined the relationship between meteorological data and water levels around Lake Michigan. Results show that wind and pressure can indepedently or work together to generate HFWLOs. Both wind and pressure have a similar weighting in the excitation of HFWLOs in northern Lake Michigan. Hydrodynamic modeling was employed to assess how pathways (speed and direction) of moving meteorological sources affect the spatial and temporal evolutions of HFWLOs. In open water with a water depth of 100m, HFWLOs are generated through Proudman resonance with a moving storm speed of 30 m/s. At the nearshore, HFWLOs are generated through Greenspan resonance with a moving storm speed of 10~15 m/s. At the northen Lake Mihcigan, the largest HFWLOs are generally caused by southwestern moving storms. For rapid assessment of HFWLO events, we derived a heuristic relationship based upon storm speed and direction. *Keywords: Atmosphere-lake interaction, Hydrodynamic model, Water level fluctuations, Meteotsunamis, Waves, Lake Michigan.*

WU, W. and PERERA, C.R., Clarkson University, Box 5710, 8 Clarkson Avenue, Potsdam, NY, 13699. **3-D Numerical Simulation of Flows in Large Lake.**

A three-dimensional (3-D) model has been developed to simulate water flows in large water bodies, such as lakes, due to river inflow, wind driving, temperature change, etc. The model solves the 3-D shallow water flow equations with variable water density. The eddy viscosity is determined using a modified mixing length model. The governing equations are solved using an implicit finite-volume method based on a multiple-level quadtree rectangular mesh on the horizontal plane and the sigma coordinate in the vertical direction. All the primary variables are arranged in a non-staggered system and stored at cell centers. Fluxes at cell faces are determined using the Rhie and Chow's momentum interpolation, to avoid the possible spurious checkerboard oscillations caused by linear interpolation. Each of the discretized governing equations is solved iteratively using the flexible GMRES method with ILUT preconditioning, and coupling of water level and velocity among these equations is achieved by using the SIMPLEC algorithm with under-relaxation. The model has been tested in Lake Ontario. The calculated water levels and velocities are in good agreement with the measured *Keywords: Hydrodynamic model, Lake model, Water currents.*

WYNNE, T.T. and STUMPF, R.P., NOAA, 1305 East-West Highway, Silver Spring, MD, 20910. **Predicting impacts of cyanobacteria in Lake Erie based on spatiotemporal trends.**

Interannual variations in cyanobacterial bloom intensity may be estimated from nutrient loading and discharge. However, in a large lake, such as Lake Erie, the spatial and temporal frequency may show sufficient variability to influence management strategies. Remotely sensed ocean color imagery from the MERIS and MODIS sensors from 2002 to 2014 are used to establish frequencies throughout the bloom season. Blooms were identified using previously published algorithms to detect cyanobacteria, as well as a variation of these algorithms to account for the saturation of the MODIS ocean color bands. Images were binned into 10-day composites to reduce cloud and mixing artifacts. These composites were used to determine frequency of presence of both detectable cyanobacteria and high risk (>100,000 cells mL-1) blooms. A climatological mean was then made using the 12 years of data. Maps show the pattern of development and areas most commonly impacted. The results give potential probability of occurrence during years with severe blooms *Keywords: Cyanophyta, Satellite technology, Lake Erie.*

# X

XIA, Z.Q.[5], ZHANG, L.[1], ZHOU, W.[3], HAMILTON, P.B.[4], and HAFFNER, G.D.[5], [1]Southwest University, Chongqing, CHINA; [2]Chongqing International S&T Performance Base, China-Canada Three Gorges Water Science Center, Chongqing, CHINA; [3]Water Environmental Monitoring Center of Tangtze River Basin, Wuhan, CHINA; [4]Canada Museum of Nature, Ottawa; [5]Great Lakes Institute for Environmental Research, Windsor, ON. **Spatial Characteristics of Nutrient and Phytoplankton and their Causes of the Three Gorges Reservoir.**

The Three Gorges Reservoir (TGR) plays a critical role in flood control and clean power generation in China. However, harmful algal blooms (HABs) after impoundment have resulted in this great hydraulic engineering project becoming a controversial issue. To illustrate the distribution and causes of HABs, we studied nutrient and phytoplankton from inflow (IN), backwater (BW), estuary (ES) of 22 tributaries to the reservoir and at 6 stations along the main Yangtze (MY) stretch of the TGR in March 2013. The results indicated high level of TN (averaged 1.51 to 2.01 mg/L) and TP (averaged 0.115 to 0.191 mg/L) but no spatial differences among the four category locations. In accordance with eutrophication level and HABs occurrence frequency, chlorophyll a and algae abundance in BW and ES were significantly higher than in IN and MY. The most common HAB was Peridiniopsis sp. which was determined by low temperature and caused a decline in water transparency. Ordination analysis suggested that HABs were more associated with area where thermal stratification could develop such as BW and ES compared with IN and MY where stratification did not occur. It is concluded that HABs in TGR are not simply a function of high nutrient availability, and that physical factors regulating the onset and length of stratification play a more important role. *Keywords: Harmful algal blooms, Trophic level, Watersheds.*

XIAO, C.[1] and LOFGREN, B.M.[2], [1]CILER, University of Michigan, 4840 S State Rd, Ann Arbor, MI, 48108; [2]NOAA Great Lakes Environmental Research Laboratory, 4840 S State

Rd, Ann Arbor, MI, 48108. **A Dynamical Downscaling study in the Great Lakes Region Using WRF-Lake.**

As the largest group of fresh water bodies on Earth, the Laurentian Great Lakes have significant influence on local and regional weather and climate through their unique physical features. Due to the limited spatial resolution and computational efficiency of general circulation models (GCMs), the Great Lakes are geometrically ignored or idealized into several grid cells in GCMs. Thus, the dynamical downscaling technique serves as a feasible solution. The Weather Research and Forecasting model (WRF) with an updated lake scheme is employed to conduct this study downscaled from CMIP5 models. It is a one-dimensional mass and energy balance scheme with 20-25 model layers, including up to 5 snow layers on the lake ice, 10 water layers, and 10 soil layers on the lake bottom, based on the actual lake points and lake depth. The preliminary results show that WRF-Lake model, with a fine horizontal resolution and realistic lake representation provides significantly improved hydroclimates, in terms of lake surface temperature, annual cycle of precipitation, ice content, and lake-effect snowfall. Those improvements suggest that better resolution of the lakes and the mesoscale process of lake-atmosphere interaction are crucial to understanding the climate and climate change in the Great Lakes region. *Keywords: Atmosphere-lake interaction, Model studies, Lake model.*

XU, J.[1], ZHANG, A.[1], KELLEY, J.G.W.[2], ANDERSON, E.J.[3], and LANG, G.[3], [1]NOAA/NOS/CO-OPS/OD, Silver Spring, MD, 20910; [2]NOAA/NOS/OCS/CSDL, Durham, NH; [3]NOAA/OAR/GLERL, Ann Arbor, MI. **Upgrade of NOAA/NOS' Lake Erie Operational Forecast System (LEOFS).**

The existing Great Lakes Operational Forecast System (GLOFS) was originally developed by The Ohio State University and NOAA's Great Lakes Environmental Research Laboratory (GLERL) in the late 1980's and 1990's and transitioned to operation at NOAA in 2006. NOAA's National Ocean Service (NOS) and GLERL are working together to upgrade GLOFS, starting with the Lake Erie Operational Forecast System (LEOFS), to provide improved forecast guidance of water level, currents and temperature. The upgraded system will use FVCOM as its core ocean circulation model and a new approach for specifying the lateral boundary conditions. The FVCOM-based LEOFS will have higher spatial resolution, improved forecast guidance, and extended forecast horizon, and provide ice forecast guidance in the future. The upgraded LEOFS is scheduled to become operational in September 2015, and the upgrade of other four lakes will be completed before 2019. A test website for the upgraded LEOFS will be built to run in parallel with the existing LEOFS for all interested users to evaluate the new model products. *Keywords: Lake Erie, Operational Forecast System, Model testing, FVCOM, Monitoring.*

XU, W.[1], COLLINGSWORTH, P.[2], and MINSKER, B.S.[1], [1]Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, Urbana, IL, 61801; [2]Environmental Protection Agency, Great Lakes National Program Office, Chicago, IL, 60604. **Algorithmic Detection of Deep Chlorophyll Layers in Great Lakes Water Quality Data.**

Deep Chlorophyll Layers (DCL) are water layers with high chlorophyll concentrations that lie below the thermocline in stratified lakes. Typically, the detection of the DCL from vertical profile data has been a manual and subjective process. We proposed to automate DCL detection from vertical profile data using a peak detection algorithm. The algorithm is able to detect the location of DCL and also extract other DCL features including the number of significant peaks, the sizes of peaks and the shapes of peaks. The methods were developed and tested with fluorescence data collected by the Environmental Protection Agency using Seabird vertical profilers in Great Lakes from 1996 to 2013. We visualized DCL features and compared our algorithm with expert opinions from historical surveys. The results indicate that the algorithms are highly effective at automatically identifying the DCL and revealing spatial and temporal trends of DCL. Finally, the algorithm is incorporated into an open source Python GUI application to help rapid adaptive sampling during the monitoring activities. *Keywords: Phytoplankton, Signal processing, Monitoring.*

XU, Y.[1], ISLES, P.[2], SCHROTH, A.[3], RIZZO, D.M.[4], and STOCKWELL, J.D.[2], [1]Vermont EPSCoR, University of Vermont, Burlington; [2]Rubenstein School of Environmental and Natural Resources, University of Vermont, Burlington, VT, 05401; [3]Department of Geology, University of Vermont, Burlington, VT, 88001; [4]School of Engineering, University of Vermont, Burlington, Burlington, VT, 05401. **Applying spectral analysis to quantify the drivers of cyanobacterial blooms.**

Intrinsic population oscillations and extrinsic environmental variations could lead to cyanobacterial blooms in eutrophic lakes, yet the relative importance of different drivers, which vary across ecosystems, is still poorly understood. We will present a conceptual approach of integrating spectral analysis (SA) and high-frequency monitoring (HFM) to quantify the mechanisms of cyanobacterial blooms. First, we use the hourly-time series from the observation buoy in a eutrophic bay of Lake Champlain to describe temporal cyanobacterial and environmental dynamics. Next, the power spectra, generated using spectral analysis of the time-series, suggest periodic signals of cyanobacterial and environmental fluctuations. Lastly, cross-spectral analysis, which can measure the coherency, is employed to detect whether cyanobacterial blooms are resonant with environmental fluctuations at specific periods. A high coherency indicates that the extrinsic environments control dominantly cyanobacterial blooms, while a low coherency suggests that the intrinsic population oscillations are dominant. This case study provides an illustration of the SA-HFM approach, the structure of which is broadly applicable as an ecosystem-specific tool for the research of cyanobacterial blooms in other eutrophic systems with similar high-frequency datasets. *Keywords: Phytoplankton, Eutrophication, Model studies.*

XUE, P.[1], SCHWAB, D.J.[2], HU, S.[3], and AUSTIN, J.A.[4], [1]Great Lakes Research Center, Michigan Technological University, Houghton, MI, 49931; [2]Water Center, University of Michigan, Ann Arbor, MI, 48104; [3]Shanghai Ocean University, Shanghai, 201306, CHINA; [4]Large Lakes Observatory, University of Minnesota-Duluth, Duluth, MN, 55812.

**Interaction of atmospheric surface forcing and hydrodynamic modeling of the lake thermal structure.**

As the largest of the five Laurentian Great Lakes, Lake Superior is characterized with immense surface area, large water depth and complex bathymetry. Consequently, the thermal structure of Lake Superior exhibits large spatiotemporal variability. The objective of this study is to document our recent modeling advances on the simulation of the lake thermal structure and explore underlying dynamic explanations of the observed modeling success. In this study, we built an integrated system consisting of a three dimensional hydrodynamic model and an assimilative weather forecasting model and applied it to a case study of the annual heating and cooling cycle in Lake Superior. Model performances are examined through the comparison with satellite products and in-situ measurements. Analysis reveals that the key to the modeling success is to resolve the lake-air interactions and apply appropriate representations of different meteorological forcing, based on the nature of their variability. The close agreement between model simulation and observations also suggests that using 3-D hydrodynamic model may provide creditable estimates of heat budgets over Lake Superior. *Keywords: Lake Superior, Hydrodynamic model, Atmosphere-lake interaction.*

# Y

YONGABO, Y.P.[1], NYINAWAMWIZA, N.L.[1], VODACEK, V.A.[2], and NIYIBIZI, N.L.[1], [1]University of Rwanda-College of Agriculture, Animal Sciences and Veterinary Medicine, Musanze, N, 210, RWANDA; [2]Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology, Rochester, New York, NY. **Assessment of the Impact of Land Cover and Land Use on Rwandan Fisheries and Catches in Lake Kivu.**

Lake Kivu is one of the East African Lakes shared between Rwanda and Democratic Republic of Congo. It has methane gas and fish as major resources, fisheries was developed in this lake for the purpose of generating income and supply proteins to the riparian population. Fish catches decline has been observed over time in Lake Kivu, and it may due to in-lake factors or outside lake factors. This study has been performed in order to identify major land cover and land use categories and assessing their impact on the fisheries and fish catches in Lake Kivu. Field surveys and annual fisheries statistics records for 2013 have been done for acquiring necessary data. GIS tools have been used for land use categorization and spatial analyses, correlation analyses were performed for assessing the impact. Our results showed 4 major land use categories with agricultural land as the dominant followed by forest land, built up area and wetland. Forest and wetland influence positively fish catches, agricultural land is not significantly influencing fish catches and built up area showed a negative influence. Reforestation/afforestation, wetland protection and use of agroforestry system were recommended for conserving the watershed. *Keywords: Lake Kivu, Watersheds, Land use, Fisheries, Fish.*

YOUNG, B., USFWS, 11 Lincoln St., Essex Junction, VT, 05452. **Controlling Lake Champlain Sea Lamprey in Québec Using a Seasonally-Installed, Trap-and-Sort Weir.**

The sea lamprey population of Lake Champlain was indexed in 2006 as causing wounds to 99 of 100 lake trout. To restore native lake trout, Atlantic salmon, lake sturgeon and other fish species, sea lamprey must be controlled. While lampricides and permanent barriers have proved successful control methods in New York and Vermont, these methods are not acceptable in Québec where the largest uncontrolled population of larval sea lamprey remains. In response, the U.S. Fish and Wildlife Service worked to design a first-of-its-kind sea lamprey barrier that could 1) be placed in the river only during sea lamprey spawning season, 2) facilitate passage of non-target species, 3) prevent impoundment using flow-through screens, 4) avoid floods using a high-flow-tripped, screen release mechanism, and 5)

serve as an interpretive tool for exposure and promotion of the Lake Champlain sea lamprey control program. In its first year of use, we captured 134 adult sea lamprey while mortality of non-target species was less than 0.5%. After some modifications and improvements, the 2015 season is expected to be even more successful as this innovative barrier design serves as an example of how sea lamprey can be controlled without the use of lampricides in certain rivers. *Keywords: Invasive species, Management.*

YU, A.W.[1], MOUW, C.B.[1], MOORE, T.S.[2], TWARDOWSKI, M.S.[3], SULLIVAN, J.M.[3], and STOCKLEY, N.D.[3], [1]Michigan Technological University, Houghton, MI; [2]University of New Hampshire, Durham, NH; [3]WET Labs, Narragansett, RI. **Assessing Spatial and Temporal Distribution of Harmful Algal Blooms in Western Lake Erie.**

Harmful algal blooms (HABs) in Western Lake Erie have significant ecological and socioeconomic impacts. Agricultural runoff transported by the Maumee River, heavy rains, and wind events have been attributed as causes for bloom initiation. However these and other potential ecological drivers influencing the temporal and spatial distribution of the bloom are not fully understood. Here we merge satellite imagery with continuous in water measurements to further elucidate spatial and temporal patterns of HABs. Continuous observations of chlorophyll, phycocyanin, and CDOM fluorescence, oxygen, phosphate, temperature, turbidity and conductivity were recorded in the summer of 2013 and 2014 from a Land/Ocean Biogeochemical Observatory (LOBO) buoy. The buoy monitored surface waters for multiple environmental parameters, and detected HAB events in both summers. Satellite imagery classified into optical water types are used to quantify spatial and temporal variability and to determine what water mass the LOBO is sampling at a given time. In addition to bloom characteristics, the data may reveal the influence of the Maumee and Detroit Rivers on bloom dispersal and mixing lending further insight into the drivers of bloom variability. *Keywords: Spatial distribution, Lake Erie, Harmful algal blooms.*

YULE, D.L.[1], DEROSE, A.[1], ADAMS, J.V.[1], STOTT, W.[2], CLARAMUNT, R.M.[3], EBENER, M.P.[4], and MOORE, S.A.[5], [1]U.S. Geological Survey, Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105; [2]Michigan State University, East Lansing, MI, 48824; [3]Michigan Department of Natural Resources, 96 Grant Street, Charlevoix, MI, 49720; [4]Chippewa Ottowa Resource Authority, 179 W. 3 Mile Road, Sault Ste. Marie, MI, 49783; [5]Grand Portage Band of Lake Superior Chippewa, 27 Store Road, Grand Portage, MN, 55605. **Morphometric and genetic analyses of contemporary Great Lakes cisco (Coregonus artedi).**

Cisco (*Coregonus artedi*) were the dominant planktivorous prey fish species in the Great Lakes, but is now abundant only in the upper two lakes with only remnant populations found elsewhere. Prior to their collapse, a study of *Leucichthys spp.* (now *Coregonus spp.*) in the Great Lakes described two primary cisco morphotypes; a "slim terete" morphotype (*L. artedi artedi*), and a "deep compressed" morphotype (*L. artedi albus*). During the 1920s, the slim morphotype was predominant in Lakes Superior, Huron, Michigan and Ontario while the deep-bodied form was dominant in Lake Erie and present in Lakes Superior and Ontario. Based on morphometric data of 15 current populations, the two dominant morphotypes can still be found with the slim morphotype predominant in Lakes Superior and Michigan and the deep-bodied morphotype dominant in northern Lake Huron and Lake Ontario. Genetic differentiation was observed among lakes, but genetic differences did not necessarily translate to morphometric differences. We conclude that contemporary cisco having shapes matching the missing historic morphotypes in the lower lakes warrant consideration as donor populations. *Keywords: Fish management, Biodiversity, Fish populations.*

# Z

ZAQOUT, M. and DROUILLARD, K.G., Great Lakes Institute for Environmental Research, 2990 Riverside Dr. W., Windsor, ON, N9C 1A2. **Comparison of chemical kinetics in mussels and SPMDs using a consistent set of PRCs.**

Mussel biomonitors and semi-permeable membrane devices (SPMDs) are commonly applied as samplers for water contamination of hydrophobic chemicals. Although past studies have compared accumulation of contaminants between mussels and SPMDs placed along side of one another, few studies have corrected for differences in sampling rates between the two techniques. For SPMDs, performance reference compounds (PRCs) are added to the lipid matrix prior to deploying the sampler to correct for in situ sampling rates. However, in mussels, not many studies have used PRC to correct for the sampling rate. In this study, SPMDs and mussel biomonitors (*Elliptio complanata*) were dosed with a common set of 14 non-environmental PCB congeners used as PRCs. Mussels and SPMDs were deployed at 10 locations in the Detroit and St. Clair River during October-November 2012 and July 2013. Data on mussel PRC elimination were consistent in $K_{ow}$ trend with past biomonitoring studies but exhibited slower overall elimination due to cooler water temperatures. PRC elimination rates showed distinct differences between mussels and SPMDs, with more rapid time to steady state evident for mussels. Comparisons between environmental PCB composition measured in water from the two sampling systems following PRC-steady state correction are discussed. *Keywords: Bioaccumulation, SPMDs, PCBs, Biomonitoring, Environmental contaminants, Detroit River.*

ZHANG, H.[1], CULVER, D.A.[2], XU, X.[1], and BOEGMAN, L.[3], [1]University of Michigan, Ann Arbor, MI; [2]The Ohio State University, Columbus, OH; [3]Queen's University, Kingston, ON. **Spatiotemporal distributions of phosphorus loads and their impacts on Lake Erie's water qualities.**

We used a two-dimensional (vertical-longitudinal) hydrodynamic and ecological model, EcoLE, to evaluate the spatiotemporal distribution of external and internal phosphorus loads and their impacts on the lower trophic levels of Lake Erie. Simulations of lake-wide longitudinal distributions of phosphorus loaded from external sources during the growing season showed that the external loads were mainly concentrated in the western and west-central basins, with only minor input into the east-central and eastern basins. Internal-loaded phosphorus was distributed homogeneously in the water column in the western basin. In the stratified central and eastern basins, however, internal-loaded phosphorus released by organic matter and pelagic communities (algae, and crustacean zooplankters) was concentrated in the epilimnion supporting ~60% of the daily algal P-demands, while phosphorus excreted by dreissenids and that released by anoxic sediments was distributed primarily in the hypolimnion. Different algal groups, non-diatom edible algae, non-diatom inedible algae, and diatoms responded differently to changes in the external phosphorus loading among years. Simulation results suggested that year-round monitoring and numerical simulation are needed to obtain a full picture of the impacts of P loading. *Keywords: Ecosystem modeling, Eutrophication, Phosphorus.*

ZHANG, X.F.[1], LIU, Z.W.[2], JEPPESEN, E.[3], TAYLOR, W.D.[4], GULATI, R.D.[5], and RUDSTAM, L.G.[6], [1]Department of Ecology, Jinan University, Guangzhou, CHINA; [2]Department of Ecology, Jinan University, Guangzhou, CHINA; [3]Department of Bioscience, Aarhus University, Silkeborg, DENMARK; [4]Department of Biology, University of Waterloo, Waterloo; [5]Department of Aquatic Ecology, The Netherlands Institute of Ecology, Wageningen, NETHERLANDS; [6]Cornell Biological Field Station, Department of Natural Resources, Cornell University, Bridgeport, NY. **Benthic-Pelagic Coupling by Worms and Bivalves in Shallow Lakes: the Key Role of Benthic Algae.**

Benthic-pelagic coupling is important in shallow lake dynamics. Mesocosm and microcosm experiment were conducted to evaluate effects of deposit-feeding tubificid worms and filter-feeding bivalves on benthic-pelagic coupling. In mesocosm experiments we found higher nutrients in water, higher pelagic algal biomass and lower benthic algal biomass in worm *Limnodrilus hoffmeisteri* treatments than in controls, while nutrients and pelagic algal biomass were lower, benthic algal biomass higher in bivalve *Anodonta woodiana* treatments. In microcosms with sediment labeled with $^{32}P$, $^{32}P$ activity in water was higher in both bivalve *Corbicula fluminea* and worm treatments compared with controls, but highest in worm treatment. Thus worms accelerated sediment P release which promotes pelagic algal growth, while bivalves stimulated benthic algal growth. We also examined the role of benthic algae in P cycling between sediment and water in tubes containing sediment with and without benthic algae. This experiment showed that benthic algae removed P from water and reduced sediment P release. Higher levels of oxygen inhibiting sediment P release were also recorded in sediments with algae. The study indicates that benthic algae reduce water P levels, and may help maintain a clear-water state in shallow lakes. *Keywords: Water quality, Biofilm, Benthos.*

ZHAO, Z.H., ZHANG, L., and WU, J.L., Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, 73, East Beijing Road, Nanjing, 210008, CHINA. **The fate of polycyclic aromatic hydrocarbons (PAHs) and organochlorine pesticides (OCPs) in sediment.**

A total of 111 sediment samples were collected from shallow lakes along the middle-lower reaches of the Yangtze River and the Huaihe River for the determination of organochlorine pesticides (OCPs) and polycyclic aromatic hydrocarbons (PAHs). OCPs were detected in all sediment samples, with residual values ranging from 8.14 to 202.85 ng/g dw, while those of PAHs ranged from 11.80 to 231.89 ng/g dw. HCHs and DDTs were major components, accounting for 29.1±18.7% and 21.1±14.3% of the total OCPs and mostly originating from historical usage. PAHs were mainly composed of 3-, 4-, and 5-ringed congeners, accounting for 86.0±10.0% of the total PAHs. Diagnostic ratios coupled with principal component analysis-multivariate linear regression (PCA-MLR) demonstrated the major contribution of coal combustion coupled with emissions of diesel-powered vehicles to PAHs in sediments from Jiangsu and Anhui, while emissions from diesel-powered vehicles was preferentially responsible for PAHs observed from Hunan and Hubei. Sediment risk assessment based on sediment quality guidelines (SQGs) suggested that heptachlor epoxide, p,p'-DDD and lindane could be the potential contaminants of more ecotoxicological concern. *Keywords: Chemical analysis, PAHs, Organochlorine compounds.*

ZIA, A., SCHROTH, A., XU, Y., ISLES, P., HAMED, A.A., TSAI, Y., MOHAMMED, I.N., and BOMBLIES, A., University of Vermont, 146 University Place, Burlington, VT, 05482. **An Autoregressive Bayesian Network to Assess Climate & Nutrient Variability Impacts on Water Quality.**

Anthropogenic climate change could adversely affect water quality in Lake Champlain from more frequent and more intense flooding events in Lake Champlain Basin as well as reduced ice cover internally in the lake system. Concern within the Lake Champlain system arises from the continued eutrophication of shallow bays such as Missisquoi Bay and the South Lake. The severity of algal blooms are subject to a variety of influences, ranging from N and P fluxes in the lake segments, water depth, formation and evolution of zooplankton species, and vertical and horizontal profiles of temperature gradients. In this paper, we present an Autoregressive Bayesian Network Model (ABNM) to predict the bi-weekly probability of HABs in the Missisquoi Bay and the South Lake segments of Lake Champlain under different climate change and nutrient flux scenarios. The LCBP and USGS monitoring data from 1992 to 2010 are used to train the ABNM, while 2011-2014 monitoring data is used to test the predictive power of the ABNM. Finally, we provide a generalization approach of this ABNM to other fresh water lakes, where sensors and monitors could be set up. Implications for environmental policy and management are drawn. *Keywords: Global warming, Sensor networks, Environmental policy, Harmful algal blooms.*

ZIOLA, B.A., GEHRING, T.M., and UZARSKI, D.G., Central Michigan University, Mount Pleasant, MI. **Effects of Mute Swans Overwintering in Northwestern Lake Erie and the Detroit River.**

Mute swans (*Cygnus olor*) are an aggressive invasive species in Michigan that compete with and exclude native waterfowl. Intensive foraging by mute swans could have a large impact on macroinvertebrates, fish and native waterfowl that depend on SAV for food and habitat. The aims of this study include quantifying mute swan impact on SAV tubers and determining if the distribution of mute swans and native waterfowl follows the ideal despotic hypothesis during winter in coastal wetlands of northwestern Lake Erie and the Detroit River. Exclosure and control plots were established in SAV beds in October/November 2014 to quantify mute swan herbivory on SAV tubers in terms of biomass removal. Subsamples of plots will be taken and tuber measurements compared. Observations were made of waterfowl species every two weeks from December to March of 2014 and 2015. Polygons representing the species, quantity and location of waterfowl were created in ArcMap and will be compared to determine percent overlap among species. We expect to find mute swans are having an impact on SAV during the winter and that mute swan and other waterfowl polygons will not overlap due to the aggressive nature of mute swans. *Keywords: Avian ecology, Invasive species, Submerged plants.*

ZISCHKE, M.T.[1], BUNNELL, D.B.[2], TROY, C.D.[3], and HÖÖK, T.O.[1], [1]Department of Forestry and Natural Resources, Purdue University, 195 Marsteller St, West Lafayette, IN, 47907; [2]USGS Great Lakes Science Center, 1451 Green Rd, Ann Arbor, MI, 48105; [3]School of Civil Engineering, Purdue University, 550 Stadium Mall Dr, West Lafayette, IN, 47907.

**Recruitment Synchrony of Lake Whitefish *Coregonus clupeaformis* in the Great Lakes Region.**

Fish populations often display high inter-annual variation in recruitment that may be linked to key environmental factors. If these environmental factors are similar across broad spatial scales, spatially separated populations may display recruitment synchrony. We examined variation in recruitment among lake whitefish *Coregonus clupeaformis* populations in lakes Erie, Huron, Michigan and Superior using fishery-dependent and -independent data from 1971-2014. Relative year class strength (RYCS), calculated as the average deviance of catch-curve residuals for each year-class across multiple years, was compared among sampling locations. The spatial scale of recruitment synchrony was calculated and compared recruitment synchrony scales reported for other species in freshwater and marine environments. We also investigated potential environmental factors that may influence recruitment synchrony by relating RYCS to regional indices of annual climate (e.g. spring-summer temperature, winter temperature and spring precipitation). Results provide an improved understanding of lake whitefish population dynamics and may be incorporated into stock assessment models to improve the efficacy of management. *Keywords: Recruitment, Environmental effects, Spatial analysis.*

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