IAGLR 2012
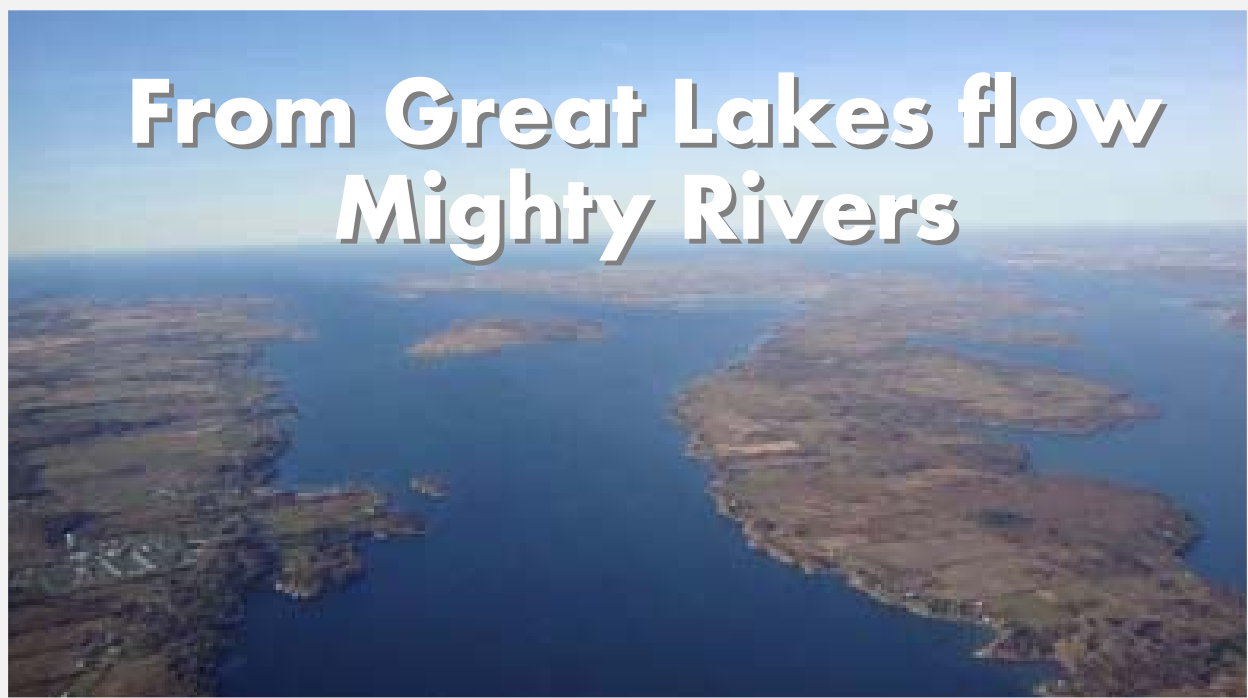## MAY 13-17 CORNWALL

55th Annual Conference of the International Association for Great Lakes Research

From Great Lakes flow Mighty Rivers

ABSTRACT BOOK

IAGLR

Queen's UNIVERSITY

St. Lawrence **River Institute** of Environmental Sciences

CORNWALL ONTARIO CANADA
May 13-17, 2012

55th Annual Conference
International Association for Great Lakes
Research Conference (IAGLR)

From Great Lakes Flow Mighty Rivers

May 13-17, 2012

NavCentre, Cornwall, ONTARIO CANADA

<u>PUBLISHED BY</u>

International Association for Great Lakes Research Office

4840 South State Rd., Ann Arbor, Michigan 48108

www.iaglr.org

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From Great Lakes Flow Mighty Rivers

ABMA, R.A. and HAFFNER, G.D., Great Lakes Institute for Environmental Research, 401 Sunset Ave., Windsor, ON, N9B 3P4. **Mercury Bioaccumulation in Lake Trout Reflects Non-Steady State Dynamics.**

Mercury toxicity has been a relevant, global issue since it was discovered to be a severe neurotoxin in 1958. Mercury levels in the Great Lakes region have been monitored since the 1970s after the first signing of the Great Lakes Water Quality Agreement. Since then, bioenergetics and kinetics models have been proposed as means of predicting mercury body burden in fish. Although these models are accurate for some species and sites, they are less predictive when applied to others. My study investigated an assumption associated with current models: that all parameters remain constant over time. The study looked at lake trout, a predatory species used for contaminant biomonitoring since the late 1970s. 150 lake trout were collected from 4 sites across Lake Huron, then were processed and analyzed for whole-body mercury contamination. Individuals were aged using otoliths and separated into age classes. Cohort analysis revealed a nonlinear increase of mercury body burden with increasing age, indicating that lake trout do not reach steady state mercury accumulation at any time between the ages of 0-11. This means that one or more parameters of the model continue to change over time. These data emphasize the necessity of considering non-steady state accumulation dynamics for future bioenergetics and kinetics modeling of mercury. *Keywords: Trout, Bioaccumulation, Mercury.*

ACKERMAN, J.D.[1], BOUFFARD, D.[1], BOEGMAN, L.[2], and YERUBANDI, R.R.[3], [1]Integrative Biology, University of Guelph, Guelph, ON, N1G 2W1; [2]Civil Engineering, Queen's University, Kingston, ON, K7L 3N6; [3]Environment Canada, National Water Research Institute, Burlington, ON, L7R 4A6. **Impact of Physical Processes on the Oxygen Depletion in Central Lake Erie.**

Hypoxia in the hypolimnion of Lake Erie has been examined by assessing (i) the spatial and temporal extent of the hypoxia and (ii) linking the rate of oxygen (DO) depletion to the hypolimnion thickness. The former has shown that hypoxia typically occurs between July and October in the central basin and can extend over 10^4 km^2, whereas the latter has shown that a thin hypolimnion is needed to sustain low DO. However, assessing the processes driving inter-annual variability in oxygen and the small-scale temporal and spatial patchiness in DO depletion (-2 to +1 mg/L/d) remain unknown. The goal of the present study is to focus on the short-term variability in DO depletion and its link to the rate of vertical mixing. The use of a vertical oxygen budget enabled us to quantify how much of the DO variability is controlled by physical processes, relative to biological processes and the sediment oxygen demand (SOD). The data are the summers of 2008 and 2009 in central Lake Erie involving 13 moorings with high-frequency temperature loggers, acoustic Doppler current profilers, dissolved oxygen loggers, chlorophyll and turbidity loggers and temperature microstructure profiles. These high-temporal resolution field data allowed us to investigate the dynamics of the oxygen depletion. *Keywords: Lake Erie, Hydrodynamics, Oxygen.*

AHMED, S. and TROY, C.D., Purdue University, 550 Stadium Mall Drive, West Lafayette, IN, 47907-2051. **Spatial Structure of Poincare Waves in Lake Michigan.**

Near-inertial (Poincare) internal waves are the dominant basin-scale baroclinic response to wind forcing in the Great Lakes during the stratified period. The spatial structure of these ubiquitous waves is not well-understood for Lake Michigan, which has important implications for the spatial distributions of vertical mixing, lateral dispersion, and near-bottom turbulence. To investigate the spatial structure of the dominant Poincare modes, three-dimensional numerical simulations are carried out with the unstructured numerical model SUNTANS. Both idealized wind forcing - spatially uniform wind impulses lasting for half the inertial period - as well as observed wind fields are used to drive the model. While the nearly-identical periods of the dominant modes excited make their separation difficult, an attempt is made to reconcile the observed structure with known modal structure in large lakes (e.g. Schwab 1977). In addition to basic induced currents and thermocline displacements, the observed mode structure is used to identify elevated shear and cross-thermocline mixing potential hotspots. The effect of seasonal changes in stratification on Poincare modes and the corresponding shear and cross-thermocline mixing are also examined. *Keywords: Hydrodynamic model, Internal waves, Waves, Poincare, Lake Michigan, Basin scale.*

ALBEN, K.T.[1], SOBIECHOWSKA, M.[2], BRIDOUX, M.[3], and FUENTETAJA, A.P.[4], [1]New York State Dept Health, Empire State Plaza, Albany, NY, 12201-0509; [2]Polish Academy of Sciences, Institute of Oceanography, Marine Chemistry and Biochemistry, Sopot, 81-712, Poland; [3]University of Washington, School of Oceanography, Seattle, WA, 98195-5351; [4]Buffalo State College, Biology Dept., Buffalo, NY, 14222. **Use of Algal Pigments to Trace Food-Web Relationships between Invertebrates and Fish in the Great Lakes.**

Pigments representing different classes of algae were determined in diverse benthic invertebrates and species of fish, primarily from the eastern basin of Lake Erie (2003 to 2005), with some from Lakes Ontario (LO) and Superior (LS). Benthic invertebrates were distinguished by pigments from their diet, with bioaccumulation factors ranging from 4 (dreissenids and chironomids, LS diporeia) to 25 (oligochaetes; LS mysis; LO dreissenids). Specific tissues of fish helped differentiate recent ingestion (digestive tract of small fish; stomach and intestinal contents of large fish) from cumulative diet (liver; muscle; skin; eyes; brain; gonads). Chlorophyte biomarkers were common to digestive tracts of nearshore fish (yellow, white and trout perch, rock bass, black crappie, round goby; only sheepshead negative). Astaxanthin, a crustacean biomarker, was more widely dispersed (nearshore trout perch, rock bass; offshore pelagic rainbow smelt, emerald shiner; offshore benthic L trout). Biomarkers for diatoms, cryptophytes and cyanobacteria were found in digestive tracts and livers of many fish. Levels of bioaccumulation ranged from low (< 10-fold: rainbow smelt, emerald shiner, white perch), to intermediate (10-fold: yellow perch, round goby, rock bass, sheepshead, L trout, L whitefish), and high (> 10-fold: trout fish; burbot). *Keywords: Algae, Benthos, Carotenoids, Diets, Fish.*

ALLAN, J.D.[1], MCINTYRE, P.B.[2], HALPERN, B.S.[3], BOYER, G.L.[4], BUCHSBAUM, A.A.[5], BURTON, G.A.[1], CAMPBELL, L.M.[6], CHADDERTON, W.L.[7], CIBOROWSKI, J.J.H.[8], DORAN, P.J.[7], EDER, T.A.[9], INFANTE, D.L.[10], JOHNSON, L.B.[11], READ, J.A.[12], RUTHERFORD, E.S.[13], SMITH, S.D.P.[1], SOWA, S.P.[7], STEINMAN, A.R.[14], JOSEPH, C.G.[1], MARINO, A.A.[1], and ALLEN, J.D.[1], [1]School of Natural Resources & Environment,, University of Michigan, Ann Arbor, Mi, 48109; [2]Center for Limnology, University of Wisconsin, Madison, WI, 53706-1413;; [3]National Center for Ecological Analysis and Synthesis, Santa Barbara, CA, 93101; [4]College of Environmental Science and Forestry, State University of New York, Syracuse, NY, 13210; [5]National Wildlife Federation, Ann Arbor, MI, 48104; [6]Dept. of Biology, Queens University, Kingston, ON; [7]The Nature Conservancy, Lansing, MI, 48906; [8]Dept. of Biological Sciences, University of Windsor, Windsor, ON; [9]Great Lakes Commission, Ann Arbor, MI, 48104; [10]Dept. of Fisheries and Wildlife, Michigan State University, Lansing, MI, 48824; [11]Natural Resources Research Institute, University of Minnesota, Duluth, MN, 55811; [12]Michigan Sea Grant, Ann Arbor, MI, 48109; [13]NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI, 48104; [14]Annis Water Resources Institute, Grand Valley State University, Muskegon, MI, 49441; [15]SNRE, Ann Arbor. **Assessing Cumulative Influence of Multiple Stressors at Large Spatial Scale.**

The Great Lakes are subject to multiple stressors whose impacts are challenging to assess due to differing spatial distributions and varying influence among habitats. The ability to map the presence or intensity of individual stressors across the Great Lakes, weight individual stressors for their impact, and combine multiple stressors into an integrated total impact map could significantly enhance our ability to manage and restore the Great Lakes ecosystem. Here, we report results based on 34 individual stressor layers mapped as 1 km2 pixels across the surface of the five Great Lakes, and we evaluate levels of cumulative stress at locations where lake-derived ecosystem services are present (e.g., recreation, food, biodiversity protection). Individual stressors represent such broad categories as climate change, invasive species, coastal development, land runoff, chemicals of concern and aquatic habitat. Overall, cumulative stress is higher in nearshore than offshore waters and in the lower than the upper lakes. Locations that reflect human value as indicated by recreational activity are disproportionately proximate to areas of high stress. This effort, modeled upon recent global threat analyses for marine waters and rivers, will facilitate prioritizing restoration and conservation actions throughout the Great Lakes region. *Keywords: Regional analysis, Great Lakes basin, Stressor synthesis, Risk assessment.*

ALLARD, S.W. and KANAVILLIL, N., 500 University Avenue, Lakehead University Orillia Campus, Orillia, ON, L3V 0B9. **Phytoplankton as Indicators of Water Quality: A Study at Northwestern Ontario Inland Water System.**

Due to increased human pressure on the surrounding ecosystem, Lake Simcoe saw a decline in its ecological health but has had improvements in recent years. Increased monitoring methods that focus on biological components are needed to accurately quantify aquatic resources and evaluate the effectiveness of the rehabilitation programs. In this study six sampling sites along Lake Simcoe and Lake Couchiching were monitored for water quality. Biweekly shoreline sampling was conducted for a span of five months (Aug-Dec, 2011). Hydrologic parameters,

nutrients (total phosphorus), phytoplankton biomass and species composition and chlorophyll a were used to assess lake contamination. The total number of phytoplankton species in the study varied significantly between all six sampling sites. Site 2, which receives effluent discharge from the City of Orillia's water treatment plant, and Site 3 (1 km downstream of Site 2) were the most enriched sites according to phytoplankton biomass, total phytoplankton species and chlorophyll a concentration. Melosira species, which are indicators of pollutants, were also present in high density at these two locations. Such high densities of Melosira along with the presence of Anabaena species suggest that phosphorus loading remains an issue in Lake Simcoe and a cause of concern for Lake Couchiching. *Keywords: Biomonitoring, Water quality, Phytoplankton.*

ALTHOUSE, B.J.[1], HIGGINS, S.N.[2], and VANDER ZANDEN, M.J.[1], [1]University of Wisconsin-Madison, 680 N. Park Street, Madison, WI, 53705; [2]Fisheries and Oceans Canada, 501 University Crescent, Winnipeg, MB, R3T 2N6. **The Contribution of Benthic and Pelagic Autotrophy to Whole Ecosystem Primary Production along a Gradient of Light, Nutrients and Zebra Mussel (*Dreissena polymorpha*) Density in Green Bay, Lake Michigan.**

Phytoplankton and benthic algae are the autotrophic bases of the two main energetic pathways in freshwater systems. Shifts in the contribution of pelagic and benthic autotrophy to whole ecosystem primary production may have significant effects on food web structure and other ecosystem processes. Pelagic and benthic primary production were measured along a gradient of nutrients, light and zebra mussel density in Green Bay, Lake Michigan from June to August 2011 using a combination of sondes and *in vitro* incubations of benthic substrata. Pelagic production ranged from 0.01 g C/m^3/day to 3.629 g C/m^3/day and benthic production varied from 0.167 g C/m^2/day to 1.081 g C/m^2/day. Benthic producers contributed greater than 50% of depth integrated total primary production up to approximately the 5m contour line in mesotrophic middle Green Bay. Additionally, benthic producers constituted up to 50% of depth integrated total production at depths approaching 1m in eutrophic inner Green Bay. Our results suggest that benthic primary production may represent a substantial portion of whole ecosystem primary production even in large lakes, a role that may be augmented by reductions in nutrient loading and the effects of zebra mussel establishment. *Keywords: Periphyton, Green Bay, Phytoplankton.*

AMARAL, N.D., 5 Shoreham Drive, Downsview, ON, M3N 1S4. **Ecological and Geomorphic Impacts of a Severe Storm Event on Watersheds in the Toronto Region.**

On August 19th 2005, the Toronto Region experienced a severe storm event that rivaled Hurricane Hazel in terms of total daily precipitation. The narrow band of intense rain that traveled through the region, released the majority of it's downpour within the span of an hour and caused extensive flooding and damage to infrastructure in several locations. The daily total precipitation ranged from 41.4 mm to 141 mm in and around the city of Toronto. In comparison, Hurricane Hazel which struck Southern Ontario on October 15, 1954 produced 121 mm of precipitation (Lester B. Pearson Airport). The Toronto and Region Conservation Authority monitored the effect of this event on the aquatic community through their Regional Watershed Monitoring Program. This presentation highlights the hydrological impacts on aquatic biota,

namely macroinvertebrate communities and fish assemblages as well as the geomorphic responses in the Humber River, Don River and Highland Creek watersheds to this severe storm event. Results from this monitoring help shed light on the future regional ecological effects associated with severe weather and climate change. *Keywords: Extreme storm event, Urban watersheds, Biological impacts, Hydrodynamics.*

AMINOV, Z.[1], GALLO, M.[1], MORSE, G.[1], HAASE, R.[1], SCHYMURA, M.J.[1], SCHELL, L.[1], SANTIAGO-RIVERA, A.[1], and CARPENTER, D.O.[1], [1]University at Albany, Albany, NY, 12222; [2]University at Albany, Albany; [3]University at Albany, Albany; [4]University at Albany, Albany; [5]University at Albany, Albany; [6]University at Albany, Albany; [7]University at Albany, Albany; [8]University at Albany, Albany. **Diabetes and Organochlorine Chemicals at Akwesasne.**

We studied organochlorines and diabetes in 967 Mohawks ages 10 to 95 years, including those in the original study. Blood samples were analyzed for 101 PCBs congeners, mirex, DDE, and HCB as well as serum glucose, lipids and other physiologic parameters. Diabetes was defined as diagnosed diabetes or serum glucose levels >100 mg/dL. Logistic regression was used with adjustment for age, gender and BMI. All exposure variables were categorized using quintiles. Prevalence of diabetes was less among women than men (OR=0.59) and positively correlated with BMI (OR=1.1). Total PCB concentration was not significantly associated with risk of diabetes after adjustment for pesticides, there was no significant association with DDE or mirex, but an OR of 3.8 highest to lowest quintile for HCB. Total estrogenic PCB congeners were protective. Dioxin-like TEQ showed an increased risk in the 2nd quintile, but was protective in the 4th. The strongest significant relation was with tri-/tetra ortho PCB congeners with an OR of 46 top to bottom quintile. Total mono-ortho congeners had OR=9.7 and 12.8 in 4th and 5th quintiles. These results show that one must consider congener groups, not just total PCBs, when evaluating risk of diabetes, and suggest that only certain PCB congeners strongly increase risk of diabetes. *Keywords: PCBs, Akwesasne, Human health, Diabetes, Pesticides.*

ANDERSON, C., LOCATELLI, J.A., CLICHE, B., LAVOIE, V., and DESMARAIS, G.S., Ministere du Developpement durable, de l'Environnement et des Parcs, 675 boul. Rene-Levesque Est, Quebec, QC, G1R 5V7. **Sustainable use of Quebec's Water Sources Within the Context of the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement.**

In 2005, the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement (Agreement) was signed by eight US states (Illinois, Indiana, Michigan, Minnesota, Ohio, New York, Pennsylvania, and Wisconsin) and two Canadian provinces (Ontario and Quebec). Its primary aims are to prohibit new diversions of water outside of the Great Lakes-St. Lawrence basin (Basin) and to sustainably manage water withdrawals and consumption levels within the basin. This presentation will provide an overview of Quebec's efforts to implement the Agreement through legislation, multi-scale assessment of cumulative impacts of water usage and conservation and efficiency initiatives. *Keywords: Withdrawal declarations, Legislation, St. Lawrence River, Withdrawal permitting, Conservation and efficiency, Great Lakes basin.*

ANDERSON, E.J.[1], SCHWAB, D.J.[2], and CAMPBELL, K.B.[1], [1]University of Michigan - CILER, 4840 S. State Rd, Ann Arbor, Mi, 48108, United States; [2]NOAA/GLERL, 4840 S. State Rd, Ann Arbor, Mi, 48108, United States. **Upper St. Lawrence River Forecasting System: Real-Time Conditions and Forecasts of Water Levels and Currents.**

The Upper St. Lawrence (USL) River stretches from Lake Ontario to the Moses-Saunders Hydro-Electric Dam at Cornwall, Ontario. The USL is home to the 1000 Islands area and supports summer tourism and a large recreational boating community as well as supplies the only shipping channel between the Atlantic Ocean and the Great Lakes. Large fluctuations in water levels along the USL can impede recreational boating in some stretches of the river, where low levels can prevent launching or cause boaters to become stranded in the river until the levels rise enough to return to shore. As the communities around the USL rely on tourism and boating to support local economies, the ability to forecast water level fluctuations is critical. Using FVCOM, a 3D hydrodynamic model of the USL was developed to predict water levels and currents in real-time on scales down to 30 meter resolution. The model uses observed and forecasted conditions for water levels at Lake Ontario and the Moses-Saunders Dam as well as wind stress to simulate the physical conditions in the river. The operational model is run at NOAA/GLERL and provides model nowcasts (present conditions) and 48-hour forecasts every 3 hours. Model output is made available to the public through an interactive webtool developed by the Great Lakes Observing System (GLOS). *Keywords: Hydrodynamic model, St. Lawrence River, Observing systems.*

ARDREN, W.[1], STAATS, N.[1], BOUCHARD, H.[2], SMITH, S.[1], CHIPMAN, B.[3], MACKENZIE, C.[4], KELSEY, K.[5], and SCHOCH, W.[6], [1]U.S. Fish and Wildlife Service, Lake Champlain Office, Essex Junction, VT, 05452; [2]U.S. Fish and Wildlife Service, Dwight D. Eisenhower National Fish Hatchery, North Chittenden, VT, 05763; [3]Vermont Fish and Wildlife Dept, Fisheries, Essex Junction, VT, 05452; [4]Vermont Fish and Wildlife Dept, Fisheries, Rutland, VT, 05452; [5]Vermont Fish and Wildlife Dept, Ed Weed Fish Culture Station, Grand Isle, VT, 05458; [6]New York Dept. of Environmental Conservation, Fisheries, Ray Brook, NY, 12977-0296. **Landlocked Atlantic salmon Restoration and Management in Lake Champlain.**

Landlocked Atlantic salmon (LAS) are an important part of the Lake Champlain ecosystem and fishery. Native LAS were extirpated in the Lake Champlain basin approximately 150 years ago. In the 1970s, LAS were reintroduced to the lake through stocking of hatchery fish. This hatchery program supported by NY, VT, and USFWS continues to provide for a popular lake fishery. However, few fish return to tributaries to spawn. Effective sea lamprey control efforts over the past eight years have resulted in a large reduction of wounding rates on LAS. Fish passage and riparian habitat restoration efforts have provided access to key spawning habitat in VT and NY. Increased numbers of fish, survival to older age classes, and access to spawning and rearing habitat provides new opportunities to enhance the river fishery and natural recolonization of tributaries by hatchery-origin adults spawning in the wild. Lab and field experiments have been initiated in the Winooski River, VT and Boquet River, NY to increase river-runs of hatchery-origin LAS and to reestablish natural populations. Activities include physiology, genetic, morphometric, lab, and field studies focused on improving quality of

hatchery fish by optimizing culture conditions and modifying stocking strategies to enhance survival, improve imprinting, and increase adult returns. *Keywords: Salmon, Lake Champlain, Fish hatcheries, Native species reintroduction, Fish management.*

ARHONDITSIS, G.B.[1], LABENCKI, T.L.[2], BOYD, D.[2], O'CONNOR, K.[3], and HALL, J.D.[3], [1]University of Toronto, Department of Physical & Environmental Sciences, Toronto, ON, M1C1A4, Canada; [2]Ontario Ministry of the Environment, Environmental Monitoring and Reporting Branch, Toronto, ON, M9P3V6, Canada; [3]Canada Centre for Inland Waters, Hamilton Harbour Remedial Action Plan, Burlington, ON, L7R4A6, Canada. **Towards the Development of an Integrated Modelling Framework in the Hamilton Harbour: A Bayesian Synthesis of Empirical Knowledge and Model Predictions.**

We examine the likelihood of delisting the Hamilton Harbour, Ontario, Canada, as an Area of Concern, if the nutrient loading reductions proposed by the Remedial Action Plan are actually implemented. Our Bayesian modelling analysis suggests that the delisting objectives are achievable, but the water quality setting process should explicitly accommodate the natural variability by allowing for a realistic percentage of violations, e.g., exceedences of less than 10-15% of the weekly samples during the stratified period should still be considered as compliance of the system. Phosphorus dynamics in the sediment-water column interface need to be revisited, as the internal nutrient loading can conceivably be a regulatory factor of the duration of the transient phase and the recovery resilience of the Harbour. We also pinpoint two critical aspects of the system dynamics that invite further investigation and will likely determine our predictive capacity to assess system compliance with the water quality criteria, i.e., the nutrient recycling mediated by the microbial food web and the structural shifts towards a zooplankton community dominated by large-sized and fast-growing herbivores. Our study aims to illustrate how empirical knowledge and rational modelling can be used to guide system restoration in highly disturbed settings. *Keywords: Model testing, Uncertainty analysis, Ecosystem modeling, Water quality criteria, Eutrophication, Risk assessment.*

ASADZADEH, M.[1], RAZAVI, S.[1], TOLSON, B.[1], FAY, D.M.[2], and WERICK, W.[3], [1]Civil and Environmental Engineering Department, 200 University Avenue West, Waterloo, ON, N2L 3G1; [2]Great Lakes - St. Lawrence Regulation Office, Environment Canada, 111 Water St., 2nd Floor, Cornwall, ON, M3H 5T4; [3]14508 Chesterfield Lane, Culpeper, VA, 22701. **A New Rule Curve Based Regulation Plan for Lake Superior.**

A directly interpretable rule curve is developed for Lake Superior (SUP) regulation. Parameters of the rule curve are obtained by solving a multi-objective optimization problem that reflects multiple concerns, criteria and benefits in SUP regulation to better meet the contemporary needs of the stakeholders. The optimization problem maximizes the total increase in commercial navigation, hydropower generation, and shore protection benefits relative to the current SUP regulation plan 1977-A. It also minimizes extreme lake levels of SUP and Lakes Michigan-Huron. Moreover, it considers multiple water supply sequences that represent a variety of future climate scenarios to increase the robustness of the proposed plan. The objective function values of each solution are evaluated in a computationally intensive Shared Vision

Model that compares the solution with plan 1977-A. The optimization algorithm, Pareto Archived Dynamically Dimensioned Search (PA-DDS) is combined with a novel pre-emption technique that identifies and avoids full evaluation of low quality solutions. Results show that the utilized solution technique significantly reduces the computational burden of the optimization problem. Moreover, the selected rule curve is robust and typically more reliable than plan 1977-A when facing various future extreme climate conditions. *Keywords: Lake Superior, Optimization, Regulations, Climate change.*

AUER, D.W.[1], KUIPERS, D.A.[2], WOOLNOUGH, D.A.[3], and ZANATTA, D.T.[3], [1]Department of Biology and Environmental Studies Interdisciplinary Program, Central Michigan University, Mt. Pleasant, MI, 48859; [2]College of Veterinary Medicine, Michigan State University, East Lansing, MI, 48824; [3]Institute for Great Lakes Research and Department of Biology, Central Michigan University, Mt. Pleasant, MI, 48859. **Pelecypod and Gastropod Communities: Understanding Variations in Different Ecosystems.**

Pelecypod (freshwater bivalves) and gastropod (freshwater snails) communities were studied in southwestern Michigan to determine the diversity and variation in and among riverine, wetland, and lake habitats. These faunal groups are two of the most understudied, least understood and most at risk of extirpation in North America. The mollusk communities were compared to the non‐mollusk macroinvertebrate communities, quantified and compared with overall water quality. The mollusk communities were also compared to communities in three other water bodies (Kalamazoo, Looking Glass, and Thornapple Rivers). One river was determined to be a pristine habitat for many Unionidae in the watershed and supported a unionid density of over 21 individuals per m^2 which was a much greater density than other river sites sampled. The wetlands, depending on location, had a very large diversity and abundance of pelecypods and gastropods. Aquatic invasive species are a real threat to the most pristine sampling site. We show that the mollusk data may be a better predictor of ecosystem variation than classic macroinvertebrate indices. Responsible management and monitoring of these water bodies is vital to maintain the pristine environments and these imperiled organisms. *Keywords: Mollusks, Unionids, Ecosystems.*

AUER, M.T.[1], ATKINSON, J.F.[2], and DAYTON, A.I.[1], [1]Department of Civil & Environmental Engineering, Michigan Technological University, Houghton, MI, 49931; [2]Department of Civil, Structural and Environmental Engineering, University at Buffalo, Buffalo, NY, 14260. **Feeding the Beast: Temporal Scale, Cladophora and the Nearshore Phosphorus Shunt.**

The role of dreissenids as ecosystem engineers mediating the nearshore phosphorus shunt has drawn significant attention with respect to nuisance growth of Cladophora. Recent field studies have demonstrated that dreissenids are capable of creating a concentration boundary layer (CBL) immediately above mussel/Cladophora beds that is enriched in soluble reactive phosphorus (SRP). Empirical relationships and modeling studies have shown that the presence of the CBL and the SRP concentration which it hosts are a function of turbulent mixing, i.e. wind speed and fetch. The time scales over which the salient processes respond: duration of a turbulence regime, maturation of a CBL and resource acquisition by Cladophora vary

significantly. Here, we apply a mathematical model to identify combinations of rates of SRP excretion by mussels, duration of quiescent conditions and rates of SRP uptake by Cladophora necessary for creating stored P reserves in the algae that would yield nuisance levels of growth. *Keywords: Cladophora, Nearshore phosphorus shunt, Mussels, Phosphorus.*

AVLIJAS, S.[1], DOKA, S.E.[2], and RICCIARDI, A.[1], [1]Redpath Museum, McGill University, Montreal, QC, H3A 2K6; [2]Great Lakes Laboratory for Fisheries & Aquatic Sciences, Fisheries & Oceans Canada, Burlington, ON, L7R 4A6. **Patterns of Distribution and Abundance of *Hemimysis anomala* in the St. Lawrence River in Relation to Physico-Chemical Variables.**

Hemimysis anomala, a Ponto-Caspian crustacean, is expanding its range in the Great Lakes - St. Lawrence River basin. Negative impacts associated with the introductions of other mysid species to North American and European lakes raise concerns about the potential ecological consequences of this invasion. Risk assessments require a predictive understanding of the habitat conditions that promote the establishment and proliferation of local populations of *H. anomala*. To address this need, we related *H. anomala*'s local occurrence and abundance to physico-chemical variables in the St. Lawrence River. Our survey targeted a diverse suite of sites at two spatial scales: 1.5km-wide sites and 10m-wide nested subsites. Mysid populations were found across sites in the river at densities spanning more than 3 orders of magnitude. The mysid's occurrence at sites was limited by low conductivity, and its abundance increased with shoreline heterogeneity. Within sites, mysid abundance increased with shoreline slope and the interaction between depth and distance from shore. As the St. Lawrence is the first North American river to be colonized by *H. anomala*, these results offer predictive information for future invaded rivers. *Keywords: St. Lawrence River, Distribution patterns, Invasive species.*

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, 48018. **Modeling Thermal Structure and General Circulation in the Great Lakes with FVCOM.**

An unstructured Finite Volume Coastal Ocean Model (FVCOM) was applied to all five Great Lakes to simultaneously simulate water circulation and temperature conditions. Lakes Michigan, Huron are connected, while others are kept disconnected due to the nature of human management. 3-hourly winds, air temperature, specific humidity and cloudiness from the North American Regional Reanalysis dataset were used to force the model from 1993 to 2008. Model results were validated by available water temperature observations. Including a surface wind wave mixing scheme, the model successfully reproduced a reasonable thermo-structure during the stratification period. The 15 years averaged winter mean currents show typical two-gyre type wind-driven circulations in the smaller lakes (Lakes Ontario and Erie) and one large cyclonic circulation in the larger lakes (Lakes Michigan, Huron and Superior). During summer, the circulation pattern becomes complicated: large cyclonic circulations remain in Lakes Superior, Huron and Ontario occupying the most parts of the lakes; Lake Michigan has a large cyclonic circulation in north and an anti-cyclonic one in south basin; Lake Erie has a typical two-gyre pattern in central basin and a cyclonicin central basin in eastern basin. The currents are the

strongest during winter and the weakest during summer. *Keywords: Water currents, Thermal structure, Hydrodynamic model, Model studies.*

BAIRD, C.J.[1], HARPER, L.H.[2], LAVOIE, R.A.[1], and CAMPBELL, L.M.[3], [1]Department of Biology, Queen's University, Kingston, ON, K7K 1H7; [2]Riveredge Associates LLC, 58 Old River Road, Massena, NY, 13662; [3]Environmental Science, St. Mary's University, Halifax, NS, B3J BN8. **Mercury in Common Terns (*Sterna hirundo*) breeding Along the St. Lawrence River: A Comparison between Summer and Winter Habitat.**

The Common tern (Sterna hirundo) is considered a sentinel wildlife species for the St. Lawrence River Cornwall/Massena Areas of Concern (AOC). Further, terns forage at a relatively high trophic level, making them an important bioindicator for biomagnifying contaminants such as mercury (Hg). Here, we investigate the relationship between Hg bioaccumulation and diet using stable isotopes of carbon (d13C) and nitrogen (d15N) in three tern colonies along a 150-km transect of the St. Lawrence River. The foraging range of the colony furthest downstream includes both the Massena and Cornwall AOC's while the two upstream colonies are more removed from known point sources of Hg. We also sampled winter- and summer- grown breast feathers to compare diet and Hg exposure on the terns' breeding ground vs. the terns' wintering grounds. Terns were sampled twice: upon arrival to the breeding grounds to collect 'winter' breast feathers, and just prior to hatching the same individuals were re-trapped to sample regrown 'summer' breast feathers. The results of this study should assist managers evaluating the effectiveness of the Remedial Action Plan for the St. Lawrence River in relation to a key migratory piscivorous bird species. *Keywords: Mercury, Common terns, St. Lawrence River, Trophic level.*

BAKER, A.J.[1], SMITKA, J.[2], HADDRATH, H.[1], and IMHOF, J.[2], [1]Royal Ontario Museum, 100 Queen's Park Cres, Toronto, ON, M5S 2C6; [2]Trout Unlimited Canada, c/o University of Guelph, Guelph, ON, N1G 2W1. **Restoring Atlantic salmon to Lake Ontario One Gene at a Time.**

Restoration of Atlantic salmon to Lake Ontario is a monumental task especially when there are no remnant stocks within the Lake Ontario watershed. When Europeans first arrived, they found a lake teeming with salmon. Human activities that followed settlement changed both the terrestrial and aquatic habitats. By 1896, the salmon were gone. We report recovery of ancient DNA from six Lake Ontario salmon museum mounts as well as an unspecified number of fish from bones from 9th, 13th and 14th century Native American middens. Both mitochondrial sequences and microsatellite analyses have been employed to compare the historical and now extirpated Lake Ontario salmon population to 10 extant populations in North and South America. Our results show that populations introduced to Argentina from North America in 1900 were not fish from the Lake Ontario population. Populations from the tributaries of the St. Lawrence River are genetically closer to Lake Ontario salmon. This project will provide important information concerning the genetic distinctiveness of the Lake Ontario population, the historical biogeography of Atlantic salmon on the east coast and Lake Ontario, a history of evolutionary genetic changes over several centuries, identify the approximate time of

colonization and possibly influence management implications. *Keywords: Genetics, Restoration, Lake Ontario, Salmon.*

BAKER, D.B., KRAMER, J.W., MERRYFIELD, B.J., EWING, D.E., and ROERDINK, A.R., Heidelberg University NCWQR, 310 East Market Street, Tiffin, OH, 44883, USA. **Watershed-Scale Observations of Direct Runoff of Broadcast Phosphorus Fertilizer Applications in Northwestern Ohio.**

Increased loading of dissolved reactive phosphorus (DRP) from cropland has been identified as a contributor to the increasing blue-green algal blooms in Western Lake Erie. Phosphorus stratification in area soils and direct runoff of broadcast phosphorus fertilizer have been identified as sources of the increased DRP runoff. Because of wet fall weather in 2011, the windows of opportunity for broadcast applications of phosphorus fertilizer were limited, with the longest opportunity occurring November 7-12. From October 1, 2011 through January 20, 2012, nine distinct rainfall/runoff events occurred in area rivers. By far the highest DRP concentration during these events followed a storm event beginning November 13. In the 386 km2 Honey Creek watershed, the DRP concentration reached 0.98 mg/L with a storm event mean concentration of 0.63 mg/L and a storm load of 5.9 metric tons. Subsequent storm events had much lower DRP concentrations as DRP sources switched from direct runoff of fertilizer to DRP released from surficial soils. Within these storms suspended sediment (SS) concentrations varied in relation to rainfall intensity, suggesting that SS concentrations in area rivers directly reflect land use/rainfall interactions rather than streamflow-dominated transport of legacy sediments stored in the stream system. *Keywords: Phosphorus, Broadcast fertilizers, Pollution sources, Storm events, Sediment transport.*

BANDA, J.A., TLOCZYNSKI, K.H., and DE VAULT, D.S., 4625 Morse Rd., Ste. 104, Columbus, OH, 43230. **Changes in Dissolved Phase PCB and Hexachlorobenzene (HCB) Concentrations in the Ashtabula River Pre- and Post-Environmental Dredging.**

The Ashtabula River, an area of concern in the Great Lakes, was severely impacted by PCBs, HCB and other chlorinated industrial compounds primarily originating from approximately 1.6 miles upstream of Lake Erie at the Fields Brook Superfund site. Following cleanup activities at Fields Brook, environmental dredging was conducted on the Ashtabula River between 2006 and 2008. High volume water samples were collected in 2001 and at five of the same locations in 2011, and dissolved phase PCB and HCB concentrations were compared pre- and post-environmental dredging. Samples taken in late June 2001 and early July 2011 were compared and show the mean concentrations of dissolved phase PCBs declined from 44.6 ng/l pre-dredging to 3.4 ng/l post-dredging and that the mean dissolved phase HCB concentrations declined from 11 ng/l to 0.6 ng/l. Significant but lesser declines in mean dissolved phase PCB and HCB concentrations were observed between samples taken in late August 2001 and early September 2011. Dissolved phase PCB concentrations were highest near the confluence of Fields Brook and declined downstream toward Lake Erie in 2001. No spatial distribution pattern was observed in 2011. Declines in contaminant concentrations, including individual PCB congeners will be discussed. *Keywords: PCBs, Lake Erie, Cleanup.*

BARANOWSKA, K.A., POSTE, A.E., DILLON, P.J., and NORTH, R.L., Trent University, 1600 West Bank Drive, Peterborough, ON, K9J 7B8. **Drivers of the Spatial and Temporal Variation in δ^{15}N and δ^{13}C Signatures of Particulate Organic Matter in Lake Simcoe.**

Stable isotopes of carbon and nitrogen are a useful tool to study trophic interactions and the flow of energy in an ecosystem. To compare variations in trophic structures among food webs, one must first account for variations at the base of each food web by establishing a baseline using primary producers, and adjusting the signatures of consumers against it. This is especially important for nitrogen isotopes. However, baseline isotopic signatures are highly variable and the cause of this variability remains unclear. Previous studies found a relationship between lake trophic state and δ15N baseline signatures (Gu et al. 1996), yet studies seem to contradict each other when looking at the relationships between δ15N baseline signatures and limiting nutrients in lakes. In this study we determined the extent of spatial and temporal variability of particulate organic matter (POM) carbon and nitrogen isotopes by collecting monthly samples from Lake Simcoe and its tributaries. The lake was sampled from seven depths at two off shore locations. We then compared the POM isotopic signatures to the amount of light, dissolved oxygen, chlorophyll a, as well as different phosphorus and nitrogen species found in the water in order to determine what drives this variability of baseline isotopic signatures. *Keywords: Lake Simcoe, Particulate Organic Matter, Stable isotopes, Nutrients.*

BARBIERO, R.P.[1], LESHT, B.M.[2], and WARREN, G.J.[3], [1]CSC, 1359 W Elmdale Ave Suite 2, Chicago, IL, 60660; [2]CSC & Dept of Earth and Env. Sci., 845 W Taylor St, Chicago, IL, 60607; [3]US EPA GLNPO, 77 W Jackson Blvd., Chicago, IL, 60604. **Convergence of the Lower Food Web in Lakes Huron, Michigan and Superior.**

The open waters of both Lake Huron and Lake Michigan have shown signs of oligotrophication in recent years. Spring total phosphorus (TP) and the relative percentage of particulate phosphorus in both lakes have declined, and spring soluble silica concentrations have increased significantly in both lakes, consistent with decreases in productivity. Transparencies in Lakes Huron and Michigan have increased, and in most regions are roughly equivalent to those seen in Lake Superior. Seasonality of chlorophyll, as estimated by SeaWiFS satellite imagery, has been dramatically reduced in lakes Huron and Michigan. The spring bloom is now largely absent from both lakes with a seasonal maximum occurring instead in autumn, as is the case in Lake Superior. As of 2006, the loss of cladocerans and the increased importance of calanoids have resulted in crustacean zooplankton communities in Lake Huron and Lake Michigan closely resembling that in Lake Superior in size and structure. Decreases in Diporeia in offshore waters has resulted in abundances of non-dreissenid benthos communities in these lakes that approach those of Lake Superior. These changes have resulted in a distinct convergence of the lower food webs in the three lakes, with Lake Huron currently as - or more - oligotrophic than Lake Superior by many measures. *Keywords: Trophic level, Zooplankton, Productivity.*

BARKACH, J., MCCAULEY, D., and ROSIER, D., Great Lakes Environmental Center, Inc., 31700 W. Thirteen Mile Road, Suite 215, Farmington, MI, 48334, United States. **Practical Aspects of Sediment Sampling and Bathymetric Data Collection to Support Sediment Yield and Dam Capacity Studies in Great Lakes Watershed.**

This presentation discusses practical aspects of sediment sampling and bathymetric data collection associated with sediment accumulation studies. Bathymetric surveys, suspended sediment collection and analysis, velocity profiles, and other field and historical reconnaissance are considered. This presentation is based on the "lessons learned" from the implementation of various sampling and analysis procedures over many years of field experiences. Advantages and disadvantages of several common types of sediment sampling equipment are presented, including: vibracore sediment sampling equipment, conventional drilling equipment, gravity corers, and dredge samplers. *Keywords: Sediment load, Hydrodynamics, Sediment transport.*

BARNSWELL, K.D., DWYER, D.F., and STRUFFOLINO, P., 6200 Bayshore Rd., Oregon, OH, 43616, USA. **Increased Accuracy in Predicting Water Quality at Swimming Beaches Using a Time Adjusted Environmental Model.**

Elevated densities of Escherichia coli (an exceedance of 235 CFU/100 ml) at the lakeside beach of Maumee Bay State Park (MBSP), in western Lake Erie, resulted in swim advisories posted an average of 20/100 days in each of the last 10 recreational seasons. These results were based on traditional methods of enumeration that require 24 h to complete; as a predictive tool, they represented both overestimations (10%) and underestimations (14%) of actual densities of E. coli. We developed real-time, environmentally based, predictive models for estimating densities of E. coli with the goal of reducing over- and underestimations of exceedances. The models were tested during two recreational seasons (2010-2011) using data for wind direction and speed, water temperature, solar radiation, turbidity, precipitation, and lake level. We obtained correct estimations of exceedances for 85% of the days (N = 94) studied with 3% overestimations and 12% underestimations. To further reduce the occurrence of underestimations, we added data for hydrologic measurements (e.g. discharge, velocity, stage height) for a nearby stream that is a primary source of E. coli for MBSP. The results suggest that separate models using discharge (positive values at 6:00 am and negative values at 7:30 am) be developed for 2012. *Keywords: Human health, Model testing, Water quality.*

BASKARAN, M.[1], KUMAR, A.[1], HEICHEL, R.L.[1], MILLER, C.J.[2], SELEGEAN, J.P.[3], and CREECH, C.T.[3], [1]Department of Civil and Environmental Engineering, Wayne State University, Detroit, Mi, 48202, United States; [2]Dept of Geology, Wayne State University, Detroit, Mi, 48202, United States; [3]U.S. Army Corps of Engineers, Wayne State University, Detroit, Mi, United States. **Reconstruction of Landuse Changes Using Carbon and Nitrogen Isotopes in Sediment Cores from Dams in Michigan.**

Temporal variations in the stable isotopes of carbon and nitrogen in dated sediment cores from lakes have been used to reconstruct changes in the sources of carbon and nitrogen and to investigate processes that lead to such changes. We analyzed carbon and nitrogen isotopes along

with C/N elemental ratios on the total organic matter in a suite of sediment cores collected from two dams in Michigan. Excess Pb-210 and Cs-137 based sediment accumulation rates were determined to be 0.28 and 0.64 g/sqcm/y. There are distinct vertical variations in the carbon and nitrogen isotopic ratios in these two dated cores. There is a depletion of ~1‰ in carbon isotope ratios between 1999 and 2007, while the nitrogen isotopes showed a decrease from 7.8‰ to 6.7‰.There is scatter in the C/N ratios. The vertical trends in the carbon and nitrogen isotopic ratios in two different dams are not identical, indicating different sources and processes affecting the sedimentary record differently. These vertical variations are attributed to vegetational changes in the watershed, post-depositional diagenetic changes in the sedimentary record and changes in the atmospheric input for nitrogen isotopes. Intercomparison of the carbon and nitrogen isotopic ratios from more than 2 sediment cores/dam for two different dams will be presented. *Keywords: Carbon, Dating of sediments, Geochemistry, Carbon and nitrogen cycling, Sediment transport.*

BAUMANN, P.C.[1], BLUKACZ-RICHARDS, E.A.[2], MCMASTER, M.E.[3], SHERRY, J.P.[3], and PARK, J.B.[4], [1]US Geological Survey, 99 Blenheim Road, Colombus, OH, 43214; [2]Environment Canada, 4905 Dufferin St., Toronto, ON, M3H 5T4; [3]Environment Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6; [4]Department of Fisheries and Oceans, 501 University Crescent, Winnipeg, MB, R3T 2N6. **Assessment of the Fish Tumor BUI for Canadian Areas of Concern in the Lower Great Lakes.**

Research during the last 35 years demonstrated elevated liver tumor prevalence in a variety of fish including brown bullhead from Canadian and United States waters of the Great Lakes. We analyzed liver lesion data from brown bullhead (Ameiurus nebulosus) (n=1,548) captured at six Areas of Concern (AOCs), nine reference locations, and four far-field sites in Canadian waters of the lower Great Lakes. There was little weak support for associations (Kendall's tau) between preneoplastic hepatic lesions and liver tumours. Basophilic preneoplastic lesions alone were not significantly correlated. Liver tumor prevalence was not significantly dependent on gender, except in the Hamilton Harbour AOC. Similarly liver tumor prevalence was dependent on both fork length and age, in both the Hamilton Harbour and St. Lawrence River AOCs. Of nine putative reference locations, eight (n=701) ranged from 0% to 2.1% tumor prevalence (averaging 1%), while Hillman Marsh (n=99) had a prevalence of 9%. Far field locations, urbanized but not near a point source, averaged a 2% liver neoplasm prevalence. AOC locations ranged from 2% (St. Lawrence River) to 5.5% (Hamilton Harbour) liver tumor occurrence. Hamilton Harbour bullhead were old (median age 8) relative to fish at other locations. *Keywords: Environmental contaminants, Biomonitoring, PAHs.*

BEJANKIWAR, R.S., WHITMAN, R., and BOUGHTON, L., 100 Ouellette Avenue 8th Floor, Great Lakes Regional Office, Windsor, ON, N9A 7A2. **Microbiological Quality of Great Lakes Beaches and Recreational Waters.**

The Great Lakes Water Quality Agreement empowers the governments of Canada and United States to restore and maintain the biological, chemical and physical integrity of the Great Lakes Basin Ecosystem. The Agreement addresses microbiological contamination including

pathogens and viruses. The International Joint Commission report focuses on two issues: the relationship between fecal indicator bacteria including those from wildlife sources and public health; and management actions that improve beach quality, with emphasis on controlling gull populations. The microbiological quality of the beach assists in identifying the sources and land uses in the "beachshed". The potential health risks from contaminated beaches will require further study. Informed decision-making and improved monitoring techniques needs to be implemented. *Keywords: Microbiological studies, Human health, Coastal ecosystems.*

BENNINGTON, V., NOTARO, M., and ZARRIN, A., Center for Climate Research - UW Madison, 1225 W Dayton St, Madison, WI, 53706, USA. **How Will the Laurentian Great Lake Water Levels Respond to Climate Change? A Regional Climate Modeling Study.**

Lakes Superior and Michigan experienced record low levels during the mid 2000s, wreaking havoc on the shipping industry, drying wetlands, reducing power generation, and making boat docking difficult. Rapidly increasing temperatures were immediately blamed and motivated the question: How will Great Lakes water levels respond to increasing temperatures over the next century? The IPCC reports a predicted increase in air temperature of 4°C by 2100 and moderate increases in both precipitation and evaporation in the region. Although global models are useful tools for large-scale projections, precipitation parameterizations are severely limited by coarse horizontal resolution, and only half of the IPCC global climate models even include any (poor) representation of the Great Lakes. Thus, global climate models are unlikely to accurately capture the dynamical air-lake interactions that impact over-lake precipitation, evaporation, and precipitation within the watershed. We utilize the ICTP Regional Climate Model 4 at 20 km horizontal resolution with an explicit lake model, groundwater module, and GLERL's channel routing model to simulate past regional climate (1978-2010) and water levels. We simulate present and future water levels using boundary conditions from the global Community Climate System Model 3. We present mod *Keywords: Water level fluctuations, Climate change, Model studies.*

BENNION, D.H., MANNY, B.A., ROSEMAN, E.F., and KENNEDY, G.W., USGS Great Lakes Science, 1451 Green Rd., Ann Arbor, MI, 48105. **Future Directions of Fish Habitat Modeling in the Huron-Erie Corridor.**

Complementing a completed physical model of fish spawning habitat in the Huron-Erie Corridor (HEC), early work is being conducted to develop a model of potential fish nursery habitat in the HEC based on water depth, flow velocity and shoreline conditions. In addition, the potential to use existing particle transport models to predict larval fish transport through the HEC is being assessed to examine connectivity between modeled spawning habitat and modeled nursery habitat. Past fish spawning reef construction projects as well as ongoing studies of benthic fish egg densities and pelagic larval fish densities will be used to ground truth output model predictions. The goal of this work is to create a landscape scale physical model of fish habitats within the HEC, predict connectivity among fish habitats in the HEC and provide input and connection to biophysical models of larval fish transport in the western basin of Lake Erie. *Keywords: Detroit River, Fish Habitat, St. Clair River, GIS.*

BENOIT, N.B. and HOWELL, E.T., Ontario Ministry of the Environment, 125 Resources Rd, Etobicoke, ON, M9P 3V6. **A Synopsis of Conditions at Nearshore Monitoring Sites in the Eastern Basin of Lake Erie from 1998-2010.**

The Ontario Ministry of Environment maintains a network of nearshore monitoring sites on the Great Lakes where a broad suite of environmental indicators including water and sediment chemistry and composition of benthic invertebrates have been periodically surveyed since the early 1990s. Four stations in the eastern basin of Lake Erie provide insight on the background conditions of the basin's nearshore including adjacent to the mouth of the Grand River, the largest tributary to the basin. Water quality features vary widely on seasonal time scales and among areas reflecting geographic differences, however, overall similar oligo-mesotrophic conditions have persisted over the years. Substantial ecological changes to the nearshore environment have occurred in the basin since the early 1990s some of which are reflected in trends in water and sediment quality and composition of benthic invertebrates at the monitoring sites. This paper will focus on summarizing general spatio-temporal changes in the nearshore environment of the Easter Basin of Lake Erie that have occurred from 1998-2010. *Keywords: Lake Erie, Monitoring, Water quality.*

BHAVSAR, S.P.[1], NEFF, M.R.[2], LAW, R.[3], FLETCHER, R.[1], CARPENTER, D.O.[4], DROUILLARD, K.G.[5], FISK, A.T.[5], and ARTS, M.T.[6], [1]Ontario Ministry of the Environment, Environmental Monitoring and Reporting Branch, 125 Resources Road, Toronto, ON, M9P 3V6; [2]Department of EEB, University of Toronto, 25 Willcocks Street, Toronto, ON, M5S 3B2; [3]Department of Human Biology, University of Toronto, 300 Huron Street, Toronto, ON, M5S 3J6; [4]Institute for Health and the Environment, University at Albany, 5 University Place, Rensselaer, NY, 12144; [5]Great Lakes Institute for Environmental Research, University of Windsor, 401 Sunset Avenue, Windsor, ON, N9B 3P4; [6]Environment Canada, National Water Research Institute, Burlington, ON, L7R 4A6. **Fatty Acid Content of Lake Erie Sport Fish.**

Research regarding fatty acid content in fishes has focused primarily on marine species, despite the fact that many human populations consume freshwater fishes. We provide information on the contents and relative proportions for several important fatty acids, including total ω-3, ω-6, and polyunsaturated fatty acids (PUFA), for fifteen species of Lake Erie sport fish. We also examine the effects of sex, season and within-lake sampling location on fatty acid content and relative proportions. We found that within-lake processes may be affecting fatty acid profiles in Lake Erie fishes, and that concentrations of ω-3 fatty acids and ΣPUFA vary by species. In particular, species such as Northern Pike and Walleye have favourable ratios of Σω-3:Σω-6 and ΣPUFA:ΣSAFA for human consumption, while mean values for essential fatty acids in eight species are sufficient to meet recommended daily intake for the general population after consumption of one 75 g fish meal. This work provides a baseline for future work regarding fatty acid levels in Great Lakes fishes, and may be used in conjunction with consumption advisories generated by fish contaminant levels in order to provide the best possible assessment of the risks and benefits associated with consuming Great Lakes sport fishes. *Keywords: Lake Erie, Fatty acids, Fisheries.*

BIDDANDA, B., KENDALL, S.T., WEINKE, A., LONG, S., SNIDER, M., GEREAUX, L., and HOLCOMB, T., AWRI-Grand Valley State U, 740 W. Shoreline Dr., Muskegon, MI, 49441. **Time-series Observations Reveal Seasonal Basin-wide Bottom Water Hypoxia in Muskegon Lake AOC.**

Muskegon Lake is a highly productive drowned river mouth that drains one of the largest Michigan watersheds into Lake Michigan. A newly established observatory for tracking ecosystem changes in Muskegon Lake Area of Concern (AOC) with EPA's GLRI funding is now gathering vital time-series data on the lake's water quality. Observatory-based measurements of dissolved oxygen (DO) in the interior of the lake have tracked the gradual development, intensification and breakdown of hypoxia in the middle of the lake from spring through fall 2011. Additional ship-based surveys have confirmed that summer-time bottom water with persistent hypoxia ($\leq$4 mg DO/L), and even intermittent anoxia (~0 mg DO/L) close to the sediments, is a widespread and sustained condition. High temperatures, nutrient run off and algal blooms are likely the proximal causes of the observed oxygen deficit with attendant consequences for fish/invertebrate habitat and phosphorus release from sediments. Questions of whether such hypoxia is driven by local and anthropogenic events on the air/watershed or by distant phenomena such as ENSO remain. Our paper examines the biogeochemical causes and consequences of hypoxia in Muskegon Lake, and ponders the local and global forces that may be driving this phenomenon in this Great Lakes coastal ecosystem. *Keywords: Oxygen, Hypoxia, Biogeochemistry, Algal blooms, Observing systems, Driving forces.*

BINDING, C.E., GREENBERG, T.A., and BUKATA, R.P., Environment Canada Water Science & Technology Directorate, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **The MERIS Maximum Chlorophyll Index; Its Merits and Limitations for Algal Bloom Monitoring Over Inland Waters.**

Satellite remote sensing methods adopting red and near infra-red wavelengths have been shown to be superior to the standard blue to green ratio based approaches in the detection of algal blooms under turbid, eutrophic conditions. This paper presents several examples where the MERIS Maximum Chlorophyll Index (MCI) has been explored for monitoring algal blooms within inland waters. Assessment of the MCI product is made under a range of conditions from intense blooms of cyanobacteria in Lake of the Woods, blooms in turbid waters of Lake Erie, low chlorophyll conditions in Lake Ontario, and diatom blooms under Lake Erie winter ice. The MCI product is shown to be a versatile tool in monitoring intense surficial algal blooms with chlorophyll concentrations ranging 10-300 mg m-3, while limited in its application to low-biomass conditions. The MERIS Level 1 MCI is demonstrated for the first time as having potential for satellite detection of winter diatom blooms in Lake Erie under winter, ice-covered conditions. Wavelength shifts in the position of the MCI peak for different chlorophyll concentration ranges, as well as variations in elastic and inelastic optical properties, are anticipated to account for regional variations in MCI-Chlorophyll relationships and potentially hinder a universally applicable quantitative MCI product. *Keywords: Algae, Remote sensing, Water quality.*

BLANKEN, P.D.[1], SPENCE, C.[2], and HEDSTROM, N.[2], [1]Department of Geography, University of Colorado, Boulder, CO, 80309-0260; [2]Environment Canada, 11 Innovation Blvd., Saskatoon, SK, S7N 3H5. **A Comparison of Simultaneous Measurements of the Surface Energy Balance on Lakes Superior and Huron.**

Simultaneous half-hourly measurements of the surface energy balance were made continuously from two remote offshore sites on Lakes Superior and Huron, from September 2009 to the present. The eddy covariance method was used to calculate turbulent fluxes of latent and sensible heat, with the former being equivalent to the evaporative water loss over an upwind distance of approximately 6 km. Differences and time-lags between the two sites are discussed, in terms of meteorological variables that are known to influence turbulent fluxes (e.g., air / water temperature and vapor pressure, wind speed, and ice conditions). Large evaporation events in the winter on both lakes were driven by the passage of strong cold fronts over the ice-free water, and the time delay was, on average, roughly 20 hours for the fronts to traverse the 295-km separation between the sites. Overall, the sensible heat flux from Lake Superior was 15% less than that from Lake Huron, yet the total evaporative water loss from the two lakes was similar (roughly 585 mm). This comparison between the characteristics and controls on turbulent fluxes helps us to better understand the spatial variation of the surface energy balance across the Great Lakes. *Keywords: Lake Superior, Lake Huron, Micrometeorology.*

BLASS, C.R.[1], GEHRING, T.M.[1], MURRY, B.A.[1], and UZARSKI, D.G.[2], [1]Institute for Great Lakes Research and Department of Biology, Central Michigan University, Mount Pleasant, MI, 48859; [2]Institute for Great Lakes Research, CMU Biological Station and Department of Biology, Central Michigan University, Mount Pleasant, MI, 48859. **Fair or Fowl? Mute Swan Impacts on Great Lakes Coastal Wetlands.**

Great Lakes coastal wetlands provide critical habitat for more taxa than any other Great Lakes ecosystem. Coastal wetlands have been impacted by anthropogenic disturbance, such as the introduction of mute swans. Therefore, coastal wetlands are of great importance to maintain and monitor. Indices of Biotic Integrity (IBI) have been developed and validated using native communities as indicators of adjacent anthropogenic disturbance to provide an assessment of the quality of coastal wetlands. This study used IBIs to determine if mute swans have an additive effect to anthropogenic disturbances on coastal wetland health. Coastal wetlands along Michigan's shoreline in Lakes Huron and Michigan were sampled for vegetation, fish, and macroinvertebrates and surveyed for mute swans. IBI metrics were scored within each wetland and related to adjacent land use and land cover. Residuals, or the variation in IBI score that was not due to adjacent land use and cover, were related to the presence of mute swans. *Keywords: Invasive species, Coastal wetlands, Indicators.*

BLERSCH, D.M., HENNESSEY, E.H., and BYRLEY, P.S., Department of Civil, Structural and Environmental Engineering, State University of New York at Buffalo, Buffalo, NY, 14260, USA. **Assessment of Benthic Algal Cultivation for Phosphorus Recapture in the Lower Great Lakes.**

The removal of excess phosphorus (P) from Great Lakes waterways is an important component of managing water quality. Controlled cultivation of benthic filamentous algae is gaining attention nationally for the removal of P from natural waters. By employing a turbulent flow in constructed raceways, algal productivity is maximized, and periodic harvesting removes P incorporated into algal biomass. The objective of this research was to investigate the utility of benthic algal cultivation for P-removal from Great Lakes tributary waterways. Two pilot-scale cultivator raceways were installed near the mouth of the Buffalo River in Buffalo, NY and operated in for six months in each 2010 and 2011. Water was continuously pumped from the river and passed over benthic algae in the raceway. Water N- and P-concentrations averaged 0.05 mg P L^{-1} and 0.14 mg N L^{-1}. Average and maximum biomass production were 8.8 and 19.6 g DW m^{-2} d^{-1}, and biomass phosphorus content averaged 0.3% DW. Algal species assemblages were dominated by *Cladophora* species in warm months, but shifted to a diatom community in cooler months. The results have severe implications for the feasibility of benthic algal cultivation for water quality management in the lower Great Lakes region. *Keywords: Algae, Productivity, Phosphorus.*

BLOCH, S.R.[1], WALSH, S.K.[2], CHEN, C.C.[1], VO, N.T.K.[1], LEE, L.E.J.[2], HODSON, P.V.[3], and BOLS, N.C.[1], [1]Department of Biology, University of Waterloo, Waterloo, ON, N2L 3G1; [2]Department of Biology, Wilfrid Laurier University, Waterloo, ON, N2L 3C6; [3]3Department of Biology and School of Environmental Studies, Queen's University, Kingston, ON, K7L 3N6. **Development from the Brain of the American Eel *Anguilla rostrata* of a Cell Line Capable of Forming Capillary-Like Structures.**

A cell line (eelB) was developed from outgrowth of adherent cells from American eel (Anguilla rostrata) brain explants. The cells grow in L-15 with serum, have a polygonal shape, been subcultivated over 50 times, retain a diploid chromosome number, and been cryopreserved. As well as adherent growth, eelB formed aggregates or spheroids in suspension. Differentiation of spheroid cells upon reattachment is being investigated. However, for conventional monolayer growth, three properties were examined: 7 -ethoxyresorufin o-deethylase (EROD) induction by 2,3,7,8-tetrachlorodibenzo-p-dioxin, glial fibrillary acidic protein (GFAP) presence through immunocytochemical staining, and capillary formation through replating. No EROD activity was induced, which suggests eelB failed to retain catalytic CYP 1A1. Some cells were astrocyte-like as they were GFAP positive. When cells were plated at about 30% confluency, even without nutrients and proliferation, capillary-like structures developed between 12 and 72 h later. Therefore, eelB appears to be primarily endothelial cells that are capable of angiogenesis. As the induction of abnormal circulatory system development by environmental contaminants is one hypothesis to explain the decline in American eel populations, eelB might be used to screen for chemicals impairing eel angiogenesis. *Keywords: Priority pollutants, Environmental health, Eel, Fish toxins.*

BLUKACZ-RICHARDS, E.A., GRABAS, G.P., ROKITNICKIWOJCIK, D., and WATTON, P., 4905 Dufferin St., Toronto, ON, M3H 5T4. **Coastal Wetland Vegetation Considerations for Lake Ontario Water Level Regulation Adaptive Management.**

It is commonly accepted that Lake Ontario water level regulation has generated shifts in coastal wetland vegetation communities. Although water levels are regulated, natural fluctuations frequently occur in coastal wetlands due to barrier beach openings and closures, wind tides, and seiches. These effects on the vegetation communities are not well understood. For the past seven years, the Canadian Wildlife Service - Ontario (CWS-ON) recorded water levels during the growing season in 22 Canadian Lake Ontario wetlands and collected vegetation data along transects at 20cm intervals from 74m - 76m IGLD (submerged -upland). In each wetland, water level fluctuations were quantified with wavelets across 12 temporal scales (hourly to seasonal) to determine the scales at which most of the variation occurred. Associations between water level fluctuation statistics (wavelet slopes) and vegetation community attributes at discrete elevations were explored. Preliminary analysis indicated that wetlands across Lake Ontario have distinct seasonal water level histories despite water level regulation. This appears to contribute to differences in vegetation community attributes which may affect wildlife habitat quality. These results may influence Lake Ontario adaptive management following the implementation of a new regulation plan. *Keywords: Biodiversity, Water level fluctuations, Wetlands.*

BLUME, L.J.[1], MIDDLEBROOK AMOS, M.[2], PALMER, C.J.[2], SCHOFIELD, J.A.[2], and BENJAMIN, E.M.[2], [1]77 West Jackson Boulevard, Chicago, IL, 60604-3590, USA; [2]6101 Stevenson Avenue, Alexandria, VA, 22304, USA. **GLRI Quality Program - Empowering GLRI Collaborators.**

In 2010 (1st year of the GLRI), funding to the EPA's GLNPO increased 10-fold with a budget of $425 million; in 2011, $325 million of funding was received. GLNPO's Quality Program responded to this dramatic increase & the associated need for QA planning by performing a multitude of outreach activities. These activities included establishing a workgroup comprised of state & federal agencies, coordinating & hosting an annual conference, providing 11 trainings to in-person & Webinar attendees, developing tools (websites, checklists, etc.) supporting project planning, providing reviews on project-level quality plans (QP), reporting on the progress of GLRI Quality Program on a monthly basis, & more. The focus of this program in FY2011 was establishing & empowering the workgroup through 1) providing training, tools, resources, & a forum for communication & 2) tracking & reporting on the status of QP for all projects. The focus for FY2012 will be 1) developing quality systems for GLRI collaborators, 2) conducting audits of GLRI-funded projects, & 3) providing quantitative updates on the status of the GLRI to the public. The success of the GLRI is dependent upon empowering its collaborators with the necessary quality infrastructure to implement projects that produce results that better the Great Lakes' ecosystems. *Keywords: Environmental education, Public participation, Management.*

BOBROWSKI, R.J.[1], WILSON, C.C.[2], and JONES, N.[2], [1]Ontario Ministry of Natural Resources, Northwest Science and Information, Thunder Bay, ON; [2]Ontario Ministry of Natural Resources, Aquatic Research and Development Section, Peterborough, ON. **Survival, Condition, and Out-migration Timing of Reintroduced Atlantic salmon in Cobourg Brook, Ontario.**

Atlantic salmon (*Salmo salar*) were historically a top predator in Lake Ontario but died out prior to the 20th century. Current recovery efforts use experimental releases of multiple life stages into selected tributary streams. This study compared survival, body condition, and movement of three juvenile life stages released into an Ontario tributary. Stocked yearlings were in poor condition but produced more outmigrants compared to stocked fry. However, fry outmigrated during the predicted smolt window whereas stocked yearlings displayed atypical outmigration during environmentally suboptimal times. Winter may present a high mortality period in nursury streams. Older life stages appear to display greater short-term survival by avoiding high mortality events in the wild, however maladaptive behaviours may develop due to increased time in captivity which may reduce overall fitness and subsequently their efficacy in re-establishing wild populations. This generalization may be valuable for other native species recovery programs when choosing a life stage to release into the wild. *Keywords: Salmon, Reintroduction, Fish hatcheries, Native species, Genetics.*

BOCANIOV, S., ULLMANN, C., BOEHRER, B., and RINKE, K., UFZ - Helmholtz Centre for Environmental Research, Department of Lake Research, Brueckstrasse 3a, Magdeburg, D-39114, Germany. **A 3-Dimensional Modeling of the Rappbode Reservoir: the First Insights into its Hydrodynamics.**

The understanding of physical processes in lakes and reservoirs involves, to a large extent, the knowledge of the relative importance of inflows, outflows and meteorological forcing for the hydrodynamic processes. In reservoirs where daily fluctuations in wind forcing coincide with the oscillations in water withdrawal the effects can be separated by using hydrodynamic models. The Rappbode Dam is the highest dam in Germany (106 m) built in late 1950s to create a water storage reservoir to be used for flood protection, power generation and as an important source of drinking water supply for more than one million people. Despite the significant amount of the scientific work undertaken in the past few years, yet little is known about major driving force for the hydrodynamics in the reservoir. In our study we combined the field observations with a 3-dimensional modeling to investigate the hydrodynamic behavior of the reservoir under different simulation scenarios. We have found that the Rappbode Reservoir is a very dynamic system experiencing high surface water currents, internal waves and upwelling/downwelling events. The modeling has revealed that wind stress is the key factor for the observed internal waves and water currents while the role of reservoir water withdrawal operating policies is negligible. *Keywords: Upwellings, Water currents, Internal waves, Hydrodynamic model, Waves.*

BOEGMAN, L.[1], BOUFFARD, D.[1], and YERUBANDI, R.R.[2], [1]Department of Civil Engineering, Queen's University, Kingston; [2]National Water Research Institute, Environment Canada, Burlington. **Instability of Poincaré Waves in Lake Erie.**

A 10,000 km^2 hypoxic 'dead zone' forms, during most years, in the central basin of Lake Erie. To investigate the processes driving hypoxia, we conducted a two-year field campaign. Mixing in the lake interior, during the stratification period, was examined using current meter and temperature logger data as well as > 600 temperature microstructure profiles; from which turbulent mixing parameters were computed. Our results demonstrate that near-inertial Poincaré waves drive shear instability, generating ~1 m amplitude and 10 m wavelength high-frequency internal waves with ~1 m density overturns. These lead to a greater than one order of magnitude increase in turbulent dissipation. The instabilities are associated with enhanced vertical shear at the crests and troughs of the Poincaré waves and may be correlated with the local gradient Richardson number. By generalizing our results to other lakes we find that that Poincaré wave induced mixing should be an important factor when the Burger number, S<0.25. In these lakes, the strong diapycnal mixing induced by the Poincaré wave activity will significantly modify the energy flux paths relative to small and medium sized lakes where S>0.25.
Keywords: Mathematical models, Linear stability, Hydrodynamics, Internal waves, Lake Erie, Trubulent mixing.

BOEHLER, C.T.[1], MINER, J.G.[1], FARVER, J.R.[2], and FRYER, B.[3], [1]Aquatic Ecology & Fisheries Lab, Dept Biological Sciences, Bowling Green State University, Bowling Green, OH, 43403, United States; [2]Department of Geology, Bowling Green State University, Bowling Green, OH, 43403, United States; [3]Great Lakes Institute for Environmental Research, University of Windsor, Windsor, ON. **Extent of Straying by Spawning Adult Lake Erie Steelhead Trout.**

The Lake Erie steelhead trout (*Oncorhynchus mykiss*) fishery relies on yearling stocking (2 million/yr) into MI, OH, PA, and NY streams. Stocking origin of adult steelhead trout can be accurately identified (86-100%) using otolith chemistry, analyzed with LA-ICPMS, in the hatchery region of adult otoliths (discriminant analysis; overall MANOVA; Wilk's λ F27,427 = 72.87; P < 0.0001). To address the extent of straying, spawning adult steelhead trout (N = 484) were collected from six Lake Erie tributaries from MI to NY during fall/spring runs. Straying occurrence (e.g., PA-stocked fish collected in a NY-tributary) ranged from 11-20% in MI, OH, and PA tributaries, while in NY, as many as 80% of adult steelhead trout originated from OH and PA. Numerous factors including, yearling size at stocking, stocking location (river mile), and stream discharge rates could affect yearling residency rates in streams and thus straying in adults. We use the extent of the transition otolith chemistry signature (i.e., marking between hatchery and Lake Erie chemical signatures) as a proxy for residence time in release-streams and compare this residency between straying adults and those using natal state tributaries. These results may give fishery managers insights to improve stocking strategies. *Keywords: Trout, Otoliths, Migrations, Chemistry, Lake Erie, Straying.*

BOEZAART, T.A.[1], STANDRIDGE, C.[2], and SOZEN, M.[2], [1]Michigan Alternative and Renewable Energy Center, 200 Viridian Dr., Muskegon, MI, 49440; [2]GVSU - Padnos College of Engineering and Computing, 301 W. Fulton St., Grand Rapids, MI, 49504. **Offshore Wind Assessment over the Great Lakes (Lake Michigan) Using Laser Wind Sensor Technology Deployed on a Floating Research Platform.**

Researchers at Grand Valley State University, the University of Michigan and Michigan State University have begun a wind resource assessment on Lake Michigan using laser wind sensor (LWS) technology mounted on a research buoy platform. A Wind Sentinel (WS) research buoy equipped with a Vindicator LWS, which incorporates Doppler technology, was deployed first in Lake Muskegon for a one month validation study by comparison with data collected from anemometers mounted on a metrological tower on the shoreline and then four miles offshore in Lake Michigan for a sixty-day field trial. Unique wind profile information at one second intervals in a vertical configuration at elevation points ranging from 50 to 125 meters above the water surface as well as other atmospheric and relevant data were collected on-board. Ten minute average wind data was remotely transmitted in real time. This data is being used in validation studies, for estimation of energy potential, and comparison of computed turbulent intensity and turbulent kinetic energy quantities with classic marine boundary layer theory. The WS will be deployed to the Lake Michigan mid-lake plateau in early spring for a full research season. Prior, the WS will gather wind data to evaluate performance during winter conditions. *Keywords: Remote sensing, Atmosphere-lake interaction, Buoys.*

BOLKHARI, H. and BOEGMAN, L., Queen's University, 58 University Avenue, Kingston, ON, K7L 3N6, Canada. **Potential Effects of Climate Change on Aquatic Ecosystem of Lake Simcoe.**

Lake Simcoe is the largest inland lake in southern Ontario, it supports a fishery and tourism industry of $200 million/year and is the source of drinking water for 8 municipalities. The lake had eutrophication problems from excessive nutrients, algae growth, decreased water clarity and hypoxia, which affects the cold water fish, but has seen improvement in recent years. The emerging threat from climate change may worsen its condition, by increasing stratification, total phosphorus loads and hypoxia. Conversely, increased storm activity may reduce stratification and the associated water quality issues. In this paper, we apply a 1D hydrodynamic, biogeochemical model DYRESM-CAEDYM to investigate the impacts of climate change on Lake Simcoe. The model is run with observed and GCM predicted data and the results are validated against observations from 2008-09. In both years, temperature RMS errors ranged between 1 to 4ºC. Dissolved oxygen RMS error was between 0.5 to 4 mg/L. Simulation of 5 algae groups show good agreement in seasonal variation between the predicted and the observed data. To assess climate change impacts, the model is run until 2100 using meteorological forcing from downscaled GCM data. The results will be summarized and generalized so they may be applied to other lakes. *Keywords: Lake Simcoe, Climate change, Algae.*

BOOTH, N.L.[1], CORSI, S.R.[2], DE CICCO, L.A.[1], and SIBLEY, D.M.[1], [1]USGS Center for Integrated Data Analytics (CIDA), 8505 Research Way, Middleton, WI, 53562; [2]USGS Wisconsin Water Science Center, 8505 Research Way, Middleton, WI, 53562. **EnDDaT: Enabling New Sophistication and Efficient Data Access for Beach Water-Quality Forecasts.**

Beach water-quality managers are improving beach water-quality forecasts by developing statistical models that assess nearshore and tributary influences for beaches of interest. Previously, a substantial barrier to developing these new models was efficient access to relevant data. The USGS Environmental Data Discovery and Transformation (EnDDaT) tool accesses, integrates and formats relevant datasets for calibrating beach water-quality models using historical observations as well as running models in an operational capacity using real-time measurements and hydrodynamic model output. The tool is built using a modern computing design that accesses data using open standards that are compliant with the Great Lakes Observing System (GLOS) Enterprise Architecture. For any selected beach, users can access historical and current data from state and federal sources including NOAA, USGS and EPA by configuring a data access profile. Locations of available data are displayed and chosen using a mapping interface. Data processing options such as moving averages, summations, and others are defined as needed for individual applications. Resulting data retrieval capabilities were defined specifically for development and operation of beach water-quality models, but are widely applicable for environmental data analysis and modeling.

BOOTSMA, H.A.[1], ZORN, M.[2], GRUNERT, B.K.[1], LATHAM, K.[1], HANSEN, T.[1], and KLUMP, V.[1], [1]Great Lakes WATER Institute, UW-Milwaukee School of Freshwater Sciences, Milwaukee, WI, 53204; [2]University of Wisconsin-Green Bay, Green Bay, WI. **GLOS Buoy Operations in Green Bay and Western Lake Michigan.**

Over the past decade a number of critical changes have occurred in the Lake Michigan and Green Bay ecosystems, including the expansion of invasive species such as the quagga mussel and the round goby, a decrease in plankton abundance, proliferation of nuisance algae, and changes in dissolved oxygen dynamics. Understanding the causes of these changes, and their consequences for ecosystem functioning, requires data with high temporal and spatial resolution. This is being done using a monitoring buoy in Green Bay (depth = 13 m) two buoys in Lake Michigan near Milwaukee (depths = 10 m and 20 m), and a monitoring system on a high-speed ferry. The buoys provide continuous meteorological and water quality data, including thermal structure and current profiles. The ferry system provides data on cross-lake spatial distribution of temperature, chlorophyll, and CO2. Administered through GLOS, data collection is currently used by researchers at the UW-Milwaukee Great Lakes WATER Institute to understand ecosystem dynamics at various temporal scales, and to calibrate / validate physical and biogeochemical models. Connections with NOAA and the NDBC are being created to allow live data feed, generated at half hour intervals, to appear on affiliated websites to allow further use by researchers and the public. *Keywords: Buoys, Green Bay, Lake Michigan.*

BOUDREAU, R.P., 22 Third Street, Nipigon, ON, P0T 2J0, Canada. **Lake Superior National Marine Conservation Area.**

Abstract: The Lake Superior National Marine Conservation Area (NMCA) at 10,850 sq km's will be the largest freshwater protected area in the world and is part of a nation-wide family of protected natural heritage places managed by Parks Canada. Parks Canada plans to have 29 NMCAs across Canada, including one in each of the Great Lakes. The objective of the program is to protect and conserve, for all time, marine areas that are representative of Canada's oceans and Great Lakes for the benefit, education and enjoyment of the world. We also intend to increase public understanding, enjoyment, and appreciation of Canada's marine heritage. An NMCA is managed for ecological sustainable use. This will require benchmarking biotic and abiotic components as we move forward in establishing Lake Superior NMCA. Parks Canada intends to develop partnerships with universities and colleges regarding research within the NMCA. Parks Canada's presentation will be focused on the Lake Superior NMCA - The history of it, why it was chosen, where we are now, and the steps in moving forward.
Keywords: Coastal ecosystems, Monitoring, Conservation.

BOUFFARD, D.[1], BOEGMAN, L.[1], and MOLOT, L.A.[2], [1]Queen's University, Kingston, ON, K7L 3N6; [2]York University, Toronto, ON, M3J 1P3. **Spatial and Temporal Variability of Phosphorus in Lake Simcoe as a Result of Hydrodynamic Circulation.**

In the past, excessive total phosphorus (TP) loads into Lake Simcoe, Canada, resulted in low hypolimnic dissolved oxygen (DO) concentration at the end of the stratified season. In recent years, a large effort has gone into predicting TP and DO concentration in the lake; however, the impact of the lake's circulation on the spatial and temporal variability of TP is still an ongoing question. We apply a simple phosphorus transport model (e.g. Schwab et al. JGLR 2009) to the temperature and current output of a 3-D hydrodynamic model (ELCOM). We validated our model against field measurements and output from a more sophisticated coupled 3D biochemical hydrodynamic model (ELCOM CAEDYM) for the years 2008 and 2009. Then, the simple transport model is used to estimate the influence of each individual TP source (tributaries, atmospheric deposition, septic systems and municipal water treatment plant effluents). This work is therefore intended to provide a simple tool for helping managers to improve Lake Simcoe's water quality. *Keywords: Lake Simcoe, Hydrodynamics, Phosphorus.*

BOURGEAU-CHAVEZ, L.L., SCARBROUGH, K.A., MILLER, M.E., BANDA, E.C., BATTAGLIA, M., LANDON, A.J., POWELL, R.B., and BROOKS, C.N., 3600 Green Court Suite 100, Ann Arbor, MI, 48105. **Mapping Coastal Great Lakes Wetlands and Adjacent Land use Through Hybrid Optical-Infrared and Radar Image Classification Techniques.**

A mapping effort is underway through GLRI funding to produce an international contemporary baseline map of wetland type, extent and adjacent land use in the Great Lakes Basin. This includes all area within 10 kilometers of the U.S. and Canadian coasts. Improved mapping and monitoring of the Great Lakes coastal wetlands will be achieved through a fusion of Synthetic Aperture Radar (SAR) and optical/infrared satellite imagery. The combination of

sensor frequencies complement one another in the identification of wetlands and adjacent land use. MTRI developed techniques to merge optical/IR and SAR for the mapping of Great Lakes coastal wetlands and adjacent land use in demonstration areas in 2004 for the Great Lakes Coastal Wetlands Consortium (GLCWC). That pilot study demonstrated the improved capabilities of merging multi-sensor SAR and Landsat data for better wetland condition monitoring. A significant database of Japanese ALOS-PALSAR imagery and field validation/training sites has already been constructed for use in monitoring Phragmites australis on the U.S. side of the Great Lakes coastal zone. These data will be combined with Landsat 5 data and new field collections to achieve the final mapped product. Hybrid algorithms are currently being refined through analysis of a series of pilot study areas. *Keywords: Invasive species, Land Cover Classification, Remote sensing, Coastal wetlands.*

BOUTIN, D., 2144 King West, room 010, Sherbrooke, QC, J1J 2E8. **The National Hydro Network (NHN) a Tool to Manage Water Resources.**

The National Hydro Network (NHN) focuses on providing a quality geometric description and a set of basic attributes describing Canada's inland surface waters. It provides geospatial vector data describing hydrographic features such as lakes, reservoirs, rivers, streams, canals, islands, obstacles and constructions, as well as a linear drainage network and the toponymic information (geographical names) associated to hydrography. The NHN forms the hydrographic layer of the GeoBase. The best available federal and provincial/territorial data are used for its production, which is done jointly by the federal government and interested provincial and territorial partners. The modeling work of the NHN is based in part on Linear referencing System (LRS) concepts. This approach allows the management of geometric representations separately from attribute information (referred to as events in LRS). Unique identifiers (called National Identifiers - NID), associated to each NHN feature, allow for efficient management of updates. The NHN is a vector, topographic data product primarily designed to allow hydrographic network analysis. It is intended for water flow analysis, water and watershed management, environmental and hydrographical applications, as well as for a multitude of cartographic applications. *Keywords: Decision making, Data acquisition, Spatial analysis.*

BOWEN, K.L., JOHANNSSON, O.E., and KARMI, S., Fisheries and Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **Consumption of *Bythotrephes longimanus* by *Mysis diluviana* and *Hemimysis anomala* in Lake Ontario.**

The invasive spiny water flea *Bythotrephes longimanus* (BL) has increased in Lake Ontario starting in 2004. The observed drop in zooplankton biomass in the 2000s may be in part related to this predator. Both the native shrimp *Mysis diluviana* (MD) and the invasive *Hemimysis anomala* (HA) may compete with BL for zooplankton prey, but this impact may be lessened if mysids can also prey on BL. Examination of MD guts collected August 2004 from SE Lake Ontario showed BL consumption rates of 4% in small MD (6-8 mm long), 0% in medium MD (9-11 mm) and 17% in large MD(>12 mm). In one-on-one lab experiments, MD as small as 6 mm and HA as small as 4 mm readily consumed BL. Lacking other prey, BL consumption was 67%, 84% and 79% for small, medium and large MD, respectively. When other zooplankton

prey was provided, corresponding rates dropped to 5%, 30% and 45%. Smaller BL were consumed more readily than larger animals. With no other food, BL consumption was 32% for medium HA (4-5mm), and 78% for large HA (≥6 mm). When alternate zooplankton prey were provided, no BL were eaten. This suggests that BL is not a preferred prey for either mysid species, although larger mysids are more willing to consume them. Further work needs to be done on field consumption rates at the high BL densities that occur in the fall.
Keywords: Predation, Bythotrephes longimanus, Invasive species, Mysids.

BOYER, G.L.[1], PERRI, K.A.[1], SULLIVAN, J.M.[1], HOTTO, A.H.[1], YANG, X.[1], SATCHWELL, M.F.[1], WILHELM, S.W.[2], and WATSON, S.B.[3], [1]Department of Chemistry, State University of New York, College of Environmental Science and Forestry, Syracuse, NY, 13210; [2]Department of Microbiology, The University of Tennessee, Knoxville, TN, 37996; [3]Environment Canada, National Water Research Institute, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **Toxic Cyanobacteria Blooms in Lake Ontario, NY: History and Current Status.**

Toxic blooms of cyanobacteria are commonly observed in the western basin of Lake Erie, Missisquoi Bay of Lake Champlain, and in the Bay of Quinte, Lake Ontario. During these blooms, hepatotoxic microcystin(s), or neurotoxins such as anatoxin-a, may be produced by one or more of several species of cyanobacteria. Most reports of cyanobacteria toxins in the Laurentian Great Lakes have focused on Lake Erie. Less is known about the occurrence of cyanotoxins in other lakes such as Lake Ontario. Starting in 2001, we have periodically sampled embayment, nearshore and offshore waters of Lake Ontario for the presence of cyanobacteria toxins. In general - the levels of observed toxins in these locations have been relatively low and rarely exceeded the WHO guidelines for drinking or recreational contact outside of Hamilton Harbor and Bay of Quinte. However this dramatically changed in 2010 and 2011 when high levels of microcystin toxins, exceeding 100 ug per liter in 2010, were observed in Greater Sodus Bay near Rochester. To our knowledge, this represents the single most toxic outbreak of cyanobacteria toxins in Lake Ontario. Here we provide a retrospective analysis of more than 10 years of data on the cyanobacteria toxin concentrations in Lake Ontario and on those environmental factors responsible for those blooms. *Keywords: Harmful algal blooms, Lake Ontario, Cyanophyta.*

BOZIMOWSKI, A.A.[1], MURRY, B.A.[1], and UZARSKI, D.G.[2], [1]Central Michigan University, Mount Pleasant, MI, 48859; [2]Institue for Great Lakes Research, Mount Pleasant, MI, 48859. **Invertebrate Co-occurrence Patterns in the Wetlands of Northern and Eastern Lake Michigan: the Interaction of the Harsh-Benign Hypothesis and Community Assembly Rules.**

Competition is presumed to underlie community assembly patterns and results in negative co-occurrence relationships; however, recent studies have found many groups of organisms (e.g. non-social invertebrates) actually show more co-occurrences than expected, suggesting a lower importance of competition in their community structure. Similarly, the harsh-benign hypothesis suggests that the level of competition varies with the amount of energy and level of disturbance present in the system. Great Lake Wetland Consortium monitoring sampled

invertebrates from wetlands throughout the Great Lakes Basin focusing on those from eastern Lake Michigan that generally experienced strong wave energy and those in northern Lake Michigan that generally experienced lower wave energy. Invertebrate abundance data identified to Genus were reformulated into presence-absence matrices and co-occurrence patterns were evaluated using a null model approach (*EcoSim 7.0* software). Data were analyzed at multiple taxonomic levels and within functional feeding groups to identify where competition is most significant. Co-occurrence patterns were influenced by the form of data aggregation (i.e. by taxonomic or functional groups) with only subtle differences related to wave energy. *Keywords: Coastal wetlands, Aquatic invertebrates, Assembly rules.*

BRAMBURGER, A.H.[1] and GAISER, E.E.[2], [1]St. Lawrence River Institute, Cornwall, ON; [2]Southeast Environmental Research Center, Florida International University, Miami, FL. **From Everglades to Alvars: Karstic Wetlands as Indicators of Environmental Change.**

Despite occurring across a wide gradient of climatic conditions, the diatom assemblages of karstic wetland systems within North America exhibit broad taxonomic similarity at large spatial scales. Taxa including *Mastagloia smithii* and *Fragilaria synegrotesca* complexes have been widely reported from wetland system ranging from tropical morasses in the Caribbean to coastal alvars in the Great Lakes Basin. Regional patterns of assemblage dissimilarity vary with latitude in these systems, and tropical assemblages exhibit lower degrees of similarity than their temperate counterparts. We examine the influences of stochastic mechanisms associated with geographic proximity and deterministic mechanisms including environmental differences and ecological specificity of taxa on assemblage dissimilarity along a latitudinal gradient. Preliminary results demonstrate that environmental differences exert a stronger influence on assemblage dissimilarity in tropical regions characterized by more ecologically specialized taxa, while geographic proximity is a more important structuring mechanism at higher latitudes characterized by generalist forms. We suggest that further investigation of these systems may provide insights into the potential effects of climate change on sensitive coastal alvar wetlands in the Great Lakes Basin.

BRANSON, D.R. and MCNAUGHT, A.S., Central Michigan University, Brooks Hall, Mt. Pleasant, MI, 48859. **Feeding Preferences of an Invasive Mysid, *Hemimysis anomala*, in Lake Michigan.**

Hemimysis anomala, a mysid from the Ponto-Caspian region, is a recent invader of the Great Lakes. In Europe where *H. anomala* has been introduced, significant changes in zooplankton abundance and diversity have been identified, however, little is known about *H. anomala's* feeding behavior. Trials were performed to determine the feeding rates, functional response, and prey preference of *H. anomala* for various species and sizes of zooplankton. *H. anomala* were collected at the Muskegon River mouth using either 30 cm net tows through swarms or bottle traps when no swarms were present. Specimens were maintained in 450 L Live Stream tanks and fed a maintenance diet of freeze-dried Artemia. Individual *H. anomala* were isolated in 600 ml beakers and starved for 24 hours. For functional response trials, prey densities of 20, 40, 60, and 80 per liter were used and surviving prey were counted at 4 and 6 hours. For

preference trials, *H. anomala* were provided prey items individually or as a 50/50 mixture at a density of 60 per liter. *H. anomala* exhibit high consumption rates, particularly in the dark, and varying functional response depending on the size, handling time, and mobility of prey. Trials demonstrate no preference for particular prey from those offered. *Keywords: Zooplankton, Invasive species, Trophic level.*

BRATTON, J.F.[1] and BASKARAN, M.[2], [1]NOAA-GLERL, 4840 South State Road, Ann Arbor, MI, 48108, U.S.A.; [2]Department of Geology, Wayne State University, 0224 Old Main, Detroit, MI, 48202, U.S.A.. **Recent Advances in Understanding of Biogeochemical and Hydrological Processes in the Great Lakes Basin Using Natural and Anthropogenic Tracers.**

The Great Lakes system includes large reservoirs of water in both groundwater and surface water. The region also contains thick lacustrine and fluvial sediments, widespread glacial deposits, Paleozoic sedimentary rock, and Precambrian crystalline rock. Economic deposits of oil, gas, salt, gypsum, limestone, and dolostone are found in the watersheds of the four lower Great Lakes, and a variety of metal ores are present in the Lake Superior watershed. Natural tracers that have been used successfully in recent years to study biogeochemical and hydrological processes in the Great Lakes system include stable isotopes (H, C, N, O, S), radionuclides (7-Be, 14-C, 210-Pb, 210-Po, 224-Ra, 226-Ra), gases (noble, biogenic, thermogenic), chloride, and phosphorus. Anthropogenic tracers have been applied to study transport and fate of elements and compounds of concern to human and environmental health, but they have also been used to track natural movements of water, air, and sediment. Examples of human-produced tracers include heavy metals (Cu, Pb), mercury, radionuclides (137-Cs), organic compounds (solvents, PCBs, PAHs, pesticides, fertilizers, personal care products, pharmaceuticals), gases (CFCs, sulfur hexafluoride), pathogenic microbes, and nutrients (P and N). Five recent examples of tracer-related studies will be reviewed. *Keywords: Microbiology, Hydrologic cycle, Groundwater, Radioisotopes, Tracers, Biogeochemistry.*

BREIDENBACH, V.K.S.[1], HERSHFIELD, M.J.[2], FRENCH, N.[2], DEPINTO, J.V.[3], and HOLMBERG, H.[4], [1]LimnoTech, 2828 Branch St, Duluth, MN, 55812; [2]Minnnesota Pollution Control Agency, 525 Lake Avenue South, Suite 400, Duluth, MN, 55802; [3]LimnoTech, 501 Avis Drive, Ann Arbor, MI, 48108; [4]LimnoTech, 2217 Vine Street, STE 205, Hudson, WI, 54016. **Developing an Implementation Framework for Delisting the St. Louis River AOC - And Beyond.**

The St. Louis River AOC is large and complex, with nine beneficial use impairments (BUIs) and a boundary straddling the Minnesota and Wisconsin state line. Many improvements have been accomplished since 1992 when the Stage I RAP was submitted. But lack of program funding has stymied coordinated, focused efforts to accomplish AOC delisting. Minnesota Pollution Control Agency is leading a GLRI-funded project to complete an integrated plan for delisting and managing the system into the future. Coordinators from trustee agencies, including a local tribe, are providing bi-state leadership together for the first time in AOC history. Stakeholder teams of local resource managers and experts are working together to develop plans to address each BUI. Part of their work involves scrutiny of the relationships between sources

and system stressors and selection of appropriate status indicators for monitoring progress and system health. The plan also employs the concept of Remediation to Restoration (R2R) for actions to address legacy contamination and habitat degradation in a manner that provides lasting ecosystem benefit for the future. The plan also provides a framework for adaptively managing the system as ecosystem goals and/or stressors change in the future. *Keywords: Management, Areas of Concern, St. Louis River.*

BRINSMEAD, J.K.[1], KOENIG, B.[1], DRAKE, D.A.R.[2], MANDRAK, N.E.[2], and COPPLESTONE, D.[1], [1]Ontario Ministry of Natural Resources, 300 Water Street, Peterborough, ON, K9J 8M5; [2]Fisheries and Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **One of These Things is not Like the Others - Prevalence of Non-target Species in Commercial Baitfish in Ontario.**

Commercial baitfish harvest and sale, and subsequent movement by anglers, are potential pathways for the spread of aquatic invasive species in Ontario. Pathways may also allow for movement of native fishes to watersheds where they are not currently found. Ontario bait harvesters and retailers use best management practices (HACCP plans) to reduce the prevalence of non-target species in commercial catches and retail tanks. We will compare the rate of occurrence of non-target fish species in commercial activities across two time periods: 2007/08 and 2011/12. We will also collect baseline data on the prevalence of invasive aquatic invertebrates and Asian fish tapeworm (*Bothriocephalus acheilognathi*) associated with commercial baitfish. Preliminary results from the fall 2011 sampling indicate that non-target fishes were found rarely (i.e., 30 non-target fishes out of a total 5723 fishes sampled; 5 of 29 sample events). Previous research indicates that low probabilities of occurrence are not trivial given the substantial number of fishing events (approx. 4.12 million/year) involving baitfish in Ontario. Results confirm that even low non-target species occurrences should continue to warrant management attention. *Keywords: Invasive species, Commercial, Risk assessment, Baitfish.*

BRODEUR, P.[1], MAILHOT, Y.[1], DUMONT, P.[2], VACHON, N.[2], MAGNAN, P.[3], and PARADIS, Y.[4], [1]Ministère des Ressources naturelles et de la Faune du Québec, 100 rue Laviolette, Bureau 207, Trois-Rivières, QC, G9A 5S9; [2]Ministère des Ressources naturelles et de la Faune du Québec, 201 Place Charles-Le Moyne, Longueuil, QC, J4K 2T5; [3]Université du Québec à Trois-Rivières, 3351, boul des Forges C.P. 500, Trois-Rivières, QC, G9A 5H7; [4]Ministère des Ressources naturelles et de la Faune du Québec, 880, Chemin Ste-Foy, Québec, QC, G1S 4X4. **Status of the Yellow Perch Stock and Fishery in Lake Saint-Pierre in 2012: Where do we go from here?**

In Lake Saint-Pierre (St. Lawrence River), historically important yellow perch commercial and sport fisheries were supported until the mid-1990's. High exploitation rates combined with poor recruitment during the 1988-1998 period led to a 70% decline in fish abundance and a three fold decline in the declared commercial catch. Despite of a major reduction of the commercial and sport fishing efforts since 1997, low recruitment persisted, the yellow perch stock gradually declined and finally collapsed. Since 1980, the seasonal growth of

young-of-the-year fish progressively decreased, leading to reduced energy reserves necessary to withstand winter mortality. The decline of habitat quality and benthic cyanobacteria proliferation in nursery areas contributed to a reduce food quantity, with an impairment of juvenile yellow perch growth and recruitment. Habitat changes also lead to changes in the fish community structure towards omnivorous benthic fish indicative of anthropogenic stress conditions. Among the other possible causes for poor recruitment are climate, low mature female abundance and predation by cormorants. Given that Lake Saint-Pierre is rapidly evolving under strong natural and anthropogenic pressures, the next management plan must include major measures to improve habitat quality as well as yellow perch restoration. *Keywords: Fisheries, Yellow perch, Habitats.*

BROFKA, W.A. and CZESNY, S.J., Illinois Natural History Survey, Prairie Research Institute, University of Illinois, Lake Michigan Biological Station, 400 17th Street, Zion, IL, 60099. **Illinois' Recreational Salmon and Trout Fishery in Lake Michigan, 1986-2010: Shifts through the Years.**

Sustainable salmonine fishery in Lake Michigan depends on delicate balance between population size which is driven by natural recruitment, stocking and sport harvest, and levels of available prey. An annual survey of the recreational fishery in Illinois waters of Lake Michigan is an integral part in this balance and has been conducted since 1986 to estimate angler effort, harvest, and biological data on harvested fish. Herein, we summarize data on directed fishing effort and harvest of salmonids over these twenty-five years, and discuss how fishing has been changing. Shifts both in the proportion of harvested species and in directed angler effort were evident during this time. Angler effort declined over time but has been relatively stable since 1999. Chinook salmon were an important component of this fishery in 1986 and 1987 but declined in 1988 with the onset of bacterial kidney disease. Even though the chinook salmon fishery began to recover in 1995 and at times since, has reached harvest levels similar to 1986-87, the Illinois salmonid fishery is dependent on coho salmon which was the single most harvested salmonid. The creel survey provides information for the Illinois Department of Natural Resources and other agencies that can help gauge the effectiveness of management policies on both a state and lakewide level. *Keywords: Fishing, Salmon, Creel survey, Lake Michigan.*

BRONNENHUBER, J.E., KIDD, A.G., REID, S.M., and WILSON, C.C., 2140 East Bank Dr., Peterborough, ON, K9J 7B8. **Testing the Efficacy of Environmental DNA Monitoring for Detecting Aquatic Invasive and Endangered Species in Ontario.**

Sensitive detection of invasive and endangered species is essential for implementing effective management strategies. In aquatic environments, detection of rare species can be further confounded by site accessibility, sampling gear, and capture efficiency, with direct observation being difficult at best. Discriminating between detection failure versus true absence can be problematic, but has significant management consequences. Long term monitoring programs would also benefit from an effective method to ascertain species presence and abundances. We assessed the efficacy of environmental DNA (eDNA) to detect the presence or true absence of freshwater species in a controlled environment, sampling water inflow and outflows at hierarchal spatial and temporal scales to quantify detection for known species

occurrences. Species-specific primers were used to amplify small fragments of the cytochrome c oxidase (COI) gene from mitochondrial DNA isolated from freshwater samples to assess 1) species-specific detection sensitivity, 2) spatial sensitivity of eDNA detection, and 3) quantitative sensitivity in controlled trials. Our results indicate that environmental DNA is a reliable method for species detection in freshwater systems and can be used as an effective sampling technique for detecting invasive and endangered freshwater species.
Keywords: Habitats, Early detection, Biomonitoring, Environmental DNA, Fish populations, Rare species.

BROOKS, C.N.[1], SAYERS, M.J.[1], SHUCHMAN, R.A.[1], AUER, M.T.[2], MEADOWS, G.A.[3], and JESSEE, N.L.[1], [1]MTRI, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [2]Michigan Technological University, 1400 Townsend Dr., Houghton, MI, 49931; [3]University of Michigan, College of Engineering-AOSS, Ann Arbor, MI, 48103. **Mapping Cladophora and Other Submerged Aquatic Vegetation in the Great lakes Using Satellite Imagery.**

We have developed a remote sensing algorithm to map the extent of Cladophora and related submerged aquatic vegetation (SAV) extent and biomass in the near-shore waters (0-15 meters depth) in the Great Lakes. The algorithm utilizes the visible bands of electro-optical satellites such as MODIS, MERIS, Landsat TM and commercial high-resolution satellite imagery from sources such as GeoEye and DigitalGlobe. The algorithm maps SAV using a depth-invariant bottom reflectance index and has been successfully tested on satellite data sets of varying resolutions in Lake Michigan where there is extensive lake truth on Cladophora extent and biomass. In Lake Michigan, the SAV is predominantly Cladophora, with localized areas of macrophytes, Chara, and diatoms. A time series analysis, both annually and seasonally, of Cladophora extent at Sleeping Bear Dunes National Lakeshore was also done using historical Landsat data. The area-weighted SAV biomass, calculated based on colonized substrate only, is 36 g Dry Weight/m2. This corresponds to a standing crop of 375,000 metric tonnes wet weight lakewide. The utility of mapping Cladophora using 1km MODIS or 330 meter MERIS data with its daily acquisitions is also compared to the results from the Landsat and commercial imagery.
Keywords: Cladophora, Algae, Remote sensing.

BROWN, B.L. and FARRELL, J.M., SUNY College of Environmental Science and Forestry, 241 Illick Hall, Syracuse, NY, 13210. **Restoring Connectivity in Coastal Wetland Habitats via Channel Creation in the Upper St. Lawrence River.**

Recent habitat and connectivity loss in the St. Lawrence River system is primarily attributed to water level regulation and the spread and dominance of invasive hybrid cattail (*T. X glauca*). Lack of access and wetland changes have influenced spawning habitat for potadromous fishes such as northern pike (*Esox lucius*), a top littoral predator in the system. We examine if an amphibious excavator can be used to reconnect habitats via channel creation by linking main channels with their remnant meadow marsh areas to enhance fish spawning habitat. The response of fish and riparian spawning habitat including wetland vegetation and seed bank response, predatory macroinvertebrates, temperature (ºC), dissolved oxygen (mg/L) and fish access given water levels were compared among sites with connectivity enhancements to natural reference

sites. Exposed floodplain sediments following excavation showed a positive response of beneficial native plants indicating seed bank viability. Use by 13 fish species was documented in created channels and northern pike production was observed. We conclude that connectivity enhancements show a positive initial success for fish and their critical habitat but projects are constrained by the system-wide effect of water levels management. *Keywords: Habitats, Connectivity, Wetlands, Restoration.*

BROWN, M., 1960 Scott St., Suite #301, Ottawa, ON, K1Z 8L8. **Ottawa River Health: Who is Paying Attention?**

The Ottawa River is 1271 km long and drains an area of 146,300 km^2. The River is the largest tributary of the St Lawrence River, and the health of the Ottawa River directly affects the health of the St Lawrence River. In the Ottawa River Watershed, it is evident that stresses are being placed on aquatic ecosystems. Beaches are often closed when water quality poses a health risk to swimmers, boil water advisories are common, many fish are contaminated to levels that make them unsafe for daily consumption and once abundant aquatic species are now classified as endangered. Given the number of jurisdictions and agencies with shared responsibility to manage water within the Ottawa River Watershed, it is no surprise that laws and regulations vary tremendously and are rarely harmonized and are not enforced consistently across the watershed. It may however come as a surprise that there is no management plan to determine priority research and action in the Ottawa River. As a first step towards developing a shared vision and protection plan for the Ottawa River, Ottawa Riverkeeper convened a one-day Ottawa River Summit. Ottawa Riverkeeper shares recommendations for next steps to govern and protect the ecological integrity of the Ottawa River. *Keywords: River health, Policy making, Governance, Management, Ottawa River, Non-governmental organizations.*

BROWN, R.S.[1], DUNKINSON, C.E.[1], ZHOU, J.J.[1], ASTON, W.P.[1], MARCOTTE, E.J.P.[2], RADCLIFFE, T.[2], GALLANT, P.J.[2], and WILTON, D.[2], [1]Dept. of Chemistry and School of Environmental Studies, Queen's University, Kingston, ON, K7L 3N6; [2]Endetec (Veolia Water Solutions and Technologies), Kingston, ON, K7L 3N6. **A New Technology for Rapid On-site Detection of *E. coli* for Beach Monitoring.**

We have developed a new detector for *Escherichia coli* bacteria that can be used on site with automated signal analysis. This new technology is rapid, yet simple to use with minimal user training. It has been certified for surface water by AOAC and demonstrated in a number of field site trials. A 100 mL sample is added to a single-use test cartridge containing a fluorogenic substrate to detect glucuronidase enzyme (the standard indicator for E. coli), growth medium and a polymer probe element. A fibre-optic-coupled optical system continuously monitors for fluorescence, produced from samples by extracting fluorescent product molecules into the polymer. Detection is insensitive to matrix interferences such as colour and turbidity, and no dilutions are required. The bacteria are quantified using the continuous signal and a growth kinetics model. Since detection in our system is automatic, the test can be done outside a laboratory environment by an operator with minimal training. Samples in the range of concern for beaches and other recreational activities are detected in 10-12 hours, while highly

contaminated samples are detected sooner. We are currently optimizing to reduce detection time by a further 2-4 hours. Lake Ontario samples are now being tested, and results compared with standard methods will be presented. *Keywords: Microbiological studies, Automated detection, Indicators, E. coli, Water quality, Recreational water quality.*

BRUSH, J.M.[1], POWER, M.[1], MARTY, J.[2], and SMOKOROWSKI, K.E.[3], [1]200 University Avenue East, Department of Biology, University of Waterloo, Waterloo, ON, N2L 3G1; [2]2 St. Lawrence Drive, St. Lawrence River Institute, Cornwall, ON, K6H 4Z1; [3]1219 Queen St. E., Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Sault Saint Marie, ON, P6A 2E5. **Food Web Responses to Variable Flow Regimes in Boreal Rivers.**

Dam construction and operation have significantly altered the physical habitat, community composition and the structure and function of food webs within river ecosystems. Thus, maintaining aquatic ecosystem integrity in light of growing demands for power generation represents a unique challenge for resource managers. The use of tools such as stable carbon ($\delta13C$) and nitrogen ($\delta15N$) isotopes can provide insights into how resource use by fishes and invertebrates and overall food web structure may be affected by variable flow regimes and ramping rate restriction changes. Variation in consumer stable isotope values, trophic position, and food chain length were examined in relation to flow variability over a 9 year period (2003-2011) in the altered Magpie River, Wawa, Ontario and unaltered Batchawana River, Sault Saint Marie, Ontario. Preliminary results from 2003-2006 indicate that following removal of ramping rate restrictions, food chain length shortened, reflecting potential changes in resource use or the degree of omnivory compared to years with restricted ramping. Such results must be considered in future management plans to ensure that modified flow regimes do not significantly alter feeding interactions and the composition and function of river food webs.
K*eywords: Hydrologic cycle, River, Food chains, Dam.*

BRUXER, J.K., 867 Lakeshore Road, Burlington, ON, L7R 4A6. **Evaluating the Feasibility and Impacts of Restoring Lake Michigan-Huron Water Levels.**

The International Upper Great Lakes Study conducted an exploratory analysis on the feasibility and impacts of restoring Lake Michigan-Huron water levels. Restoration in this case implies a permanent increase in Lake Michigan-Huron levels, relative to what they would otherwise be, to compensate for the lowering of lake levels due to episodic dredging and channel enlargement in the St. Clair River over the past 100 years. The Study examined restoring levels by increments of 10, 25, 40 and 50 cm using structures in the St. Clair River. Four previously proposed structures, as well as two relatively new technologies, were assessed for their ability to restore water levels. The positive and negative impacts of each restoration scenario on a number of key sectors in the upper Great Lakes, as well as the impacts in the St. Clair - Detroit River corridor, were evaluated. The resulting assessment revealed a mixture of benefits and costs, with navigation benefitting, shoreline damages increasing, and net hydropower losses. There is a trade-off between the positive ecological effects for the Georgian Bay region, especially its wetlands, and the uniformly negative ecological effects in the St. Clair - Detroit River system

that would result from any of the proposed restoration structures. Institutional considerations were also reviewed. *Keywords: Water level, Lake Michigan-Huron, St. Clair River, Restoration, Dredging.*

BURLAKOVA, L.E.[1], TULUMELLO, B.L.[2], KARATAYEV, A.Y.[1], and ZANATTA, D.T.[3], [1]Great Lakes Center, Buffalo State College, 1300 Elmwood Ave., Buffalo, NY, 14222; [2]Biology Department, Buffalo State College, 1300 Elmwood Ave., Buffalo, NY, 14222; [3]Biology Department, Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, MI, 48859. ***Dreissena* Impacts on Unionidae: Recent Trends in Lake Erie.**

Native freshwater mussels (Family: Unionidae) of the Great Lakes were heavily impacted by Ponto-Caspian zebra mussels in the 1980s and 1990s, resulting in dramatic decline in their diversity and density. However over the last 10 years the overall dreissenid density in Lake Erie has declined and zebra mussels have been almost completely replaced by quagga mussels. Considering the quagga mussels weaker attachment strength when compared to zebra mussels, we hypothesized that the adverse impact of dreissenids on unionids is now less than the early stages of the invasion. In the summer of 2011, we conducted extensive surveys of unionids in lakes Erie and St. Clair funded by the Great Lakes Fish and Wildlife Restoration Act, and recorded the number, weight, and species of dreissenids attached to unionids shells. Confirming our hypothesis, most of the unionids found were free of dreissenids. Infested unionids had tenfold fewer attached dreissenid mussels than in the early 1990s, and lower than the threshold number causing unionid mortality. Despite the quagga mussels' lake-wide dominance, zebra mussels were more often found on unionids, and their number and weight per host unionid were higher than those of quagga mussels. *Keywords: Mussels, Unionids, Dreissena, Lake Erie, Exotic species, Effect.*

BURROWS, M.J., International Joint Commission Great Lakes Regional Office, 100 Ouellette Ave., Windsor, ON, N9A 6T3, Canada. **Binational Aquatic Invasive Species Detection and Response - Assessment of Monitoring, Response and Planning Efforts.**

Aquatic Invasive Species (AIS) present one of the toughest challenges facing the Great Lakes basin. United States and Canadian initiatives aimed at preventing the introduction of AIS to the Great Lakes should continue to be a top priority; however it is in the best interests of the public and the Great Lakes to have a backup plan in case prevention efforts fail. Conducting a response to AIS in the boundary waters of the U.S. and Canada is complicated by many factors, including the multi-jurisdictional, binational nature of the landscape, a diverse range of threats and potential responses that can vary greatly depending on the organism invading. In 2009-2011 an International Joint Commission work group built on a 2009 binational AIS rapid response policy framework and made significant progress towards a workable binational response plan to help responders make well-informed decisions about actions for eradicating and/or stopping the spread of the AIS. The work group assessed programs geared towards early detection and risk assessment, response tools available to managers and the lessons learned from efforts to stop Asian carp from invading the Great Lakes. As a benefit of Great Lakes Restoration Initiative

(GLRI), funding the work group is on course to complete a pilot response plan in 2012. *Keywords: Assessments, Exotic species, Planning.*

BURROWS, M.J., International Joint Commission Great Lakes Regional Office, 100 Ouellette Ave., Windsor, ON, N9A 6T3, Canada. **The Great Lakes Association of Science Ships - A Grass Roots Effort to Foster Collaboration between Operators of U.S. and Canadian Science Ships.**

Great Lakes Science Ships are Government, research, and educational vessels dedicated to the study and exploration of the Great Lakes ecosystem. Former USGS-GLSC Director, Greg Smith, and former NOAA-GLERL Lab Director, Al Beeton, conceived and organized the first workshop to discuss concerns about the lack of profile and recognition for the aging Great Lakes research vessel fleet, the need to explore the ways and means of increasing funding for maintenance, upgrades and replacement, and the desire to improve utilization, cooperation and coordination. The workshops were binational from the outset and since the 1970's the Great Lakes Basin Commission, NOAA and the IJC have maintained a research vessel inventory, now found at www.CanAmGLASS.org. Over the years this grass roots effort has become the Great Lakes Association of Science Ships (GLASS), led by a steering committee representing the interests of the 40 different U.S. and Canadian agencies, universities, private and nonprofit organizations. Seeking greater efficiencies, utilizing new technology, encouraging modernization and expanding collaborative efforts are considered critical needs that must be addressed in order to meet the challenges of the future. GLASS seeks to expand its efforts to promote 100% utilization of vessels and best serve the needs of science. *Keywords: Research Vessels, Capacity, Research Coordination.*

BYER, J.D.[1], BROWN, R.S.[1], CASSELMAN, J.M.[1], HODSON, P.V.[1], ALAEE, M.[2], BACKUS, S.[2], KEIR, M.[2], PACEPAVICIUS, G.[2], LEBEUF, M.[3], TROTTIER, S.[3], RAACH, M.[3], and ST-PIERRE, S.[3], [1]Queen's University, Chemistry, Biology and Env. Studies, Kingston, ON, K7L 3N6; [2]Environment Canada, Burlington, ON, L7R 4A6; [3]Fisheries and Oceans Canada, Mont Joli, QC, G5H 3Z4. **Spatial and Temporal Trends of Dioxin like Compounds in American Eels.**

Over the past three decades eel populations (*Anguillid sp.*) have undergone severe decline. Several hypotheses have been put forward to explain these declines; among them, the possibility of persistent organic pollutants affecting recruitment. i.e., early-life stage embryo toxicity from maternally derived dioxin-like compounds (DLCs) that bioaccumulated in eels during their growth and maturation. In this presentation we focus on spatial and temporal trends of polychlorinated dibenzo-p-dioxins and dibenzofurans and dioxin-like polychlorinated biphenyls (PCBs) in American eels (*Anguilla rostrata*) collected from Lake Ontario in 1988, 1998 and 2008, and spatial samples collected from seven locations in Canada between 2007 and 2009, one location in the United States, as well as European eel (*Anguilla anguilla*) from one location in Belgium, used as a positive control. The goal was to assess the past and current risk of the above mentioned DLCs to eels. A decline in concentrations of DLCs was observed between 1988, 1998 and 2008. Also, an east to west gradient was observed in concentration of

DLCs from Lake Ontario to the Gulf of St. Lawrence. Results from this study correlated well with the embryo- toxicity assays reported by Hodson *et al.* in this symposium.
Keywords: Priority pollutants, Americal Eel, Chemical analysis, Dioxin-like compounds, Environmental contaminants, Co-planar PCBs.

CABANA, G.[1], PARADIS, Y.[2], GLEMET, H.[1], and MINGELBIER, M.[2], [1]Centre de Recherche sur les Interactions entre Bassins Versants et Écosystèmes Aquatiques (RIVE), Université du Québec à Trois-Rivières, Trois-Rivières, QC, G9A 5H7; [2]Service de la faune aquatique, Direction de l'expertise sur la faune et ses habitats, Ministère des Ressources Naturelles et de la Faune, Québec, QC, G1S 4X4. **Measuring Trophic Linkages and Duration of Exposure of Large Mobile Fish to Municipal Effluents using N isotopes.**

Ecotoxicological studies of contaminants released by municipalities have commonly used small organisms with low mobility collected at strategic sites to characterize their effects on aquatic ecosystems. Investigating contaminant bioaccumulation in larger, more mobile species, such as piscivorous fish, is more problematic since the length of time free-ranging individuals are exposed to the effluent is unknown. The incorporation of particulate organic matter from sewage (SPOM) released from sewage treatment plants into aquatic food webs has been shown to be traceable with nitrogen stable isotopes ($\delta15N$). Using a multiple-tissue approach (muscle, fin, and blood) which enables to distinguish long- from short-term trophic linkage to SPOM, we analyzed the $\delta15N$ of walleye, and other large species over 100 km reaches of the St-Lawrence River up- and downstream of the effluent of Montreal. Fish $\delta15N$ were systematically lower at the effluent site compared to all other sites, indicating a strong trophic connection to SPOM. However, a very high variance in $\delta15N$ in all species indicated that some individuals were long-term residents (both long and rapid-turnover tissues near equilibrium with SPOM), while others had been at the effluent site only recently (only the rapid-turnover tissue showing lower $\delta15N$).

CALDWELL, R.J. and FAY, D.M., Environment Canada, 111 Water St E, Cornwall, ON, K6H 6S2. **Simulation of Recent Lake Ontario Outflow Regulation Using Plan Bv7.**

After a half century of Lake Ontario regulation with Plan 1958-D, the IJC is proposing a new, balanced approach to regulating flows that would help create more natural water levels in the lake and upper river while continuing to provide substantial benefits and protections. More natural Lake Ontario levels and flows should help restore diversity to wetland habitats that has been lost over the past 50 years. But these more variable levels may also reduce the benefits enjoyed by some stakeholders. To demonstrate the effects on levels and flows of the proposed approach, water release decisions were simulated from 2001 through present to compare results with actual conditions. The need for Control Board intervention through deviations (and within-week flow adjustments) relative to Plan flows was much less frequent and generally of lesser magnitude. Flows tended to be less varied. The range of weekly Lake Ontario levels would have expanded 30 cm and the lake averaged 7 cm higher, and would have peaked 22 cm higher in 2011. Levels downstream of Cornwall/Massena would have changed little. *Keywords: Lake Ontario, Water level, Regulations.*

CARLSON, D.M.[1] and MCKENNA, J.E.[2], [1]NYSDEC, Watertown, NY; [2]USGS, 3075 Gracie Rd., Cortland, NY. **Comparison of Fishes in Nearshore Areas of the St. Lawrence River, New York, over 35 years.**

Near shore fish catches from the St. Lawrence River of New York in each 1976 and 2009-10 showed some striking differences. Each study was intended for purposes beyond this comparison, but both sampled the shore and island areas from Cape Vincent to the Quebec border. The most commonly caught species in both years was yellow perch, while the next most common species were highly dissimilar between the two studies. Round goby has apparently displaced tessellated darter in these shallow zones in recent times, and bluntnose minnow was commonly caught in both periods. Spottail shiner and fallfish were much less commonly caught in the recent period than in 1976. Shiners known to be associated with submerged aquatic vegetation and also to be sensitive to environmental disturbances (bridle shiner, blackchin shiner, blacknose shiner and pugnose shiner) were well represented in both periods. This simple comparison of results highlights temporal changes in fish community composition, but directed studies are needed to determine the likely causes of those changes.

CARLSON MAZUR, M.L.[1], FITZPATRICK, F.A.[2], AMOROSO, N.A.[3], GRANNEMAN, J.[3], ALLEN, J.D.[3], BENNION, D.H.[3], and GAUGUSH, R.F.[4], [1]Boston College / Devlin 213, 140 Commonwealth Ave, Chestnut Hill, MA, 02467; [2]USGS Wisconsin Water Science Center, 8505 Research Way, Middleton, WI, 53562; [3]USGS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105; [4]USGS Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Road, La Crosse, WI, 54603. **Understanding Hydrogeomorphic Influences on Rivermouth Ecosystem Structure.**

The hydrodynamics of Great Lakes rivermouth ecosystems, where river and lake waters collide, shape geomorphic and habitat structure. The specifics of these dynamics, however, are poorly understood. An improved scientific framework characterizing these processes across a wide disturbance gradient is needed to enable more successful conservation, management, and restoration of these coastal areas that provide critical habitat for fish and other biota. To this end, a multidisciplinary team of scientists is examining hydrogeomorphic structure and lake-tributary mixing in three Lake Michigan rivermouths using conceptual modeling, water chemistry analysis, stable isotope analysis, and water-level monitoring. Results from the first year of the study show that bidirectional mixing occurs between lake and river water, with river water predominantly stratified atop lake water. The extent to which lake water influences the upstream river channel is site-specific and may depend on the river gradient, flow regime, and connectivity with the Great Lake. *Keywords: Coastal ecosystems, Hydrogeomorphology, Habitats.*

CARPENTER, D., BOYSEN, E., and BEJANKIWAR, R.S., 100 Ouellette Avenue, 8th Floor, Windsor, ON, N9A 6T3. **Risks and Benefits of Fish Consumption.**

During 2009-2011, the Science Advisory Board of the International Joint Commission conducted a study that assessed the risks and benefits of consuming Great Lakes fish. During the

investigation the work group found that 7-8% of people in the Great Lakes basin consumed the Great Lakes Sport Caught Fish. Another study then showed that a significant proportion of the Great Lakes residents are at risk for developing illness that are from environmental toxins that are being carried by the fish. These environmental toxins are caused by anthropomorphic activities that are producing toxins into this fragile environment. These Toxins that are found in the Great Lakes include persistent organic pollutants, DDT and Mercury. All these pollutants have and are known to cause effects to the human body such as infertility. But there are still benefits to the human body that come from eating Fish. Fish are a great source of Fatty Acids such as Omega 3. They also have high amounts of DHA/EPA which are known for lowering blood pressure. The work group concluded that monitoring of the persistent pollutants by taking sample fish from each lake for identification along with more research on the long term effects on the health of individuals that eats these fish is still needed. *Keywords: Fish toxins, Ecosystem health, Risks.*

CARR, J. and ROWAN, D.J., Atomic Energy of Canada Ltd., Chalk River Laboratories, Chalk River, ON, K0J 1J0. **The Distribution and Abundance of Hexagenia in the Ottawa River at Chalk River Laboratories.**

The Ottawa River has received nuclear reactor effluent from Chalk River Laboratories for more than 60 years, including releases from a partial core meltdown in 1952. Recent interest in the potential impact of these historical releases and the possible need for remediation of a small region immediately downstream from the release point has led to comprehensive studies to assess ecological risk. In this paper, we present the results of an extensive survey of *Hexagenia* distribution and abundance in the Ottawa River in the vicinity of the Chalk River Site. By comparing *Hexagenia* frequency of occurrence and abundance between different depth and sediment zones and among upstream, downstream and reactor outfall sites, we found no significant differences in occurrence or abundance among sites. Our results suggest that contamination near the reactor outfall or other areas where reactor derived radionuclides are found in the Ottawa River near Chalk River Laboratories has no significant impact on *Hexagenia* occurrence or abundance. Thus, over 65 years of radionuclide releases from reactors at the Chalk River Site and the accumulation of reactor derived radionuclides in sediments do not have a significant adverse effect on the population of a highly sensitive benthic invertebrate, *Hexagenia*. *Keywords: Radioisotopes, Risk assessment, Benthos.*

CARRICK, H.J.[1], SCANLAN, A.[2], WECKMAN, G.[3], and MILLIE, D.[3], [1]Dept. of Biology & Institute for Great Lakes Research, Central Michigan University, Mt. Pleasant, MI, 48859; [2]Dept. of Biology and Health Sciences, University of Pittsburgh, Bradford, PA, 16701; [3]Department of Industrial and Systems Engineering, Ohio University, Athens, OH, 45701; [4]Florida Institute of Oceanography, University of South Florida, St. Petersburg, FL, 33701. **Evidence for Ecological Thresholds: Abrupt Changes in Stream Diatoms along Both Experiment and Environmental Gradients.**

Variation in watershed land use can influence stream biogeochemical, although few studies have evaluated variation as it relates to specific thresholds in land use and nutrients. We

tested the hypothesis that benthic biofilms change abruptly as a function of watershed forest cover. To test this, we conducted seasonal sampling (spring, summer, and fall of 2005-06) in 43 third order streams in the Chesapeake Bay watershed. Stream biogeochemical conditions (28 variables), benthic chlorophyll concentrations, and the relative abundance of diatom were measured in each stream. Watershed forest cover explained significant variation in chlorophyll (stepwise linear regression, $r^2 = 39.2\%$) as selected from a set of relevant variables (TN, TP, % Forest cover, % Agriculture, and stream temperature). Benthic chlorophyll and nutrient tolerant diatom guilds had a negative correlation with forest cover, while nutrient sensitive diatom species had a positive correlation. Regression tree analysis indicated abrupt changes in chlorophyll and diatom guild at thresholds of 60% and 82% forest cover. Despite the correlative nature of this study, the findings here suggest individual ecosystems may exhibit abrupt changes in ecosystem function following declines in forest cover, particularly at the thresholds identified herein.

CARSON, M., MATISOFF, G., and PILASKY, N., Case Western Reserve University-Department of Earth, Environmental and Planetary Sciences, 10900 Euclid Ave., Cleveland, OH, 44106. **Suspended Sediment Sources, Resuspension and Nutrient Depositional Fluxes in Lake Erie.**

A decline in water quality in Lake Erie during the last decade, despite increased effort to limit nutrient loading, may be better understood by examining internal processes in the lake. We employed 7Be, 210Pb and 137Cs measurements of suspended matter in tributaries and in the lake water column, in atmospheric precipitation, in sediment traps and in bottom sediments collected in June and August/September 2011 to estimate the fraction of the suspended matter that is resuspended from the bottom. The 7Be/210Pb ratio for each sediment source was used in a two-component mass balance model and indicated that resuspension of bottom sediment generally accounted for more than 70% of the suspended material and was greater after the fall overturn and at the nearshore sites. Sediment trap material indicated that at the nearshore site ~94% of suspended matter in the water column was resuspended bottom sediment, while, offshore, resuspended sediment made up only ~87%. In addition, 210Pb and 137Cs dating and nutrient analyses of an offshore core indicated that there has been a general increase in the depositional flux of nitrogen (from ~0.30mg/cm2/y to ~0.60mg/cm2/y) over the last 80 years but no substantial change in the depositional flux of phosphorus (mean=0.14mg/cm2/y) was observed. *Keywords: Lake Erie, Radioisotopes, Mass balance, Nutrients.*

CARTWRIGHT, L.A.[1], CVETKOVIC, M.[1], TOZER, D.C.[2], and CHOW-FRASER, P.[1], [1]Biology Dept., McMaster University, 1280 Main St. West, Hamilton, ON, L8S 4K1; [2]Bird Studies Canada, 115 Front St., Port Rowan, ON, N0E 1E0. **The Importance of Volunteer Training and Avian Identification Ability on the Results of Great Lakes Marsh Monitoring Program Bird Surveys.**

Volunteer monitoring contributes important information for managers, often at large scales that would be impossible otherwise. Despite the advantages, citizens typically lack experience identifying and estimating numbers of the species they monitor. The objectives of this

study were to 1) assess the effectiveness of training in improving volunteer avian identification ability and 2) determine how volunteer avian identification ability affects the results of Bird Studies Canada's Marsh Monitoring Program (MMP) bird surveys. The use of training materials improved identification ability on self-administered tests by 11-25 percent. In the field, avian identification ability did not significantly affect total bird abundance or species richness, but species composition differed depending on identification ability. Volunteers of lower ability detected more obligate marsh bird species and this affected the Index of Biotic Integrity (IBI) scores calculated at one of the sites. When the IBI scores were pooled for all volunteers, the data accurately reflected the degree of disturbance at each site. These results suggest volunteers of varying abilities can contribute useful information on MMP surveys, but that caution should be taken when calculating IBIs for marshes based on data gathered by a single volunteer of unknown ability. *Keywords: Avian ecology, Monitoring, Bioindicators.*

CASTANEDA, R.[1], SIMARD, A.[2], and RICCIARDI, A.[1], [1]Redpath Museum, McGill University, Montreal, QC, H3A 2K6; [2]Ministère des ressources naturelles et de la faune, 880 chemin Sainte-Foy, Quebec, QC, G1S 4X4. **Distribution, Abundance and Condition of the Asian Clam (*Corbicula fluminea*) along a Thermal Gradient in the St-Lawrence River.**

The Asian clam *Corbicula fluminea* - one of the world's most invasive bivalves - was introduced to North America from Asia in the early 19th century and has since spread to many watersheds in the United States, South America and Europe. Although the clam's physiological requirements are thought to restrict its distribution to habitats where water temperatures exceed 2ºC, it has been detected in north temperate regions where waterbodies are artificially heated and recently in Lake George (N.Y) where they are exposed to freezing temperatures during winter. In November 2009, a population of the Asian clam was discovered in the St. Lawrence River in the thermal discharge plume of the Gentilly-2 power plant. During June-August 2011, sampling of the benthic community of the thermal plume at Gentilly was conducted to determine the distribution, abundance and condition of the Asian clam population. Benthic grabs were taken at sites inside and outside the thermal plume to test the following hypotheses: 1) *C. fluminea*'s occurrence is restricted to sites within the plume, and 2) its abundance and condition declines with distance from the discharge source. Initial results indicate a thriving population at densities comparable to other invaded rivers. *Keywords: Invasive species, Mollusks, St. Lawrence River.*

CHAFFIN, J.D. and BRIDGEMAN, T.B., University of Toledo, Lake Erie Center& Dept Environmental Sciences, Toledo, OH, 43606, United States. **The Re-eutrophication of Lake Erie: Should We Target Nitrogen?**

Western Lake Erie, especially Maumee Bay (MB) has experienced re-eutrophication in recent years. High phosphorus (P) loadings need to be reduced but reducing nitrogen (N) may further control eutrophication. To test this hypothesis, nutrient dilution assays were conducted with MB water during summer 2011. MB water containing known concentrations of phytoplankton and nutrients was diluted with filtered (phytoplankton removed) low-nutrient central basin water and/or filtered MB water, thereby reducing both P and N (-PN). Mixtures of filtered MB and central basin water were used to create gradients of P and N (n=10). Further, N

was added back to a set to test for the effect of P-only reduction (-P) while P added to another set for the N-only reduction effect (-N). This experiment allowed comparing the effects of P-only reduction to P and N reduction. Growth rate plotted against P for -P and -PN resulted in similar growth curves in all experiments with maximum growth reduced by 83% at the lowest P concentration. Growth rate was reduced only by 37% in the -N set, which had excess P. These results suggest that reducing N concentration will not augment P reduction, or suggest that in order for N to slow eutrophication, N needs to be lower than N obtained in this experiment. *Keywords: Eutrophication, Nutrients, Phytoplankton.*

CHAMPOUX, L., Science and Technology Branch, Environment Canada, 801-1550 avenue d'Estimauville, Quebec, QC, G1J 0C3. **Trends in Contaminants in the Great Blue Heron along the St. Lawrence River.**

Colonial waterbirds are widely used as bioindicators of ecosystem health because they can accumulate high levels of persistent and bioaccumulative contaminants. This was one of the reasons that the great blue heron (*Ardea herodias*) was selected as a sentinel species for monitoring the state of the St. Lawrence River and the Gulf of St. Lawrence in Québec, Canada. As part of this monitoring, selected great blue heron colonies along the St. Lawrence River and its estuary were visited at five year intervals from 1991 to 2011, to collect eggs as well as blood samples from juveniles. Contaminant analyses were conducted at Environment Canada's National Wildlife Research Centre (NWRC, Ottawa). Contaminants measured included mercury, PCBs, organochlorines and more recently, brominated flame retardants. When data from all colonies were taken together, mercury, PCBs and DDT in eggs showed significant decreases. However, when colonies are considered individually, those trends often disappeared. Contaminant trends in plasma from juvenile birds show more spatial variability than do the trends seen in the eggs. *Keywords: St. Lawrence River, Great Blue Heron, Bioindicators, Environmental contaminants.*

CHAN, F.[2], BAILEY, S.A.[1], ELLIS, S.M.[1], BRONNENHUBER, J.E.[1], BRADIE, J.N.[1], and SIMARD, N.[3], [1]1Great Lakes Laboratory for Fisheries and Aquatic Sciences, 867 Lakeshore Road, Burlington, ON, L7R 4A6; [2]University of Windsor - GLIER, 401 Sunset Ave, Windsor, ON, N9B 3P4; [3]Institut Maurice-Lamontagne, 850 Route de la Mer, Mont-Joli, QC, G5H 3Z4. **Risk Assessment for Ship-Mediated Introductions of Aquatic Nonindigenous Species to the Great Lakes and St. Lawrence River Region.**

The Great Lakes, where over 182 aquatic nonindigenous species (NIS) have established, is one of the most highly invaded ecosystems globally. The majority of these NIS are the result of unintentional introductions via ballast water discharge. We conducted a relative risk assessment for the two major shipping vectors (ballast water and hull fouling) to freshwater ports in the Great Lakes and the St. Lawrence River (GLSLR). First, the probability of introduction was estimated by combining the individual probabilities of successful transition through each stage of the invasion process (i.e., arrival, survival and establishment) based on ship arrival/ballast water discharge data and environmental conditions at GLSLR and potential donor ports. Second, the potential magnitude of impact of introduction was estimated based on the

number of high impact ship-mediated NIS recorded for ecoregions of ports directly connected to GLSLR ports through shipping activities. The probability of introduction and potential magnitude of consequences were then combined for a final relative invasion risk rating. Our study highlighted Montreal, Québec; Québec City, Québec and Duluth-Superior, Minnesota for hull-mediated invasion risk, and Duluth-Superior, Minnesota, Québec City, Québec and Montréal, Québec for ballast-mediated invasion risk. *Keywords: Ballast, Hull fouling, Invasive species, Freshwater ports.*

CHANG, F.C.[1], PAGANO, J.J.[2], CRIMMINS, B.S.[1], MILLIGAN, M.S.[3], XIA, X.[1], HOPKE, P.K.[1], and HOLSEN, T.M.[1], [1]Clarkson University, CEE Box 5710, Potsdam, NY, 13699; [2]SUNY Oswego, Oswego, NY, 13126; [3]SUNY Fredonia, Fredonia, NY, 14063. **Temporal Trends of Polychlorinated Biphenyls and Organochlorine Pesticides in Great Lakes Fish, 1999-2009.**

Temporal trend analysis of the latest Great Lake Fish Monitoring and Surveillance Program (GLFMSP) data showed statistically significant decreases in persistent bioaccumulative and toxic (PBT) contaminants (polychlorinated biphenyls (PCBs), dichloro-diphenyl-trichlorethane and its metabolites (DDTs), dieldrin, cis-chlordane, oxychlordane , cis-nonachlor) concentrations in Lakes Huron, Ontario, and Michigan lake trout over the period of 1999 to 2009. In contrast, for most contaminants no statistically significant concentration trends were found in top predator fish in Lakes Superior and Erie during the same period. For Lakes Huron, Ontario, and Michigan a $5.0 \pm 2.6\%$ average annual concentration decreases were found for PCBs, DDTs, dieldrin, and other organochlorine pesticides (OCs) decreased at a faster rate, ranging from $10 \pm 4.3\%$ to $20 \pm 7.1\%$ per year. For these three lakes, with the exception of PCBs, these current decreases are greater than were shown by an earlier trends analysis that estimated an annual contaminant decrease of about 2-5% for the period of 1980 to 2003. For Lakes Superior and Erie, the finding of no statistically significant trend is in agreement with what has been previously reported for these lakes. *Keywords: Bioaccumulation, Fish toxins, Lake trout.*

CHANG, F.C., CRIMMINS, B.S., and HOLSEN, T.M., 8 Clarkson Avenue, Potsdam, NY, 13699. **A Novel Method to Determine Fatty Acid Levels in the Great Lakes Fish.**

An online derivatization method was developed to determine fatty acid (FA) concentrations in Great Lakes Fish as part of the Great Lake Fish Monitoring and Surveillance Program. Fatty acid analysis by gas chromatography is typically performed by extracting the fish matrix with organic solvent. The solvent is then evaporated to near dryness. The residue is then derivatized to a methyl ester and partitioned into a nonpolar solvent prior to analysis on a gas chromatograph (GC). A new method has been developed that automates sample preparation using Agilent 7890 GC equipped with 7693 autosampler. The new method eliminated the manual manipulation of the extracts beyond bulk extraction. Specifically, internal standard addition, derivatization, and solvent partition are all performed using on the instrument. The method precision and accuracy was validated using NIST Lake Trout Standard Reference Materials

(SRM 1946 and 1947). This paper will present these results. *Keywords: Fatty acids, Great Lakes Fish.*

CHAPRA, S.C.[1] and DOLAN, D.M.[2], [1]Civil & Environ. Engineering, Tufts University, Medford, MA, 02155; [2]Natural and Applied Sciences (Statistics), University of Wisconsin Green Bay, Green Bay, WI, 54311. **GL2K: A Mass-Balance Modeling Framework for Simulating Long-Term Trends of Great Lakes Water Quality.**

GL2K is a water quality model to simulate long-term trends of total phosphorus (TP) and conservative ions for the North American Great Lakes. It is based on an approach originally developed in the 1970s in which an annual time scale is adopted and major parts of the Great Lakes are idealized as well-mixed segments. Whereas Lake Ontario is represented as a single well-mixed system, the main bodies of lakes Michigan, Huron and Erie are divided into segments to better capture horizontal gradients. In the same spirit, Whitefish Bay is treated as a separate segment in order to better capture the concentrations leaving Lake Superior via the St. Marys River. In addition, the major embayments, Green Bay, North Channel, Georgian Bay, and Saginaw Bay, are represented by segments. Saginaw and Green Bay are further divided into several subsegments to better represent observed gradients. GL2K is implemented within the Microsoft Windows environment. Excel is used as the graphical user interface and all interface operations are programmed in the Microsoft Office macro language: Visual Basic for Applications (VBA). All coding is open source and the model is available for general use. A long-term simulation of TP trends from 1800 to 2010 is used to illustrate the model's use. *Keywords: Eutrophication, Phosphorus, Mathematical models.*

CHAPRA, S.C.[1], DOVE, A.[2], and DOLAN, D.M.[3], [1]Civil & Environ. Engineering, Tufts University, Medford, MA, 02155, USA; [2]Water Quality Monitoring and Surveillance Ontario, Environment Canada, Burlington, ON, L7R 4A6, USA; [3]Natural and Applied Sciences (Statistics), University of Wisconsin-Green Bay, Green Bay, WI, 54311, USA. **Analysis of Interlake Mass Loading Trends of Major Ions and Nutrients via Great Lakes Interconnecting Channels.**

Trends of loading rates (mass per time) are assessed using both data and a mass-balance model (GL2K) for salts and nutrients carried between the Great Lakes via major interconnecting channels and outflows. Although all interconnecting channels and outflows are assessed, major emphasis is devoted to transport into (Niagara River and Welland Canal) and out of Lake Ontario (St. Lawrence River). In the same spirit, although all major ions and nutrient species have been assessed, this presentation focuses on chloride and total phosphorus. The loading rates are computed as the product of outflow and concentration. Wherever possible, the latter is based on direct measurements in the interconnecting channel. Where this is not possible, in-lake concentration measurements are employed. The analysis indicates that all interlake mass transfers of TP via connecting channels have dropped since phosphorus control measures were implemented beginning in the mid-1970s. *Keywords: Nutrients, Connecting channels, Niagara River, Salts, St. Lawrence River.*

CHEN, M.[1], LUPI, F.[1], KAPLOWITZ, M.[2], and WEICKSEL, S.[1], [1]Dept. of Ag., Food & Resource Economics, Agriculture Hall, Michigan State University, East Lansing, MI, 48824-1024; [2]CARRS, Natural Resources Bldg., MSU, East Lansing, MI, 48824. **Great Lakes Beaches: Who Goes and How Often?**

Despite the importance of Great Lakes beaches, there is little information on the quantity of visits and the types of people that visit Great Lakes beaches. For example, although the National Survey on Recreation and the Environment contains information on beach uses, it does not distinguish between inland waters and Great Lakes. To address this gap, a mail survey was sent to a random sample of Michigan residents, and 11,028 surveys were returned for a response rate of 37%. Our objective was to study participation in a broad range of recreation and leisure activities in Michigan. The questionnaire included items about Great Lakes beach visits. Our results show that more people visited Great Lakes beaches in 2011 than went fishing or boating on the Great Lakes. We create a demographic profile of Great Lake beachgoers which shows, among other findings, that Great Lakes beach visitors are significantly ($p<0.01$) more likely to be younger, to be employed full-time, to be white, to have higher education and to have higher income. Our results provide resource managers with information on the quantity of beach visits as well as the demographic characteristics of those who do and do not visit Great Lakes beaches. *Keywords: Human dimensions, Visits, Beaches.*

CHERWATY-PERGENTILE, S.L.[1], TEPAS, K.[2], STADLER-SALT, N.A.[1], and HORVATIN, P.[3], [1]867 Lakeshore Rd., Burlington, ON, L7R 4A6; [2]77 W. Jackson Blvd. (G-17J), Chicago, IL, 60604; [3]77. W. Jackson Blvd. (G-17J), Chicago, IL, 60604. **The Success of SOLEC and State of the Great Lakes Reporting.**

Since 1994 the State of the Lakes Ecosystem Conference (SOLEC) and State of the Great Lakes reports, lead by Environment Canada and U.S. Environmental Protection Agency, have been using indicators to transfer science-based information to Great Lakes decision-makers and the public. The approach and products continually evolve in response to lessons learned, changes in priorities and monitoring programs, and feedback from the Great Lakes community. During SOLEC 2011 a new reporting format was used to describe the current conditions and trends of the Great Lakes ecosystem. The approach focussed on ten stories that represented a change in the ecosystem and/or issues that impact people's well-being. In response, 99 % of the conference participants, including representatives from all levels of government, industry, NGOs, and tribes indicated that they would use the information from SOLEC 2011 in their work activities. This presentation will share key lessons learned, challenges and successes from within the SOLEC process and the varied approaches used by organizers to communicate Great Lakes science to assist and enable environmental managers to make well-informed decisions. *Keywords: Great Lakes basin, Indicators, Education.*

CHIANDET, A.S. and SHERMAN, R.K., Severn Sound Environmental Association, 67 Fourth St, Midland, ON, L4R 3S9. **Long Term Changes in the Phytoplankton Community of Severn Sound in Response to Environmental Change.**

Severn Sound, a series of bays in southeastern Georgian Bay, was listed as an Area of Concern in the Great Lakes due to eutrophication. Through watershed-based remedial action, conditions in the Sound improved and it was delisted as an Area of Concern in 2003. One such improvement was a dramatic reduction in algal biovolume. To assess community level changes over the past 39 years, algae was sampled over the ice-free period at 5 long term stations (3 deep (>8m) & 2 shallow (<5m)). Total biovolume decreased significantly at all stations. At all but the shallowest station, relative chrysophyte biovolume increased over the last 10 years. All stations showed an increase in mixotrophic chrysophytes in particular. This change is consistent with what has been observed in other South-Central Ontario lakes. Multivariate analysis showed factors, such as reduction in phosphorus loadings, nutrient concentrations and temperature, to be important in shaping the phytoplankton community. Infestation of zebra mussels also coincided with a dramatic reduction in total biovolume, and shifts in community composition (e.g. increases in Microcystis). Understanding drivers of community change is essential in enabling us to predict impacts of future stress, such as changes in climate and nutrient loading, on the algae community. *Keywords: Eutrophication, Trophic level, Phytoplankton.*

CHOI, J.M.[1], TROY, C.D.[1], HAWLEY, N.[2], and MCCORMICK, M.J.[3], [1]Purdue University, Civil Engineering, West Lafayette; [2]NOAA / GLERL, Ann Arbor; [3]CILER, Ann Arbor. **Seasonal Variation of Poincaré Waves and Vortex Mode in Southern Lake Michigan.**

In this talk we examine two fundamental basin-scale modes observed in southern Lake Michigan: the near-inertial internal Poincaré mode, and the 4-day "vortex mode" found by Saylor et al. (1980). The seasonal variations of these basin scale waves are studied to see how the energy from the wind transfers to the wave modes during periods of differing thermal stratification and wind. A unique full-year data set from deep water in Lake Michigan's southern basin is examined to explore this seasonal variability. Spectral analysis is performed to show the variation of dominant wave modes and energy distributions over the frequency domain for the currents observed during strongly and weakly stratified seasons. The measurements indicate that the strength of the Poincaré wave is negligible during the un-stratified season, but that Poincaré waves are supported by even a small amount of stratification in the water column, with the strongest Poincaré activity occurring during the strongest thermal stratification. The vortex mode is observed over the whole year, but contains more energy during the un-stratified season. Numerical simulations of a wind-forced, idealized circular lake with a parabolic bathymetry are found to capture many of the above features of both waves. *Keywords: Vortex mode, Poincaré waves, Lake Michigan.*

CHOMICKI, K.M.[1], TAYLOR, W.D.[1], HOWELL, E.T.[2], and KALTENECKER, G.[2], [1]University of Waterloo, 200 University Ave W., Waterloo, ON, N2L 3G1; [2]Ontario Ministry of the Environment, 125 Resources Road, Toronto, ON, M9P 3V6. **Soluble Reactive Phosphorus and Conductivity as Measures of Land-Based Influences to the Nearshore Environment.**

Rivers and shoreline inputs transport large amounts of phosphorus into lake nearshores, however, it is unclear the extent to which P from these sources contributes to nearshore eutrophication. An important challenge in determining their potential in nearshore eutrophication is gaining an understanding of the availability of these inputs to nearshore biota. Phosphorus is a key limiting nutrient for the growth of both planktonic and attached algae and increased SRP concentrations are, in part, responsible for their excessive growth. In this work, we examined several regions along the shores of Lakes Ontario and Erie with varying land use in adjacent watersheds, and with catchments containing small to moderate-sized rivers draining into the lakes. Using SRP as an estimate of the biologically available fraction of P and conductivity as a neutral tracer of river and shoreline based inputs, we develop SRP-conductivity relationships for the sites. Spatial maps were created by interpolating near-continuous georeferenced vessel-based samples providing a high-resolution description of water quality patterns in the nearshore. We estimate the area associated with elevated SRP based on SRP-conductivity relationships and interpolated spatial conductivity maps. Changes in nearshore P liability are explored by examining temporal SRP:TP trends. *Keywords: Water quality, Coastal ecosystems, Nutrients.*

CHRISTENSEN, R.J., MARKLE, C., and CHOW-FRASER, P., McMaster University, 1280 Main St West, Hamilton, ON, L8S 4K1. **Comparing the Movement Characteristics of Blanding's Turtles (*Emydoidea blandingii*) in two Coastal Eco-Regions of Ontario with Contrasting Habitat Features.**

The Blanding's turtle distribution in North America is centred on the Great Lakes region where high levels of development have diminished populations, resulting in their designation as a species at risk. Blanding's turtles are particularly sensitive to habitat loss and fragmentation because of their migratory behaviour and relatively large home ranges. To create effective management strategies for their survival and recovery, the unique spatial ecology of geographically distinct populations must be well understood. Our objective was to determine the environmental characteristics that influence movement patterns, home range size, and habitat use of Blanding's turtles in two eco-regions: Georgian Bay Islands National Park (GB) and Rondeau Provincial Park (RD). We used radio tracking to record the movements of 20 turtles in GB and RD, and used GPS loggers to supplement locational data in GB. We found sex specific patterns of seasonal movement within GB and RD, and significant differences in home range size and movement patterns between turtles from GB and RD. Our findings highlight the need for management strategies that are tailored to the unique requirements of distinct populations, and that consider the seasonal spatial requirements of turtles within each population. *Keywords: Coastal ecosystems, Blanding's Turtle, Habitats, Radio tracking, Conservation, Spatial ecology.*

CHU, C.[1], KOOPS, M.A.[2], RANDALL, R.G.[2], KRAUS, D.[3], and DOKA, S.E.[2], [1]University of Toronto, c/o OMNR, DNA Building, Trent University 2140 East Bank Drive, Peterborough, ON, K9J 7B8; [2]Fisheries and Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6; [3]Nature Conservancy of Canada, Orchard Park Office Centre, RR#5, 5420 Hwy 6 North, Guelph, ON, N1H 6J2. **An Ecological Classification for the Nearshore Zone of Lake Ontario.**

The nearshore zones of the Great Lakes provide essential habitat for biota and are the regions of lakes that are most impacted by human activities. Despite the importance of these zones, they have been generally overlooked in research and monitoring programs in the Great Lakes, which concentrate mainly on offshore assessments, and watershed planning, which often ends at river mouths. The main objective of this study was to develop an ecological classification for the nearshore of Lake Ontario using the fish community (species composition and richness) as an ecological indicator. Canonical correspondence analysis indicated that 73% of the variation in the community data was related to physical characteristics: average effective fetch and elevation profile of the nearshore, and land cover characteristics: urban development and dense coniferous forest in the contributing watershed. These variables were used to develop a 16-group ecological classification of the nearshore. The nearshore zone is generally comprised of exposed bluffs and embayments with more development along the western reaches. Species richness was highest in the embayments and lowest in the beach classes. This ecological classification explicitly links nearshore fish community composition to habitat characteristics and surrounding land cover. *Keywords: Coastal ecosystems, Lake Ontario, Fish.*

CIBOROWSKI, J.J.H.[1], AXLER, R.P.[2], BHAGAT, Y.[1], BRADY, V.J.[2], BROWN, T.N.[2], DANZ, N.P.[3], GATHMAN, J.P.[4], HOST, G.E.[2], HOWE, R.W.[5], JOHNSON, L.B.[2], KOVALENKO, K.E.[1], NIEMI, G.J.[2], and REAVIE, E.D.[6], [1]Department of Biological Sciences, University of Windsor, Windsor, ON, N9B 3P4; [2]6Natural Resources Research Institute, University of Minnesota Duluth, Duluth, MN, 55811; [3]Department of Natural Sciences, University of Wisconsin Superior, Superior, WI, 54880; [4]Department of Biology, University of Wisconsin River Falls, River Falls, WI, 54022; [5]5. Department of Natural and Applied Sciences, University of Wisconsin Green Bay, Green Bay, WI, 54311; [6]Ely Field Station, University of Minnesota Duluth, Ely, MN, 55731. **Comparing Bioindicator Responses to Gradients of Agricultural vs Urban Stress at Great Lakes Coastal Margins.**

We evaluated the biological communities in over 120 coastal locations ordinated along gradients of anthropogenic stress at the US coastal margins of the 5 Great Lakes. Initially, we used principal component analysis to summarize the influence of 213 GIS-based measures of disturbance associated with human land use and watershed geomorphology in each of 723 second-order watersheds. The 120 sites sampled spanned the resultant stress scales. Algae, invertebrates, fish, birds, habitat and water quality were sampled during summers of 2002 and 2003. Subsequently, we used a simplified subset of stressor variables to derive two orthogonal (statistically independent) scales, one for urban and one for agricultural-related stress. Four analytical methods were then used to ordinate biological responses to the measures of the intensity of urban and agricultural development, respectively and identify threshold values of each type of stress at which important biological change points occurred. The resultant threshold values could represent preservation/ restoration targets at which the biological communities are

at risk of change between reference and nonreference conditions. Biological changes that accompanied increasing urban stress generally differed from changes associated with increasing agricultural stress. *Keywords: Bioindicators, Coastal ecosystems, Great Lakes basin.*

CLEMENT, T.A., MURRY, B.A., and UZARSKI, D.G., Institute for Great Lakes Research, CMU Biological Station, Department of Biology, Central Michigan University, Mount Pleasant, MI, 48859. **Size Structure of Small Lake Fish Assemblages: The Role of Lake Size, Biodiversity, and Disturbance.**

The distribution of individuals among body size classes can be highly structured and predictable in aquatic systems. Size spectra are a common approach to studying community size-structure. Most size spectra research has been conducted on large aquatic systems with relatively high biodiversity and varying degrees of anthropogenic disturbance. However, little is known how ecosystem size, low diversity, and natural disturbance influence size spectra dynamics. We hypothesized that limits exist in each of these characteristics where a predictable size-structure would no longer occur below a certain threshold. We studied patterns of size-structure of the fish assemblages from six small lakes (<200 ha) of Beaver Island, MI to evaluate limits of predictable size-structure. Ecosystem size, fish diversity, and disturbance all varied, therefore, affecting lake size-structure. We found that ecosystem size, diversity, and disturbance regime influenced lake size-structure. We also found evidence that recent stocking of a non-native top predator may have had a strong impact on assemblage size-structure. We conclude that lakes as small as 14 ha and species richness as low as 10 are sufficient for predictable size-structure to form, but that natural and anthropogenic disturbances can alter size-structure. *Keywords: Assessments, Biodiversity, Size spectra, Fisheries.*

CLITES, A.H.[1], SMITH, J.P.[2], GRONEWOLD, A.D.[1], and HUNTER, T.S.[1], [1]NOAA Great Lakes Environmental Research Laboratory, 4840 S. State Rd, Ann Arbor, MI, 48108; [2]Cooperative Institute for Limnology and Ecosystems Research, University of Michigan, 4840 S. State Rd, Ann Arbor, MI, 48108. **A Web-Based Portal for Understanding Great Lakes Water Level Dynamics and Climate Variability.**

There is a growing need among the research and resource management communities in the U.S. and Canada to access Great Lakes hydrologic and climate data in an interactive framework that facilitates both analysis over different time scales as well as comparisons between data and forecasts from different sources. NOAA's Great Lakes Environmental Research Laboratory (GLERL) has begun development of a web-based tool to address this need. The initial phase includes lakewide-average water levels and GLERL water level forecasts. Subsequent phases will include regional climate data and additional hydrological variables. Unique features of the portal include a scalable time series axis, allowing data access across a broad range of time scales, and the option to overlay data from different sources. The ultimate goal of this tool is to help translate the unique hydroclimate story of the Great Lakes by allowing direct interaction with model forecasts and data at a variety of user-defined time scales. Providing a single web-based resource for Great Lakes water level, climate data, and model forecasts is expected to help management agencies and to serve as a valuable educational tool for

the general public. *Keywords: Water level fluctuations, Data visualization, Data storage and retrieval, Model testing.*

COLTON, M., NOAA-GLERL, 4840 South State Road, Ann Arbor, MI, 48108, U.S.A.. **Integration of Measurements, Models, and Missions in Great Lakes Ecosystem Science.**

Integration of physical and ecological sciences has always been a significant obstacle to understanding and effectively managing Great Lakes ecosystems. A 1995 book, The Freshwater Imperative: A Research Agenda (eds., R.J. Naiman et al.), summarized a two-year effort by a diverse international working group that emphasized that effective approaches to address water resource degradation "depend on partnerships...among natural scientists in complementary disciplines." Support from the Great Lakes Restoration Initiative has accelerated both development of more effective partnerships across disciplines within Great Lakes science organizations, as well as the growth of large-scale cooperative research programs among multiple organizations. One excellent example of this is a new joint effort beginning in 2012 by USEPA, USGS, and NOAA to understand the impacts of non-native species on the full food web in Lake Huron. The work will include studies of sediment, benthos, phytoplankton, zooplankton, and fish in a context of measurements and models of currents, temperature, nutrients, and optical properties of the water column. Projects like this one can serve as models of how limited research resources can be applied most effectively to answer the most pressing ecosystem science questions for which resource managers need answers. *Keywords: Environmental policy, Government agencies, Computer models, Integration, Ecosystems, Research agenda.*

CONFESOR, R.B., RICHARDS, R.P., and BAKER, D.B., NCWQR, Heidelberg University, 310 E Market St., Tiffin, OH, 44883. **Modeling Sediment and Nutrient Exports From Lake Erie Watersheds.**

Sediment and total phosphorus (P) loads from the Maumee and Sandusky have decreased since the 1970s as shown by the data from the National Center for Water Quality Research (NCWQR), Heidelberg University. Although the dissolved P load also declined, it has been increasing since the mid-1990s corresponding to the reappearance of massive harmful algal blooms in Lake Erie. Researchers have been exploring the selection and optimal placement of best management practices (BMPs) to reduce nutrient exports from agricultural lands. Watershed models (e.g., the Soil and Water Assessment Tool, SWAT) are vital tools in these studies. This report evaluates SWAT's performance in simulating sediments, P forms, and nitrate from two largely-agricultural watersheds of Lake Erie. Management scenarios include different crop rotations, tillage practices, and fertilizer types and application methods. *Keywords: Watersheds, SWAT, Pollution load, Model studies.*

CONNERTON, M.J.[2] and <u>STEWART, T.J.</u>[1], [1]Ontario Ministry of Natural Resources, Lake Ontario Management Unit, Picton, ON, KOK2T0; [2]New York Sate Department of Environmental Conservation, Great Lakes Fisheries Section, Cape Vincent, NY, 13618. **A Strategic Plan for the Reestablishment of Native Deepwater Ciscoes in Lake Ontario.**

Until the mid 1950's, Lake Ontario was home to a very diverse assemblage of deepwater cisco species. Currently, only the shallow-water form of Lake Cisco (C. artedi) remains in Lake Ontario. We summarize proposed objectives and strategies for reintroducing deepwater cisco to Lake Ontario and tracking progress. The goal is to establish a self-sustaining population of deepwater cisco in Lake Ontario within 25 years. Objectives and associated strategies are specified for sources of gametes, culture facilities, culture capacity, stocking, detection of wild fish, increasing our understanding of ecological consequences and public education. Potential benefits of restoring deepwater cisco include increasing the diversity and resilience of the food web, increasing wild production of salmon and trout by reducing thiaminase impacts of a diet based on Alewife and Rainbow Smelt, supporting a small commercial fishery, restoring historical food web structures and function and increasing trophic transfer efficiency. Potential risks relate to the unpredictability of food web interactions in an evolving Lake Ontario ecosystem. Progress in gamete collection and culture trials is summarized. *Keywords: Lake Ontario, Deepwater cisco, Fish management, Biodiversity.*

<u>COOPER, M.J.</u>[1], KOSIARA, J.M.[1], UZARSKI, D.G.[2], and LAMBERTI, G.A.[1], [1]Department of Biological Sciences, University of Notre Dame, Notre Dame, IN, 46556; [2]Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, MI, 48859. **Nitrogen and Phosphorus Conditions and Nutrient Limitation in Coastal Wetlands of Lakes Michigan and Huron.**

Nutrient data from over 500 sampling events in 64 coastal wetlands of Lakes Huron and Michigan conducted between 2001 and 2011 revealed that dissolved P concentrations rarely exceeded our analytical detection limit of 0.01 mg/L, ammonium concentrations averaged 0.04 ± 0.01 mg/L, and nitrate concentrations averaged 0.23 ± 0.04 mg/L. Dissolved nutrients tended to be highest in rivermouth wetlands and in wetlands located near agricultural land uses such as those in the Saginaw Bay region. Given that dissolved P was rarely detectable in our 10-year dataset, we predicted that this macronutrient limited primary productivity and decomposition more often than N within these wetlands. During the summer of 2011 we conducted a series of nutrient amendment assays in 20 coastal wetlands of Lakes Michigan and Huron to detect N or P-limitation of periphyton growth, macrophyte decomposition, and water column metabolism (GPP and R). Assays suggested that nutrient-limitation occurred at nearly every site with N or N+P co-limitation being most common except for decomposition which was more commonly limited by P. Our results suggest that while dissolved P concentrations appear low during the growing season, N-limitation may occur frequently in coastal wetlands of Lakes Michigan and Huron. *Keywords: Coastal wetlands, Nutrients, Phosphorus.*

CORTES, A.[1], ACOSTA, M.[1], FLEENOR, W.[2], and RUEDA, F.J.[1], [1]Department of Civil Engineering and Water Institute. University of Granada, Granada, 18071, Spain; [2]Department of Civil and Environmental Engineering. University of Davis, California, USA, Davis, California. **Mixing of Density Currents Inflowing a Mediterranean Stratified Reservoir (Spain).**

Negatively buoyant inflows entering a reservoir will plunge and flow downward along the bottom as a density current until it reaches the level of neutral buoyancy (LNB). Recent laboratory experiments, though, suggest that a significant fraction of inflow water entering linearly stratified bodies might be distributed throughout the water column above the theoretical LNB. These findings agree with field observations in Lake Mead, where a fraction of river nutrients were available for primary production. To understand the processes causing the river inflow water to mix vertically reaching surface layers, detailed tracer release experiments were conducted in a Mediterranean stratified reservoir (Spain), which are supporting the simulations undertaken with a 3D hydrodynamic model. In the near field, it was found dilution rates of $O(10)$, associated to the jet-like nature of the inflows and horizontal eddy diffusivities of $O(1)$. In the far field, the two-layers stratified ambient fluid with initial Richardson number less than critical value of $Ri_\rho = 21$, contributed to split the density current into two intrusions, one along the interface and other above the theoretical LNB. This fact, link to surface cooling and internal waves dynamic, contributed to observe 2% of the inflowing tracer concentration at the surface.
Keywords: Spain, Hydrodynamic model, Stratification, Reservoirs, Mixing.

COSSU, R. and WELLS, M.G., Department of Physical and Environmental Science, University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C1A4. **Observations of Large Amplitude Internal Seiches Interacting with the Lake Bed in Lake Simcoe.**

We report observations of internal seiches in Lake Simcoe, Canada. The observations were made in the SE sector of the lake between 14 m and 21 m depth, over a 40-day period in late summer. Our data comes from four high-resolution thermistor chains and an upwards-looking ADCP velocity meter. The thermocline is located at depth of 14-18 m during this strongly stratified period, and exhibits an average fluctuation of 2-5 m over a day. During periods of strong westerly winds the thermocline is deflected as much as 10 m vertically, and hence the thermocline can interact directly with the lake beds at depth between 14 - 18 m. Near bed velocities average around 5 cm/s, but can reach 20 cm/s during periods when there are large internal seiches. We report how the movements of the thermocline are associated with increased benthic currents, and how high temperature variability associated with high frequency internal waves with the thermocline. We will use information on particle size from sediment cores to discuss the likelihood of sediment resuspension during the intermittent large amplitude internal seiches. The potential for sediment resuspension is of critical interest as it can release nutrients from lake sediments into the water column and enhance the algal productivity in this lake.
Keywords: Sediment resuspension, Lake Simcoe, Bottom currents.

COULTER, D.P.[1], TROY, C.D.[2], SEPÚLVEDA, M.S.[1], and HÖÖK, T.O.[1], [1]Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN, 47907; [2]School of Civil Engineering, Purdue University, West Lafayette, IN, 47907. **Fish Habitat Suitability and Growth Response in Dynamic Environments of Nearshore Lake Michigan.**

Nearshore areas of the Great Lakes display high thermal variability that can vary dramatically over fine temporal and spatial scales. The influence of such dynamic conditions on growth of nearshore fishes is not well understood. The objectives of this study were to 1) index fish habitat quality based on observed temperatures in nearshore Lake Michigan and 2) conduct laboratory experiments to observe fish growth responses when subjected to variable temperatures. To quantify nearhore temperature variation, we deployed a transect of thermistor chains in southern Lake Michigan (from 7-21 m). We divided vertical and horizontal temperature profiles into spatio-temporally explicit cells and quantified cell-specific bioenergetic growth rate potential, an index of habitat quality. To further explore the influence of variable temperatures on fish growth, we compared growth and consumption rates of yellow perch under constant and variable temperatures. These laboratory trials revealed that fish experiencing high temperature variability displayed increased growth and consumption rates compared to fish in more stable environments. Several future climate projections suggest that thermal variation will become more severe in the future, and studies such as ours are key to evaluating how fish will respond to such increased thermal variation. *Keywords: Habitats, Fish, Fish behavior.*

CROOKS, J.L.[1], HUNTER, T.S.[2], STOW, C.A.[2], and GRONEWOLD, A.D.[2], [1]USEPA, Research Triangle Park, NC, 27709; [2]NOAA (GLERL), 4840 South State Road, Ann Arbor, MI, 48108. **Accommodating Precipitation Estimate Bias and Uncertainty in Large Lake-Dominated Basins.**

Precipitation is the dominant driver of the Great Lakes water budget and an important index of climate change and variability. Numerous approaches are available to measure, simulate, and forecast precipitation, each with differing sources of bias and variability, and consequent implications for their use in models and decision-making. Here, we provide a review of conventional and novel procedures used to estimate both overlake and overland precipitation in the Great Lakes basin, and how those procedures are implemented in (or could be incorporated into) current operational seasonal water budget and water level forecasting. We then assess how the suite of novel procedures, including statistical models and regional climate models, provide alternative methods for simulating recent precipitation patterns, and potential alternatives for transferring those patterns onto the historical precipitation record. *Keywords: Precipitation, Water balance, Climate.*

CUTHBERT, F.J.[1], WIRES, L.R.[1], WESELOH, D.V.C.[2], and MOORE, D.J.[3], [1]University of Minnesota, 1980 Folwell Ave., St. Paul, MN, 55108; [2]Canadian Wildlife Service, 4905 Dufferin St., Toronto, ON, M3H 5T4; [3]Canadian Wildlife Service, 867 Lakeshore Rd., Burlington, ON, LTR 4A6. **Colonial Waterbirds in the St. Marys River.**

The St. Marys River (SMR) connects Lake Superior and Lake Huron and supports significant diversity of colonially nesting waterbirds on its islands and associated wetlands. The purpose of this presentation is to summarize results from the Great Lakes Colonial Waterbird Survey (GLCWS), a joint effort, spanning approximately 30 years, between the U.S. Fish and Wildlife Service and the Canadian Wildlife Service. Results will focus on nesting bird estimates and trends as well as distribution in the SMR. The GLCWS began in the mid-1970s and has been repeated four times as recently as 2007-09. Eight species of colonial waterbirds regularly nest in the SMR including Ring-billed Gull, Herring Gull, Double-crested Cormorant, Common Tern, Caspian Tern, Black Tern, Great Blue Heron and Black-crowned Night-Heron. The most abundant species is the Ring-billed Gull; Black Terns have declined significantly over the monitoring period. Primary nesting habitat includes natural and dredge spoil islands and most birds breed in the northern section of the river. *Keywords: St. Marys River, Colonial waterbirds, Conservation, Biodiversity.*

CVETKOVIC, M., MIDWOOD, J.D., and CHOW-FRASER, P., McMaster University, Hamilton, ON, L8S4K1. **Investigating the Factors Influencing Fish Community Composition and Population in Coastal Wetlands of Eastern Georgian Bay.**

Coastal wetlands in Georgian Bay, Lake Huron represent over 5000 ha of critical and relatively pristine fish habitat. Currently, there is a lack of baseline information on fish populations and communities in these high quality ecosystems, making it difficult to determine if they are stable or in flux. During the summer of 2010, we used fyke nets to sample 11 sites in two coastal wetland complexes in eastern Georgian Bay, (Moon Island and Tadenac Bay) on a monthly basis. Fish were tagged using Visual Implant Elastomers in discrete body locations based on the week caught. Despite the close proximity of the regions and absence of human influences, there were differences between the fish communities. Population estimates were generated in eight wetlands for the most common species, pumpkinseeds, and ranged from 3 422 fish/ha to 6 309 fish/ha, for both regions combined. Using a Geographic Information System and multivariate statistics, we tease out the factors influencing composition and population size using habitat variables such as macrophyte and sediment composition and cover, water quality parameters, wetland morphology, and slope. This is the first study to determine coastal wetland fish population estimates in the relatively undisturbed regions of Georgian Bay and attempt to link them to habitat variability. *Keywords: Fish populations, Coastal wetlands, Coastal ecosystems.*

CYR, J.F.[1], RICARD, S.[1], ROUSSEL, D.[1], LACHANCE-CLOUTIER, S.[1], TURCOTTE, R.[1], GAUVIN-ST-DENIS, B.[2], and CHAUMONT, D.[2], [1]Centre d'expertise hydrique du Québec, 675, Boul. René-Lévesque Est, Aile L.-A. Taschereau, 4ème étage, boîte postale 28, Québec, QC, G1R 5V7; [2]Consortium Ouranos, 550 Sherbrooke Ouest, Tour Ouest, Montréal, QC, H3A 1B9. **Assessing the Hydrological Impact of Climate Change on the Quebec Part of the St. Lawrence River Subwatersheds.**

Hydrologic modeling of watersheds is a fundamental and essential step of a large scale assessment of cumulative impacts of water withdrawals. Moreover, given that water withdrawal facilities are generally active over long periods of time, it now becomes essential that water withdrawal requests be managed within an adaptive process that takes into account the potential impact of climate changes on the availability of water resources. In that context, the government of Quebec has undertaken the development of a hydrological modeling platform that covers much of the watershed of southern Quebec, an area covering approximately 390 000 km ². That initiative, located at the convergence of the "Quebec Action Plan on Climate Change" and of the "Great Lakes/St-Lawrence River Basin Sustainable Water Resources Agreement", aims essentially to provide users, researchers and decision makers possible values of climatic drifts of hydrological indicators that are commonly used in water management. For each hydrological indicator, climatic drifts are presented in terms of spatially distributed relative values over the watershed and to which is associated an estimate of the uncertainties related to the hydroclimatic projection process. *Keywords: Climate change, Water management, Model studies, Water withdrawal management, Hydrologic budget, Cumulative impacts.*

DAHL, T.A.[1], CALDWELL, R.J.[2], FAN, Y.[2], and MCPHERSON, M.M.[3], [1]USACE - Great Lakes Hydraulics & Hydrology, 477 Michigan Ave., Detroit, MI, 48226; [2]Environment Canada, 111 Water Street East, Cornwall, ON; [3]USACE - HEC, Davis, CA. **Regulating Lake Superior - Past and Future.**

The outflow of Lake Superior has been significantly affected by human intervention since 1887 and actively regulated since 1917. Over the last century, multiple regulation plans have been used, each incorporating the viewpoints of the time. The current regulation plan, Plan 77A, attempts to "balance" Lakes Superior and Michigan-Huron differences from average while benefiting multiple stakeholder groups. The International Upper Great Lakes Study (IUGLS), under the auspices of the International Joint Commission (IJC), was set up to see if a new regulation plan could better serve the wide variety of Great Lakes stakeholders than Plan 77A. This presentation will provide an overview of both the historical regulation plans and the development of new plans that culminated in a recommendation from the IUGLS Study Board to the IJC. The final proposed plan from the IUGLS will also be described. *Keywords: Great Lakes basin, Lake Superior, Water level.*

DALEY, J.M., PATERSON, G., and DROUILLARD, K.G., Great Lakes Institute for Environmental Research, 401 Sunset Avenue, Windsor, ON, N9B 3P4, Canada. **Bioamplification as a Non-Steady State Bioaccumulation Mechanism for Persistent Organic Pollutants (POPs) in Fish and Wildlife.**

Persistent organic pollutant (POP) bioaccumulation models have been generally formulated to predict two main processes, bioconcentration and biomagnification under a steady-state framework. A third bioaccumulation process that can mediate chemical potential in an organism is bioamplification. Bioamplification occurs when an organism loses body weight and chemical partitioning capacity at a faster rate than it can eliminate contaminants. It is a non-steady state process that arises from sudden changes in steady to non-steady state conditions or from perturbations of the non-steady state trajectory. Although bioamplification is not generally recognized as a bioaccumulation process independent of biomagnification, the consequences can be important. Bioamplification generally occurs under specific life history stages when an organism experiences major bioenergetic bottlenecks. Examples of bioamplification in species found in the Great Lakes basin, including bird and fish embryos during egg development, overwintering yellow perch, larval Chinook salmon, amphibians during tadpole-frog metamorphosis and emergent aquatic insects will be presented. These examples will demonstrate that bioamplification is a general bioaccumulation process that contributes to enhanced chemical fugacities of POPs in a wide variety of animal species. *Keywords: Bioaccumulation, Life history studies, Pollutants.*

DANESH, D.[1], MCCARTHY, F.M.G.[2], and DRLJEPAN, M.[2], [1]PEARL Lab, Department of Biology, Queen's University, Biosciences Complex 116 Barrie St., Kingston, ON, K7L 3N6, Canada; [2]Department of Earth Sciences, Brock University, 500 Glenridge Avenue, St. Catharines, ON, L2S 3A1, Canada. **Non-Pollen Palynomorphs as Indicators of Long-Term Anthropogenic Impacts on Cooks Bay, Lake Simcoe, Ontario.**

Many published studies on long-term changes in the Great Lakes region have relied on the use of pollen to determine records, however little attention has been given to non-pollen palynomorphs (NPPs). Here we look at long-term anthropogenic impacts on Cook's Bay using NPPs as indicators of water quality. The paleo-record determines oligotrophic conditions prior to Euro-Canadian settlement, rapid land-clearing and development post-WWII, followed by eutrophic conditions, though a slight improvement to ecosystem health is recorded in the upper most core. *Keywords: Eutrophication, Holocene, Lake Simcoe.*

DAYTON, A.I.[1], AUER, M.T.[2], and ATKINSON, J.F.[3], [1]ARCADIS 10559 Citation Drive, Brighton, MI, 48116; [2]Michigan Technological University, 1400 Townsend Drive, Houghton, MI, 49931; [3]SUNY-Buffalo, 207 Jarvis Hall, Buffalo, NY, 14260. **Phosphorus Accumulation over Dreissenid Beds: Impact on *Cladophora*.**

Excessive *Cladophora* growth in the Great Lakes has led to beach fouling and the temporary closure of nuclear power plants and has been associated with avian botulism. As the growth-limiting nutrient for *Cladophora*, phosphorus is the appropriate target for management

efforts. Dreissenids have the ability to capture particulate phase phosphorus (otherwise unavailable to *Cladophora*) and release it in an available form (SRP, soluble reactive phosphorus). It is hypothesized that under quiescent conditions, soluble phosphorus will accumulate near the sediment-water interface, setting up vertical phosphorus gradients and conditions favorable for resource delivery to *Cladophora*. SRP levels were monitored with a resolution of 35 cm over dreissenid beds in Lake Michigan. During quiescent periods, a concentration boundary layer hosting ecologically significant levels of SRP (1-8 ugP/L) was observed immediately above the beds. Under turbulent conditions, the boundary layer was entrained and SRP concentrations were vertically uniform at ~0.5 ugP/L. The occurrence of the phenomenon proximate to sites of *Cladophora* growth confirms the importance of the nearshore phosphorus shunt. However, variability in wind-mixing imparts uncertainty to the interpretation of the broader significance of this P source. *Keywords: Phosphorus, Dreissena, Cladophora.*

DE LAFONTAINE, Y.[1], MARTY, J.[2], and DESPATIE, S.[1], [1]Centre St. Laurent, Environment Canada, Montréal, QC; [2]St Lawrence River Institute, 2 St Lawrence Drive, Cornwall, ON. **Seasonal Variability in Potential Risk of *Hemimysis anomala* Transfer by Shipping in Montreal Harbour.**

To assess the level of variation in the potential risk of uptake and transfer of the bloody-red shrimp *Hemimysis anomala* (HA) by shipping, we describe the seasonal variation in population abundance and size structure of HA in Montreal Harbour waters, St. Lawrence River (Canada). Biweekly nighttime sampling conducted in 2010 showed seasonal variation from very low abundance of large-sized HA in early spring to very high densities of HA juveniles in late-August-early-September. Maximum densities exceeded 10 000 ind./m³ at the time of seasonal peak in water temperature. Variation of size structure of HA over time suggested the production of two reproductive cohorts in a year. Spatial survey conducted in early-fall 2010 revealed high level of spatial heterogeneity in HA distribution with high densities in port basins characterized by long residence time of water. We conclude that the potential risk of HA uptake and transfer by shipping will vary seasonally, being lowest during winter months and maximal in late summer and early-fall.

DE SOLLA, S.R.[1], WESELOH, D.V.C.[2], HEBERT, C.E.[3], LETCHER, R.J.[3], and PEKARIK, C.[4], [1]Wildlife and Landscape Science Directorate, Environment Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6; [2]Canadian Wildlife Service, Environment Canada, 4905 Dufferin Street, Downsview, ON, M3H 5T4; [3]Wildlife and Landscape Science Directorate, Environment Canada, National Wildlife Research Centre, Ottawa, ON, K1S 5B6; [4]Canadian Wildlife Service, Environment Canada, 351 St. Joseph Blvd, Gatineau, QC, K1A 0H3. **Reconcilable Differences: Methodological Changes and Long Term Monitoring of Contaminants in Herring Gulls.**

Numerous long-term monitoring programs have assessed spatial and temporal trends of organochlorine pesticides and PCBs. Changes in analytical approaches can cause artifacts in the reported concentrations. In-house reference material (RM) was used to determine the analytical artifacts in the measurement of OCs and PCBs in Great Lake herring gull eggs analyzed using different methods (GC-ECD and GC-MSD). Approximately 19.0% of the variability of PCB

congeners was associated with analytical artifacts, and differences among gull colonies were obscured. After statistically removing the artifacts, only 1.4% of the variability in PCBs was associated with artifacts, and differences among colonies became apparent. We examined temporal trends in concentrations in eggs using change point regressions, to determine whether significant changes in long-term trends were associated with methodology. The highest frequency of change point occurrences shifted from 1997 (when analytical methodology was altered) to 2003 after data adjustment. The effects on the interpretation of long-term temporal trends, although not overwhelming, justified doing correction factors. When combining contaminant data obtained using different methods, the methods should be assumed to give different results unless demonstrated otherwise. *Keywords: PCBs, Herring gulls, Monitoring, Pesticides.*

DEBARROS, C.[1] and ANDERSON, J.[2], [1]Ontario Ministry of the Environment, 1529 Gardiners Rd. Unit 3, Kingston, ON, K7P 3J6, Canada; [2]Environment Canada, CCIW, 867 Lakeshore Road, Burlington, ON, L7R 4A6, Canada. **Historic Contaminant Releases to the St. Lawrence River - Their Impact and Current Environmental Signature.**

The St. Lawrence River has served as a readily accessible source of freshwater, power and transportation which has attracted a rich variety of industries over the past 120 years and resulted in the growth of communities along the river. The river also became a repository for waste by-products from both industries and communities. This talk will address the historical industrial discharges into the St. Lawrence in Ontario, with a focus on the Cornwall area, and the environmental impacts. Some of the first industries to locate at Cornwall's waterfront were related to the textile sector. Woolen mills and cotton mills were the first to be established. The paper mill, which later added wood pulping processes, originally utilized textile rags as the primary raw material. Viscose manufacturing for the production of rayon, a versatile fiber used in the textile industry, began in 1925. Various other companies located in Cornwall over the years, such as a mercury-cell chlor-akali plant, which provided the pulp and paper and viscose manufacturers with materials, chemicals and services as well as utilizing the products. Many of these past industrial activities led to poor water quality and have left their mark on the river. *Keywords: Organics, Pollution sources, Metals, St. Lawrence River, Mercury, Sediment quality.*

DEKKER, T.J. and VERHAMME, E.M., LimnoTech, 501 Avis Drive, Ann Arbor, MI, 48108. **Industry Perspective on Real-Time Buoys: Cook Nuclear Plant.**

The Cook Nuclear Power Plant located on Lake Michigan near St. Joseph, MI recently invested in a real-time buoy to monitor physical conditions in the nearshore waters of Lake Michigan. While their primary objective was to serve internal data needs an effort was made by LimnoTech to incorporate data from the buoy in other public data portals including the NOAA National Data Buoy Center, Great Lakes Observing System, and the University of Michigan's Ocean Engineering Lab's U-GLOS. The presentation will demonstrate how data from the buoy was an invaluable tool for marine contractors, local weather forecasters, boaters, fishermen, and other users. This type of public-private partnership can be used as a model to demonstrate how

private companies can meet their data needs and provide a valuable service to other users. *Keywords: Buoys, Lake Michigan, Observing systems.*

DEPINTO, J.V., VERHAMME, E.M., and REDDER, T.M., LimnoTech, 501 Avis Drive, Ann Arbor, MI, 48108. **Modeling Analysis of the Response of Microcystis and Cladophora Growth in Saginaw Bay to Phosphorus Loading and Dreissenid Density.**

As part of a NOAA-funded project to assess the relative impacts of multiple stressors on multiple ecosystem responses in Saginaw Bay, we have developed a process-based, fine-scale linked hydrodynamic-advance eutrophication model to examine the stress-response relationships of concern. The model, called SAGEM2, includes nutrient dynamics, lower food web interactions, Dreissenid growth and impacts on nutrient cycling and light regime, and *Cladophora* growth, sloughing, and fate of sloughed material. We have used this model, which has been calibrated to 2009 project data, to examine the growth response of *Microcystis* and *Cladophora* to alterations in phosphorus loading and to adjustment of Dreissenid density. A component analysis of the model results illustrates the processes that are most responsible in governing the responses. *Keywords: Phosphorus, Microcystis, Saginaw Bay, Dreissena.*

DERMOTT, R.M. and BONNELL, R.G., Fisheries and Oceans Canada, PO. Box 5050,, Burlington, ON, L7R 4A6, Canada. **Good Bye Diporeia, and Thanks for all the Fish.**

For millennia, the deepwater amphipod Diporeia spp. dominated the benthos of the Great Lakes forming 20 - 70% of the benthic biomass. Their high lipid (35%), and essential fatty acid content made this species an important food for many Great Lakes fishes. After the arrival of Dreissena spp., Diporeia populations began to disappear - first in the nearshore (30 - 60 m depth), then progressively offshore (<90 m). Competition for settling algae and diatoms is the suspected cause although often the amphipods disappeared in areas without any mussels. Since 1990, D.F.O has surveyed amphipod and mussel abundance in Lake Ontario. In 1995, Diporeia averaged 2681 m2 in the lake and decreased to 135 m2 by 2009, while quagga mussels increased to average 2575 m2 at the same sites. Deep water >90 m was considered a refuge for Diporeia, however they disappeared from the deepest area (220 m) of the lake in 2008 where quagga mussels averaged 274 m2. No Diporeia were seen in the 30 samples from the Oct. 2011 survey, including 2 sites near the Niagara River that maintained a population > 500 m2 until 2009. Small populations of Diporeia probably still exist, but bio-energetically the species is no longer functional in Lake Ontario. We say good-bye and thank you. *Keywords: Dreissena, Lake Ontario, Bio-energetics, Amphipods.*

DESJARDINS, M., LAKE, C., SCHANER, T., MATHERS, A., and MORRISON, B.J., Ministry of Natural Resources, Lake Ontario Management Unit, Picton, ON, K0K 2T0. **The Status of the Lake St. Francis Yellow Perch Fishery: A Positive Response to Management Actions.**

Lake St. Francis is a large impoundment formed by hydroelectric facilities in the St. Lawrence River. The Yellow Perch fishery is and historically was an important local fishery. For

many years it included a unique fishery based on the sale of angler-caught Yellow Perch. The Ontario Ministry of Natural Resources (MNR) has been monitoring the fish community of Lake St. Francis for over 25 years using various fisheries dependent and independent methods. Declining numbers of Yellow Perch (particularly 'jumbo' Yellow Perch) in the late 1990's thru early 2000's prompted several changes to fisheries management in Lake St. Francis. These included disallowing the sale of angler-caught Yellow Perch, imposing catch limits for angler-caught Yellow Perch, and the development of a Fisheries Management Plan for Lake St. Francis. Recent fisheries assessment programs show Yellow Perch have dramatically improved in Lake St. Francis. Several factors may have caused this resurgence including successful management actions, ecosystem change, or a combination of several factors. Both recreational and commercial Yellow Perch fisheries will be discussed, as well as contrasting views of Yellow Perch stocks in the 1000 Islands section of the St. Lawrence River and Eastern Lake Ontario. *Keywords: Yellow perch, St. Lawrence River, Management.*

DICKINSON, W.T., RUDRA, R.P., and AMILI, A., School of Engineering, University of Guelph, Guelph, ON, N1G2W1, Canada. **How Rising Temperatures are Changing Winter Hydrology across Ontario.**

.Time trends in a number of temperature variables (e.g. extreme maximum, extreme minimum, mean maximum, mean minimum) have been studied for several station locations across Ontario for annual and seasonal data sets. The data reveal that temperatures have clearly been rising steadily across the province for periods of record varying from 60 to 150 years, cooler temperatures rising at the greatest rates. Not surprisingly, therefore, the number of frost-free days, a variable directly related to minimum temperatures, has also been rising, but at increasing rather than steady rates. The less directly related variables of winter rainfall and snowfall have also been changing across the province: winter rainfall increasing and snowfall decreasing. Associated impacts of rising temperatures on winter runoff volumes and peaks, and groundwater recharge, are yet be ascertained *Keywords: Climate change, Risks, Great Lakes basin.*

DITTRICH, M., CHESNYUK, A., GUDIMOV, A., MCCULLOCH, J., and ARHONDITSIS, G.B., University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A4. **Phosphorus Diagenesis in Lake Simcoe Sediments: Modeling and Experimental Study.**

The potential for phosphorus (P) loading by the sediments from Lake Simcoe, a mesotrophic lake located in Ontario, to the overlaying water was assessed. A phosphorus fractionation scheme was used to examine the concentration of P of different chemical species and forms in the sediment. The sediment was cut in 7 layers and analyzed for inorganic and organic P. The following rank was determined for the soluble reactive P in the sediment HCl-P>Rest-P>BD-P>NaOH-P>NH4Cl-P. It was found that the largest amount of P is bound in the sediment as organic refractory apatite P, essentially inert. The metal oxide bound P (NaOH-P) was comparatively low in all the layers. The most bio available (NH4Cl-P) fraction was <1% of the total P in the sediment. BD-P was highest in the first two layers and due to its potential to be

released in anoxic conditions this is of most concern. *Keywords: PFOs, Sediments, Model studies.*

DOLSON, R., HANNIKAINEN, P., LA ROSE, J., LANGLEY, T., LIDDLE, G., ROBILLARD, M., and TRUMPICKAS, J., Lake Simcoe Fisheries Assessment Unit, Ontario Ministry of Natural Resources, 26465 York Rd. 18, Sutton West, ON, L0E1N0. **Long-Term Trends in the Fish Communities of Lake Simcoe.**

Lake Simcoe's diverse fish communities have been affected by both stressors and rehabilitative efforts in recent decades. Long-term monitoring programs reveal trends in these economically important fish communities. In the coldwater fish community, the relative abundance of several species increased in the late 2000s compared to low values observed in the 1990s and early 2000s. Notable trends included an increase in the relative abundance of lake herring (*Coregonus artedi*), naturally reproduced lake trout (*Salvelinus namaycush*) and invasive rainbow smelt (*Osmerus mordax*). In the warmwater fish community, the relative abundance of rock bass (*Ambloplites rupestris*) and bluegill (*Lepomis macrochirus*) has increased since 1992, while other large-bodied species showed variable relative abundance without long-term directional change. Several recent invaders, round goby (*Neogobius melanostomus*), bluegill and black crappie (*Pomoxis nigromaculatus*), have altered the composition of the warmwater fish community. The number of nearshore small-bodied species was lower in several parts of the lake in 2007-2009 compared to 1982-1995. Fish community trends are discussed in the context of the wide-ranging ecological changes and management activities occurring in the Lake Simcoe watershed. *Keywords: Fish populations, Monitoring, Lake Simcoe.*

DOUGLAS, A.G.[1], GLEESON, J.[2], GRAY, P.A.[2], LEMIEUX, C.J.[3], and NIELSEN, G.[2], [1]Ontario Centre for Climate Impacts and Adaptation Resources, 935 Ramsey Lake Road, Sudbury, ON, P3E 2C6; [2]Ontario Ministry of Natural Resources, 300 Water Street 2nd FL N, Peterborough, ON, K9H 8M5; [3]Department of Geography & Environmental Studies, Wilfrid Laurier University, Waterloo, ON, N2L 3C5. **A Practitioner's Guide to Climate Change Adaptation in Ontario's Ecosystems.**

Integrating climate change adaptation into natural resource and watershed management requires an understanding of the impacts of climate change and the corresponding vulnerability of, and risks to, ecosystems and the people who rely on them. Activity in the area of adaptation planning is increasing and is occurring at different geographic levels. This planning for the most part, is informed by frameworks that appear in the adaptation literature. These guides often take a community-based approach with less emphasis on the impacts to ecosystems. For this reason, and stemming from an adaptation planning process that was completed for the Lake Simcoe watershed in Ontario, an ecosystem-based approach to adaptation planning was developed. A Practitioner's Guide to Climate Change Adaptation in Ontario's Ecosystems is designed to help those in the natural resource sector respond to and prepare for climate change and introduces the concepts of climate change adaptation, vulnerability, and risk. It also describes a framework that can be used to support adaptive management in a rapidly changing climate. Ultimately, the guide seeks to help natural resource managers identify ways that climate change vulnerabilities and

risks can be integrated into decision-making processes that include adaptation action plans, strategies, and policies. *Keywords: Climate change, Adaptation, Ecosystems, Vulnerability, Decision making, Assessment.*

DOVE, A. and HILL, R.B., Environment Canada, Water Quality Monitoring and Surveillance, Burlington, ON. **Updated Long-term Trends of Nutrients and Major Ions in Lake Ontario.**

The Great Lakes Surveillance Program, Environment Canada's long-term water quality monitoring program on the Great Lakes, was initiated in the late 1960s in Lake Ontario. The Great Lakes Connecting Channels Program, initiated in the next decade, supplements the information from the open lake with information from the Niagara River and the St. Lawrence River. Here, we will provide an update on the status and trends of major ions and nutrients, including phosphorus, nitrogen calcium and silica. Similar to lakes Michigan and Huron, incidental oligotrophication appears to have occurred in Lake Ontario since the introduction of invasive mussels in about 1990. For other compounds, longer-term water quality trends are apparent. *Keywords: Water quality, Nutrients, Lake Ontario.*

DRAKE, C.C.[1] and VIS, C.[2], [1]Pukaskwa National Park, 0 - Hwy 627, Marathon, ON, P0T 1R0; [2]Ontario Service Centre, 111 Water St. E, Cornwall, ON, K6H 6S3. **Monitoring of Water Quality and Quantity in 3rd and 4th Order Streams in Pukaskwa National Park: Defining and Maintaining Ecological Integrity.**

Parks Canada's mandate is to maintain the ecological integrity of ecosystems within National Parks, an increasingly difficult task as activities outside of park boundaries such as mining, forestry, and long-range pollution can affect ecological integrity inside. Developing long-term monitoring programs to achieve ecological integrity objectives is a challenge, as recently developed monitoring programs don't provide historical data necessary for assessing a 'natural' benchmark. Pukaskwa National Park monitored eight third and fourth order streams tri-annually from 2009 to 2011 to assess water chemistry and hydrology. A combination of historical and greater park ecosystem data was compared to develop thresholds for detecting deviation in parameters from a natural condition. The national water quality index (CCME-WQI), and current guidelines for water quality were evaluated for usefulness in park monitoring, particularly as relatively unobstructed, presumably healthy streams regularly exceeded pre-determined guidelines. Variation in discharge was compared to rivers that are part of the national water sampling program in close proximity. Our work suggests locally-derived data in watersheds free from direct impacts can be more appropriate for setting ecological benchmarks than applying national guidelines to Northern Ontario. *Keywords: Ecosystem health, Stream assessment, Water quality.*

DUB, J.D., REDMAN, R.A., WAHL, D.H., and CZESNY, S.J., Illinois Natural History Survey, Lake Michigan Biological Station, University of Illinois, Zion, IL. **Spatiotemporal Variation in Size-At-Age of Juvenile Yellow Perch and Effects of Size-Selective Mortality on Year-Class Strength in Lake Michigan.**

Current estimates of yellow perch recruitment in Lake Michigan are based on the premise that year-class strength is determined prior to the end of the first growing season. However, spatiotemporal variation in size at the end of the first growing season coupled with size-selective mortality throughout the juvenile stage may have a significant influence on recruitment at sexual maturity. Temporal variation in size-at-age and cumulative size-selective mortality were investigated using juvenile yellow perch collected from 2006-2010 in Illinois waters of Lake Michigan, whereas spatial comparison of size-at-age was made using yellow perch collected near Muskegon, MI and Waukegan, IL in 2010. Sagittal otoliths were removed and fish total length was recorded. Otolith microstructure analysis was used to determine age and back-calculate size-at-age. First year overwinter mortality was examined by comparing pre and post winter length-frequency distributions. Cumulative mortality was assessed by comparing length distributions and mean length-at-age at initial capture to back-calculated lengths of the same age at a later capture date. This study provides insights into juvenile yellow perch life history and determines that mortality during this life stage has the potential to shape year-class strength.
Keywords: Yellow perch, Lake Michigan, Life history studies.

DUPONT, F.[1], FORTIN, V.[1], CHITTIBABU, P.[2], YERUBANDI, R.R.[2], and LU, Y.[3], [1]Environment Canada, 2121 Transcanadian Highway, Dorval, QC, H9P 1J3; [2]National Water Research Institute (CCIW), 867 Lakeshore Rd, Burlington, ON, L7R 4A6; [3]Fisheries and Oceans, Bedford Institute of Oceanography, 1 Challenger Drive, Dartmouth, NS, B2Y 4A2. **The Thermocline Problem in a Coupled Atmosphere-Lake-Hydrology Modelling System.**

Environment Canada recently developed a coupled lake-atmosphere-hydrological modelling system for the Laurentian Great Lakes. This modelling system consists of the Canadian Regional Deterministic Prediction System (RDPS), itself based on the Global Environmental Multi Scale model (GEM), the MESH (Modélisation Environnementale Surface et Hydrologie) surface and river routing model, and a hydrodynamic model based on the three dimensional global ocean model Nucleus of European Model of the Ocean (NEMO). The model was run from 2004 to 2009 with atmospheric forcing from GEM and river forcing from MESH and compared with available observations in selected lakes. The NEMO model is able to produce observed variations of lake levels, ice concentrations, lake surface temperatures, surface currents and vertical thermal structure reasonably well in most of the Great Lakes. However, the model produced diffused thermocline in the central basin of Lake Erie and predicted evaporation is relatively strong in the upper lakes. This presentation will focus on the thermocline problem through different sensitive experiments. *Keywords: Model studies, Atmosphere-lake interaction, Lake Erie.*

<u>ECCLESTONE, A.E.</u>, 755 Wallace Rd., Unit 5, North Bay, ON, P0T 1E0. **From Extirpation to Detection and Research; Examining the Distribution and Movement Patterns of Lake Sturgeon (Acipenser fulvescens) in the White River, a Northeastern Lake Superior Tributary in Pukaskwa National Park.**

Lake Sturgeon were classified as extirpated from the White River until investigative netting in 2010 confirmed their presence. Upon confirming that a Lake Sturgeon population resided in the White River, a radio telemetry study was developed and undertaken in 2011. A total of 82 Lake Sturgeon were captured and 40 individuals were radio tagged (CPUE=0.62 sturgeon/100' net/d). Lake Sturgeon in the White River showed a significant non-random distribution ($p<0.001$) and were heavily aggregated immediately below and 1.5 km below Chigamiwinigum Falls. Minimum displacement per day (MDPD) had a median of 53.66 m/day but significantly differed between study weeks and depending on the location of the individual ($F(10,351)=3.357$, $p<0.001$; $F(2,360)=31.180$, $p<0.001$; respectively). As well, MDPD was significantly and negatively correlated with growing degree days (GDD) per week, GDD since June 1st, and depth ($R2=0.1449$, $F(5,357)=12.0949$, $p<0.001$). The White River Lake Sturgeon population is relatively abundant, fast-growing, and its critical habitat is protected by the confines of Pukaskwa National Park. Given these characteristics, we suggest that the White River is critical to Lake Sturgeon rehabilitation in Lake Superior and that other remote northeastern Lake Superior tributaries be investigated for the presence of Lake Sturgeon. *Keywords: White River, Lake Sturgeon, Lake Superior.*

<u>ELBIN, S.B.</u>[1] and CRAIG, E.C.[2], [1]New York City Audubon, 71 W. 23 St., Suite 1523, New York, NY, 10010; [2]Fernow Hall, Cornell University, Ithaca, NY, 14853. **Population Dynamics of Double-crested Cormorants Breeding in the New York Harbor.**

Double-crested Cormorants, Phalacrocorax auritus,(DCCO) have increased in number and geographic distribution throughout the Great Lakes and eastern US coast during the past 30-35 years, becoming over abundant in some regions of northern New York State and Canada. Twenty years ago, approximately 1,000 breeding pairs were documented nesting in trees on two islands in the New York Harbor (NYH). In 2005 Chip Weseloh presented data to us on DCCO population dynamics in the Great Lakes, helping us launch our program in the New York Harbor. The number of DCCO breeding in the harbor has fluctuated every year since our surveys began in 2005. Cormorant populations are not steadily increasing. In 2011 there were 1380 pairs, 23% less than the high count (n=1806) in 1995. Our color-banding program (n= 2,000 birds banded) is starting to produce results for re-sighting birds breeding on the natal colony (n=2% return). Tree health was monitored; diet is being assessed. We collected feathers from chicks from 2007 to 2010. Using stable isotope analyses, we were able to compare 13C, 15N, and 34S in DCCO and have found significant differences in foraging habitat between coastal DCCO and DCCO breeding in a nearby freshwater reservoir. *Keywords: Avian ecology, Urban areas, Populations.*

ENDSLEY, K.A., BROOKS, C.N., ERICKSON, T., SHUCHMAN, R.A., and SAYERS, M.J., MTRI, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105. **A Water Monitoring and Information System for Lake Superior: A Web Portal with Real-Time Buoy and Vessel Data for Climate and Ecosystem Studies.**

The Lake Superior Water Monitoring and Information System offers timely observations of wave conditions, water quality, and weather conditions on Lake Superior from a variety of sources. The Michigan Tech Research Institute, with the support of GLOS and the University of Michigan, has deployed buoys at the North and South Entries of the Keweenaw Waterway. Data from this buoy are transmitted in real-time through a satellite uplink, allowing for their timely distribution on the LSWMIS web service. Near real-time data collected from the Ranger III vessel traveling between Isle Royale and Houghton, MI are also displayed on the website. Software such as the Django web framework, GeoDjango extension and PostgreSQL handle data requests while Javascript libraries enhance the user's experience by providing sophisticated visualization in charts and maps. The user-friendly open source software has allowed scientists to explore the relationship between surface winds and coastal upwelling, and buoy temperature and satellite-based temperature measurements. The long-term observations afforded by the instrumentation also help with explaining the origin of the recently-verified thermocline. These observations are also of great importance to recreational boaters, commercial fishers, and search-and-rescue operations. *Keywords: Lake Superior, Buoy, Observing systems, Data storage and retrieval.*

ESSIG, R.R., TROY, C.D., CHAUBEY, I., CHERKAUER, K.A., and TAN, J., 550 Stadium Mall Dr, West Lafayette, IN, 47907. **Temporal and Spatial Variations of Nutrient Loading from Southern Lake Michigan.**

A key focus of ongoing Great Lakes restoration efforts is the reduction of nutrients delivered to the lakes from riverine inputs. Much research has been conducted about the magnitudes and locations of tributary nutrient loading from base flows to Lake Michigan and other Great Lakes. However, sampling constraints have precluded the extension of these results to include episodic storm events, and there is much evidence from other systems suggesting that much (if not most) nutrient delivery occurs during storm events. This study focuses on the direct measurement of nutrient delivery during episodic events and aims to quantify the episodic nutrient loads from two southern Lake Michigan tributaries. Field work consists of episodic and baseline water sampling and continual water parameter measurement within the tributaries and river plume mapping within Lake Michigan. Collected sediment and nutrient loading time series as well as water quality parameters are utilized to calculate loading rates for the study tributaries, which are compared to loading rates estimated with the Soil and Water Assessment Tool (SWAT). Preliminary river plume maps are also presented to track the immediate fate of nutrients and sediments once the plume enters Lake Michigan. *Keywords: Nutrients, Lake Michigan, Tributaries.*

ETHIER, A.L.M.[1], ATKINSON, J.F.[2], DEPINTO, J.V.[3], and LEAN, D.R.S.[4], [1]Atomic Energy of Canada Limited, Stn700D, Chalk River, ON, K0J 1J0; [2]20 Jarvis Hall, University of Buffalo, Buffalo, NY, 14260; [3]Limno Tech, 501 Avis Dr., Ann Arbor, MI; [4]Lean Environmental, P.O. Box 309, Apsley, ON, K0L 1A0. **Overview and Application (Lake Ontario) of a Hg Lake Model (HERMES).**

HERMES is a mass balance steady-state mercury (Hg) lake model that considers the dynamics of the three main Hg forms; elemental Hg, methyl Hg and inorganic Hg. It was primarily developed to be used as a screening level tool for lakes or rivers with limited datasets. An overview of the model and application to Lake Ontario will be presented, along with a tutorial on how to use this freely available model (contained within an MS Excel workbook). Lake Ontario was chosen for model application because of the abundant amount of measured Hg values for model evaluation, availability of estimates from the LOTOX2-Hg model, and the large surface area and relative homogeneity (variation does exist between nearshore and offshore) of sediments within the lake. If time permits, I'll also provide an overview of Great Lakes Hg model (in progress). Bring along your laptops if possible for this presentation and model demonstration. I'll have a copy of the HERMES model on hand that I can download (with USB stick) on to your computer during the break proceeding this session (or earlier if you let me know, please contact ethiera@aecl.ca). *Keywords: Lake model, Lake Ontario, Mercury.*

EVANS, D.O.[1], RENNIE, M.D.[2], and OZERSKY, T.O.[1], [1]OMNR, Trent University, 2140 East Bank Drive, Peterborough, ON, K9J 7B8; [2]Fisheries and Oceans Canada, 501 University Crescent, Winnipeg, MB, R3T 2N6. **Stable Isotopes Reveal Shifts in Energy Flow to Benthic Invertebrates and Inshore Fishes Following Invasion of Dreissenid Mussels in a Large Lake Ecosystem.**

Stable isotopes are increasingly used by ecologists in the Great Lakes to answer questions about food web structure, energy flow, habitat use and terrestrial inputs. In this study we employed C and N stable isotopes to describe changes in food web structure and energy flow in a large inland lake in the lower Great Lakes watershed, following invasion of dreissenid mussels. Dreissenids became established in Lake Simcoe, Ontario in the mid 1990's, quickly attaining high biomass in the littoral zone of the lake. We determined stable isotope ratios of benthic invertebrates, an omnivorous fish (yellow perch), and a top piscivore (smallmouth bass) in nearshore and offshore habitats before and after establishment of dreissenid mussels using archival and contemporary materials. Spatial patterns of $\delta13C$ from nearshore to offshore revealed a gradient in contributions of littoral and pelagic energy sources to benthic invertebrates and yellow perch. Results of isotopic mixing models showed major shifts in sources of carbon to most taxa including yellow perch and smallmouth bass following dreissenid establishment. Changing food web structure and energy flow patterns in response to invasive species have important implications for lake managers with reference to community structure, water quality, and fish production. *Keywords: Fish, Foodwebs, Benthos, Energy flow, Isotope studies, Invasive species.*

FAY, D.M.[1] and WERICK, W.[2], [1]Great Lakes - St Lawrence Regulation Office, Environment Canada, 111 Water St East, Cornwall, ON, K6H 6S2; [2]Werick Creative Solutions, 14508 Chesterfield Lane, Culpeper, VA, 22701. **Dealing with Climate Variability and Change in Lake Superior Regulation Plan Selection.**

The IJC's Upper Great Lakes Study recently completed work to improve the outflow regulation of Lake Superior. A methodology was developed to evaluate the performance of alternative outflow regulation plans despite uncertain future climate variability and change. Given the irreducible uncertainty, the process was designed to consider a wide range of plausible future water supplies without explicitly considering probability or the expected values of outcomes. Different approaches to capture potential variability and change in future supplies were used including historical supplies, three different stochastic models based on the statistical characteristics of the historic supplies, climate change projections from Regional Climate Models, statistically shifted historic supplies based on climate change GCM projections of climate parameters, and a statistical model that extended linear trends in supplies to each lake since 1960. From the large datasets developed with these approaches, 13 diverse net basin supply sequences were selected to represent the full array of plausible hydrologic conditions. While some plans were best for certain supplies, the study's recommended plan performed about as well or better than the other alternatives no matter which of these 13 very different and plausible supply conditions occurred. *Keywords: Water level, Climate change, Decision making.*

FEINER, Z.S.[1], HÖÖK, T.O.[1], CHONG, S.C.[2], FIELDER, D.G.[3], KNIGHT, C.T.[4], LAUER, T.E.[5], and THOMAS, M.V.[6], [1]Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN, 47907; [2]Upper Great Lakes Management Unit, Ontario Ministry of Natural Resources, Sault Ste. Marie, ON, P6A 2E5; [3]Alpena Fisheries Research Station, Michigan Department of Natural Resources, Alpena, MI, 49707; [4]Fairport Fisheries Research Unit, Ohio Department of Natural Resources, Fairport, OH, 44077; [5]Department of Biology, Ball State University, Muncie, IN, 47306; [6]Lake St. Clair Fisheries Research Station, Michigan Department of Natural Resources, Harrison Township, MI, 48045. **Temporal and Spatial Trends in Reproductive Life History Traits of Yellow Perch in the Great Lakes.**

Yellow perch (*Perca flavescens*) in the Great Lakes have been subjected to multiple ecosystem stressors, such as fishing mortality, eutrophication, and invasive species. These changing selective pressures may have caused shifts in their maturation schedules, which can impact population growth and recruitment success. To examine spatial and temporal trends in yellow perch maturation schedules, we determined the age and length at 50% maturity, age-specific maturity ogives, and probabilistic maturation reaction norms for populations from lakes Michigan, Erie, St. Clair, and Huron. Over time, fish in Lake Michigan and Saginaw Bay exhibited increased age and size at maturity, while other populations saw no change (lakes Erie and Huron) or decreased age and size at maturity (Les Cheneaux). Spatially, fish in Lake Michigan and Georgian Bay matured at older ages and larger sizes, while fish in Lake St. Clair and Saginaw Bay matured at younger ages and smaller sizes. Temporal trends suggest that size-selective fishing was an important source of life history shifts in Lake Michigan, while different mechanisms may be driving trends in other lakes. Spatial variation in maturation schedules may not reflect recent disparities in fishing levels, rather reflecting differences in growth rates and

long term environmental conditions. *Keywords: Yellow perch, Life history studies, Great Lakes basin.*

FERA, S.A.[1], RENNIE, M.D.[2], and DUNLOP, E.S.[3], [1]Trent University, 1600 West Bank Drive, Peterborough, ON, K9J 7B8, Canada; [2]Fisheries and Oceans Canada, Freshwater Institute, 501 University Crescent, Winnipeg, MB, R3T 2N6, Canada; [3]Ontario Ministry of Natural Resources, 2140 East Bank Drive, Peterborough, ON, K9J 7B8, Canada. **Using Stable Isotopes to Analyze Dreissenid-Induced Changes in the Feeding Habits of Lake Whitefish in the Great Lakes.**

The establishment of dreissenid mussels (*D. polymorpha* and *D. bugensis*) has contributed to the re-engineering of the Great Lakes ecosystem by modifying food web dynamics and altering the availability of food sources to native species. The commercially important lake whitefish, in particular, has shown growth declines in several locations, and recent research indicates dreissenid-driven changes may be the cause. Coinciding with the establishment of dreissenids, the primary food source of lake whitefish, *Diporeia*, has declined, which may be causing a search for new prey sources. Initial research in a population of lake whitefish in South Bay, Lake Huron, showed an increased dependence on nearshore food sources as a result. We analyzed ∂13C and ∂15N isotope ratios from archived lake whitefish scales collected in several of the Great Lakes (Lakes Huron, Ontario, and Superior) to determine if there has been a wide-spread change in the depth of whitefish feeding following dreissenid establishment. Increases in ∂13C and decreases in ∂15N were found in both Huron and Ontario following dreissenid establishment, but no shift was observed in Lake Superior where dreissenids have not become established. The shifts in isotopic signatures in Huron and Ontario are indicative of a shallower depth distribution. *Keywords: Dreissena, Lake whitefish, Stable isotopes.*

FIGARY, S.F.[1], SCHULZ, K.L.[1], TEECE, M.A.[1], and RUDSTAM, L.G.[2], [1]State University of New York College of Environmental Science and Forestry, Syracuse, NY; [2]Cornell University, Ithaca, NY. **Unexpected Effects of an Invasive Zooplankton, *Cercopagis pengoi*, on the trophic Position of Planktivorous Fish, *Alosa pseudoharengus*, in New York's Finger Lakes.**

Predatory zooplankton, *Cercopagis pengoi*, invaded the Great Lakes in 1998 and spread to six of eleven New York Finger Lakes. *C. pengoi* invaded a relatively empty niche, where the native zooplankton assemblage includes few predators. We hypothesized that this mid-trophic level invasion would increase the trophic position of planktivorous fish in invaded lakes, as their diet shifts from consuming mainly herbivorous zooplankton to including the predatory invader. Alewife (*Alosa pseudoharengus*), a dominant planktivore known to consume *C. pengoi* were collected from invaded and non-invaded lakes. Stable isotopes were used to determine the trophic position of collected alewife. A significant (p=0.011) decrease in average trophic position (3.20) was found for alewife from invaded lakes compared to non-invaded lakes (3.65), opposite to the predicted trend. Alternative investigated hypotheses include: (1) *C. pengoi* is replacing native predatory zooplankton and not increasing availability, (2) lake productivity is influencing trophic positions of alewife, (3) non-invaded lakes have lower food quantity or quality, thus increased values are indicative of poor alewife conditions. These results highlight the complexity

of food web processes and necessity of quantifying food web position. *Keywords: Invasive species, Zooplankton, Food webs, Cercopagis pengoi.*

FISK, A.T.[1], <u>BRUSH, J.M.</u>[2], and JOHNSON, T.B.[3], [1]University of Windsor, Great Lakes Institute for Environmental Research, 2990 Riverside Drive West, Windsor, ON, N9B3P4; [2]University of Waterloo, Department of Biology, 200 University Avenue East, Waterloo, ON, N2L 3G1; [3]Ontario Ministry of Natural Resources, Glenora Fisheries Station, 41 Hatchery Lane, Picton, ON, K0K2T0. **Stable Isotopes, Consumer Trophic Position and Food Chain Length in Eastern Lake Ontario: Implications for Ecosystem Management Within the Laurentian Great Lakes.**

Lakes are important sources of water for trade, recreational and consumptive uses, and support a broad diversity of aquatic life, which contribute to the functioning of the lake ecosystem. Multiple stressors of natural and anthropogenic origin such as climate change, pollution, and habitat degradation have determined the current structure and health of aquatic communities. Comprehensive assessments of entire food webs are lacking, which can provide insight into how food web structure and relative ecosystem health may vary between regions with similar community assemblages. Stable carbon (δ13C) and nitrogen (δ15N) isotope composition of consumers and prey items within the Bay of Quinte and Kingston Basin revealed similar trophic structure, however trophic position and length of the food web varied between habitats. Our results demonstrate that despite variation in consumer stable isotopes and stomach contents, which were useful for characterizing feeding variation between locations, trophic position and food chain length can be used as reliable indicators of food web structure and ecosystem health. These indicators can also be used to calibrate against future food web changes that may accompany habitat improvement, interactions with invasive species, and climate changes in this, and other regions of the Laurentian Great Lakes. *Keywords: Food webs, Stable isotopes, Lake Ontario.*

<u>FLORENCE, C.V.</u>, BRYAN, N.J., MOORHEAD, D.L., and CRAIG, T.D., 2801 W. Bancroft Rd., Mail-stop 604, Toledo, OH, 43606. **Impacts of Water discharge from a Coal-Fired Power Plant on Native Unionids in Western Lake Erie.**

Native unionids are currently endangered in the Laurentian Great Lakes due to habitat degradation and biofouling by invasive dreissenids, although several refuges have been documented. We discovered one such refuge, within the thermal discharge of the Toledo Edison, Bayshore power plant in Maumee Bay, and report herein our preliminary analyses of unionid, dreissenid, and sediment data. Unionids were hand-sampled during a seiche in October 2011 at two locations: (1) within the thermal plume and (2) two kilometers east of the plant at Bay Shore Park, Oregon, Ohio. These data indicated that unionids exhibited greater recruitment, size, and longevity within the thermal plume ($P<0.05$). Dreissenid biofouling also was significantly lower within the plume ($P<0.05$). Sediment data from ponar samples collected in 2010 both within and beyond the extent of the plume showed that mean total and coarse (13-25mm) sediment dry mass, and percent organic matter were negatively correlated with distance from the plant discharge (all $P<0.05$; $R2 = 0.551, 0.497,$ and 0.479, respectively), suggesting that sediment

accumulation and composition may be important factors affecting unionids. *Keywords: Lake Erie, Thermal plumes, Unionids.*

FOLEY, C.J.[1], BOWEN, G.J.[2], NALEPA, T.F.[3], HÖÖK, T.O.[4], and SEPÚLVEDA, M.S.[4], [1]Illinois-Indiana Sea Grant, Purdue University, West Lafayette, IN; [2]Department of Earth and Atmospheric Sciences, Purdue University, West Lafayette, IN; [3]NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI; [4]Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN. **Using Stable Isotopes to Examine Potential Trophic Overlap of *Diporeia spp.* and Dreissenid Mussels.**

Historically, *Diporeia spp.* constituted a major component of benthic biomass in offshore regions of the Laurentian Great Lakes, serving as an important diet item for many fishes and playing a crucial role in foodweb cycling between the benthos and pelagia. *Diporeia* population numbers in four out of five Great Lakes have declined drastically in recent years. This crash in numbers coincides with the establishment and proliferation of dreissenid mussels, leading researchers to hypothesize that dreissenids compete with *Diporeia* for food resources. At the same time, some of the Finger Lakes, notably Cayuga Lake, appear to simultaneously support stable populations of both *Diporeia* and dreissenids. We used a suite of stable isotopes to examine potential trophic overlap between *Diporeia* and dreissenids. We compared signatures of $\delta 2H$, $\delta 18O$, $\delta 13C$ and $\delta 15N$ of *Diporeia* collected from Lake Michigan, Lake Superior and Cayuga Lake, and dreissenids collected from Lake Michigan and Cayuga Lake. Animals were collected in spring, summer and fall of 2008 and 2009. We will discuss results and their implications for Great Lakes basin foodwebs. *Keywords: Stable isotopes, Dreissena, Diporeia.*

FOSSEY, M.[1], ROUSSEAU, A.N.[1], VARIN, M.[2], FOURNIER, R.[2], THÉAU, J.[2], and POULIN, M.[3], [1]Centre Eau Terre Environnement, Institut National de la Recherche Scientifique, Québec; [2]Département de géomatique appliquée, Université de Sherbrooke, Sherbrooke; [3]Département de phytologie, Université Laval, Québec. **The Values of Wetlands under the Context of Climate Change through the Assessment of Ecosystem Services and Hydrological Benefits.**

Assessing water resources and the sustainability of associated ecosystems is a major challenge in the context of climate change. Wetlands are amongst the ecosystems most heavily altered by anthropogenic activities. The concept of ecosystem services has become widespread given the vulnerability of wetland ecosystems and the estimated costs of mitigating the impacts of climate change on natural resources and the public. The development of tools such as hydrological modelling allows an overall assessment of the role of wetlands (e.g., support for low flows, flood mitigation) and thus permits estimates of the impact of adaptation strategies (i.e., preservation/conservation). We propose a series of spatial indicators of the ecological services provided by wetlands. In the context of the impact of climate change on wetlands, we present our hydrological modelling, vegetation analysis, and spatial indicators: (a) to quantify the differences in functionality between wetlands in order to establish a typological classification for the hydrological model, (b) to evaluate the spatial and temporal variability of ecological/hydrological processes, (c) to identify the impacts of ecosystem services provided by

wetlands, and (d) to evaluate the importance of wetlands in the development of climate change adaptation strategies.

FRANCY, D.S., BRADY, A.M.G., CORSI, S.R., HAACK, S.K., HAYHURST, B.A., LANT, J., NEVERS, M.D., TERRIO, P.J., and ZIMMERMAN, T.M., 6480 Doubletree Avenue, Columbus, OH, 43229. **Developing and Implementing the Use of Predictive Models for Recreational Water Quality throughout the Great Lakes.**

To improve the timeliness and accuracy of recreational water-quality assessments, nowcast systems based on predictive models are used at a few beaches around the Great Lakes. Predictive models use variables that are quickly measured to estimate concentrations of bacterial indicators, such as E. coli, or yield the probability that a bacterial standard will be exceeded. Variables used to predict E. coli include rainfall, turbidity, wind direction and speed, lake level, water temperature, wave height, streamflow, and current direction and speed. Nowcasts have been shown to provide better estimates of public health risk than the use of the previous day's E. coli, especially in regard to predicting exceedance of the standard. The USGS, in cooperation with local and state agencies, worked to improve existing operational nowcasts and expand the use of nowcast systems to more than 50 beaches throughout the Great Lakes. Variables to improve existing operational models, such as depth to water in sand, were measured, and equipment was installed to automate measurements. Software routines, spreadsheets, and modeling programs were developed to expedite the compilation of data from external sources and to automate modeling steps. Examples of models that will be used in 2012 operational nowcast systems will be presented. *Keywords: Assessments, Nowcasts, Microbiological studies, Model studies.*

FRY, L.M.[1] and GRONEWOLD, A.D.[2], [1]Cooperative Institute for Limnology and Ecosystems Research, University of Michigan, 4840 S. State Road, Ann Arbor, MI, 48108; [2]NOAA Great Lakes Environmental Research Laboratory, 4840 S. State Road, Ann Arbor, MI, 48108. **Development of a Regional Parameter Estimation Model for a Basin-Wide Recalibration of the Large Basin Runoff Model.**

NOAA's Great Lakes Environmental Research Laboratory's Large Basin Runoff Model (LBRM) provides estimates of runoff driven by rainfall and temperature forecasts. These runoff estimates are used in the Great Lakes Advanced Hydrologic Prediction System (AHPS), which provides forecasts of lake levels used by the transportation and power generation industries. Although the LBRM provides suitable runoff forecasts for use in the AHPS forecasting system, it has been nearly 30 years since its last calibration and improved model skill may result from a new basin-wide calibration using updated climate and flow records and new methods for parameter estimation. Previously, the LBRM was calibrated to observed discharge in each subbasin, where observed discharge in ungauged portions of the subbasins was estimated by extrapolating from nearby gauges using an aerial weighting procedure. An alternative calibration procedure relying on methods for prediction in ungauged basins involves developing a regional model describing relationships between LBRM model parameters and catchment characteristics. We will present preliminary results from work that is underway to develop such a regional

parameter model and conduct a basin-wide recalibration of the LBRM. *Keywords: Hydrologic budget, Prediction in ungauged basins, Water level, Watersheds.*

FUJISAKI, A.[1], WANG, J.[2], SCHWAB, D.J.[2], and HU, H.[1], [1]CILER, University of Michigan, 4840 S State Rd, Ann Arbor, MI, 48108; [2]NOAA/GLERL, 4840 S State Rd, Ann Arbor, MI, 48108. **Interannual Variability of Ice-Circulation Coupled System in Lake Erie.**

Hindcast from 2003 to 2010 is conducted using an ice-lake circulation model for Lake Erie in order to discuss the interannual variability of ice-circulation coupled system in the lake. The model is based on the primitive equations (Princeton Ocean Model) with a horizontal resolution of 1km and 21 sigma levels in the vertical direction. The ice model consists of a continuum dynamic model and the 0-layer thermodynamic model. The ice dynamic model uses the elastic-viscous-plastic rheology. The model reasonably reproduced the interannual variability of ice extent compared with satellite observations. The interannual variability of ice extent, lake circulation, and thermal structure will be also discussed in conjunction with atmospheric conditions, as well as large-scale climate factors. The relation between the ice-circulation coupled system and the biological activity at interannual timescale will be also discussed based on satellite measurements of surface Chlorophyll-a products. *Keywords: Lake Erie, Model studies, Ice.*

FUNNELL, E., 50 Bloomington Road, Aurora, ON, L4C3R7, Canada. **Lake Simcoe Fish Community Objectives.**

Lake Simcoe is the largest inland lake in southern Ontario, is the most intensively fished inland lake in the Province and supports a valuable sport fishery. Human related activities have impacted the Lake and its watershed resulting in degradation of water quality and fish habitat and a decline in the coldwater fish community and fishery. In response, the Ontario government committed to protect Lake Simcoe and passed the Lake Simcoe Protection Act which provides the authority for the Lake Simcoe Protection Plan. The Plan commits to developing Fish Community Objectives for Lake Simcoe. The Lake Simcoe Fish Community Objectives will provide a common goal and a comprehensive set of objectives to strategically guide fisheries management decision making into the foreseeable future and enhance and guide the collective efforts amongst other agencies and organizations to manage the fishery and fisheries resources of the lake and its watershed. Multiple objectives are set for the coldwater, warmwater and tributary fish communities. They encompass a responsibility to actively manage fish communities, fisheries and their functions; maintain populations of native fish species and promote natural reproduction; provide sustainable harvest opportunities; and identify opportunities for enhancement and restoration of habitats. *Keywords: Lake Simcoe, Fish management, Policy making.*

FUSARO, A.J.[1], STURTEVANT, R.A.[1], NÚÑEZ, G.C.[2], and RUTHERFORD, E.S.[1], [1]NOAA Great Lakes Environmental Research Laboratory, 4840 South State Road, Ann Arbor, MI, 48108; [2]Worcester Polytechnic Institute, 100 Institute Road, Worcester, MA, 01609. **Assessment of High Risk Potential Great Lakes Invaders Using GLANSIS.**

The Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS - http://www.glerl.noaa.gov/res/Programs/glansis/glansis.html) is a Great Lakes specific node of the USGS Nonindigenous Aquatic Species (NAS) system. GLANSIS has been selected as the backbone for AIS information reporting for the Great Lakes region under the Great Lakes Restoration Initiative. Last year, the GLANSIS project team reviewed published literature to identify 53 nonnative fishes, invertebrates, and plants as being at risk for future Great Lakes invasion based on their presence in a known donor region, ability to survive transport or arrive in high numbers or frequency, history of successful invasion elsewhere, and environmental suitability of the Great Lakes. Our more detailed evaluation of these species' presence in one or more pathways (introduction potential), their ecological characteristics and invasion history (establishment potential), and their socioeconomic and environmental effects (impact potential) has led to creation of GLANSIS species profiles summarizing risk assessment outcomes and available management options. We present results and limitations of these assessments in support of early detection and rapid response efforts by Great Lakes resource managers and decision makers. *Keywords: Invasive species, Biological invasions, Assessments.*

GATHMAN, J.P.[1] and BURTON, T.M.[2], [1]University of Wisconsin - River Falls, 410 S. Third Street, River Falls, WI, 54022; [2]Michigan State University, 203 Natural Science Building, East Lansing, MI, 48824. **Comparing the Influences of Water-level Change and Plant-community Composition on the Fish and Invertebrate Community of a Lake Huron Coastal Wetland.**

Flooding regime and vegetation structure influence wetland fauna, but determining the direct effects of each factor is difficult because many habitat factors co-vary in coastal wetlands. We studied a fish/invertebrate community along a wetland elevation gradient while Lake Huron's water level rose and fell over three years; so the flooding conditions changed substantially while plant zonation changed very little. Multivariate analyses indicated that there was an animal community "gradient" along the elevation gradient. Animal-community composition and diversity changed substantially within vegetation zones as water level changed. Community variation along the gradient decreased because the high-elevation wet meadow community became more similar to lower-elevation communities as a result of upslope expansion in distributions of many taxa. Most taxa followed the water, moving into different plant communities from year to year, suggesting that they were influenced by flooding conditions more than vegetation. These results may have important implications for conservation of high-elevation wetland zones as refuges during high-water periods, and for coastal wetland monitoring schemes based on vegetation zones as habitat for particular animal assemblages. *Keywords: Coastal wetlands, Macroinvertebrates, Water level fluctuations.*

GE, Z., WHITMAN, R.L., and NEVERS, M.B., U.S. Geological Survey, 1100 N. Mineral Springs Rd., Porter, IN, 46304. **Validation of Empirical Models for Beach Water Quality across Years: A Case Study at Ogden Dunes.**

Recreational water quality is of critical importance for protecting public health in coastal areas. In order to overcome an 18-24 hour time delay between water sample collection and issuance of beach advisories, predictive models have been explored and developed for a quick assessment of water quality. As part of a series of projects, we constructed regression-based empirical models on various hydrometeorological variables obtained from June to August 2008 at Ogden Dunes beaches, which had Burns Ditch as a known source of contamination. A simple model and a plume-dynamics based model, both driven by turbidity only, were further identified with similar goodness-of-fit as the parsimonious model produced by standard statistical packages. In 2011, a direct application of the simple and dynamic models for daily nowcasting yielded high goodness-of-fit (R-square from 0.5 to 0.7). The models however performed poorly in predicting occurrences of E. coli concentration exceeding the 235 CFU/100 mL standard. This was in part due to the unusually large number of high E. coli counts observed in the first half of summer 2011, which revealed a significant change in the mechanisms that drove E. coli variability in the beach water from 2008 to 2011. Further analysis is underway to improve model predictive capacity for exceedances. *Keywords: Environmental health, Water quality, Model testing.*

GEFELL, D.[1], CHOY, S.[2], BANDA, J.A.[3], JORGENSON, Z.[4], MOORE, J.[5], DEVAULT, D.[6], KRSKA, R.[6], and TROWBRIDGE, A.[6], [1]USFWS, New York Field Office, 3817 Luker Road, Cortland, NY, 13045; [2]USFWS, Wisconsin Field Office, 505 Science Drive, Madison, WI, 53711; [3]USFWS, Ohio Field Office, 4625 Morse Road, Columbus, OH, 43230; [4]USFWS, Twin Cities Field Office, 4101 American Boulevard East, Bloomington, MN, 55425; [5]USFWS, East Lansing Field Office, 2651 Coolidge Road, East Lansing, MI, 48823; [6]USFWS, Region 3 Office, 5600 American Boulevard West, Bloomington, MN, 55437. **Survey of Emerging Contaminants Associated with Areas of Concern in the Great Lakes Basin.**

The intensity, geographic scale, and duration of cumulative impacts to aquatic ecosystems from exposures to chemicals of emerging concern (CECs) are largely unknown, despite expanding interest during the last decade. The Great Lakes basin provides a diversity of natural ecological contexts and anthropogenic influences within which to approach the full complexity of the issue. The USFWS, collaborating with the USEPA and USGS, is surveying the extent of CEC contamination and potential implications to fish and wildlife resources at areas of concern (AOCs) within the Great Lakes basin. Water, sediment, and fish data from seven sites (a total of 48 sub-sites) in 2010-11 are presented. Sites were located near the mouths of major tributaries of Lakes Superior, Michigan, Erie, and Ontario. Samples were analyzed for pharmaceuticals, hormones, and wastewater indicators, and gross and histopathological examinations were conducted in co-located fish samples. Geographic distribution, relative potential for effects in target fish and wildlife species, and spatial relationships to likely sources of contamination were considered in the analysis and interpretation of data. Potential future directions of the program are discussed within the context of resource management priorities of

the USFWS and collaborating environmental agencies. *Keywords: Monitoring, Emerging contaminants, Areas of concern.*

GILBERT, J.M., Gilbert and Dunn Wetland Restoration Specialists, 1117 North Rd., RR5, Langton, ON, N0E 1G0. ***Phragmites australis*: A Significant Threat to Laurentian Great Lakes Wetlands.**

Phragmites australis is considered to be the most aggressive invasive species of wetlands in North America. This robust reed is now established throughout the Great Lakes and has become a common sight along transportation corridors which act as spread vectors. Phragmites colonizes new sites via seed and rhizome dispersal but, once established, spreads through rhizomes. This clonal dominant, allelopathic plant out-competes all other species including cattails (*Typha*) and willows (*Salix*) resulting in expansive mono-dominant stands that can reach heights of 5m and densities of 180 stalks/m^2. Impacts due to the severe reduction in native plants and altered habitat on wildlife are becoming more evident. No effective natural forces currently exist to keep this plant in check underscoring the need for human intervention. Unlike in the United States, control options for expansive, well established cells are limited in Canada and non existent when surface water is present. Without a concerted effort to restore lost habitat and curtail expansion, Phragmites invasion has the potential to be cumulatively devastating for a high number of Species at Risk and other wetland dependent wildlife. Phragmites impacts, current control efforts, control limitations, and recommended actions will be discussed. *Keywords: Coastal wetlands, Phragmites, Invasive species, Management.*

GINN, B.K., Lake Simcoe Region Conservation Authority, Newmarket, ON, L3Y 4X1. **Science-Based Monitoring of Environmental Changes to the Nearshore Zone of Lake Simcoe (Ontario, Canada) with a Focus on Aquatic Plants, Sediment Nutrients, and Benthic Communities.**

Lake Simcoe has been the focus of many environmental studies, due to concerns of increased nutrient loadings and declining quality of coldwater fish habitat. One aspect which, until recently, has been relatively unstudied is the nearshore zone, a dominant feature in terms of energy cycling, biodiversity, nutrient loading, surface area (67% of the lake area) and human interaction with the lake. Since 2008, the Lake Simcoe Region Conservation Authority has undertaken an in-depth scientific research and monitoring program to study environmental changes in the nearshore zone. The program targets the development of biological indicators, establishing a baseline of ecological status for tracking future change, as well as developing and addressing the environmental concerns of watershed residents. Highlights of our achievements to date include: mapping the biomass and distribution of aquatic plants and assessing community changes; distribution of invasive dreissenid mussels; using benthic invertebrates as bioindicators of environmental status; using diatoms to track nutrient flow from tributary to lake; and tracking changes in sediment phosphorus with the potential for re-release under specific environmental conditions. *Keywords: Benthos, Phosphorus, Aquatic plants, Lake Simcoe, Invasive species, Diatoms.*

GOBIN, J.[1] and DUNLOP, E.S.[2], [1]Environmental & Life Sciences, Trent University, 1600 West Bank Dr., Peterborough, ON, K9J 7B8; [2]Ontario Ministry of Natural Resources, 2140 East Bank Dr., Peterborough, ON, K9J 7B8. **The Effects of Gear Selectivity from the Lake Huron Commercial Fishery on the Evolution of Lake Whitefish Maturation Schedules.**

Lake whitefish is the major species supporting Lake Huron's commercial fishery, comprising up to 80% of the catch annually. These populations are heavily exploited, with mortality targets of 65%, and harvest often exceeding the 3.8 million kg/year objective intended for lake whitefish and ciscoes combined. High mortality alone has been linked to contemporary evolution of life history traits, such as shifts in maturation to younger ages and smaller sizes. However as many of these traits are related to body size, size-selective fishing gear can also have an effect; driving evolution in either similar or opposing directions to existing selective pressures and affecting rates of change. As various types of gear target or select fish of different sizes, effects on life history traits are also likely to differ. Lake Huron's lake whitefish fishery employs two main gear types: trap nets that capture fish above a minimum size, and gillnets that capture mid-sized fish and exclude those smaller or larger than a certain size range. Using an individual based model our study examines the effects of these gear types on the evolution of maturation schedules of Lake Huron lake whitefish; an understanding of which is essential to the development of management strategies aimed at minimizing size-selective fisheries-induced evolution. *Keywords: Fisheries-induced evolution, Life history studies, Lake whitefish, Lake Huron, Gear selectivity.*

GORAL, M.B.[1] and YAN, N.D.[1], [1]York University, Department of Biology, 4700 Keele Street, Toronto, ON, M3J 1P3, Canada; **Can the Prediction of Long-Term Zooplankton Abundance be Improved Using the Wind Field over Harp Lake?**

The predictability of zooplankton abundance under wind-driven currents has rarely been explored and further study can help improve the understanding of zooplankton communities in aquatic ecosystems. In this study, we sought relationships between the wind field and fortnightly abundances of 8 zooplankton species at a mid-lake station in Harp Lake, Ontario from 1980 to 2004. Over the time period, average wind speed has declined by 25%, while direction has shifted 21 degrees towards the north. Multiple linear regressions were generated to predict seasonal and interannual changes in daily zooplankton abundance combining year, Julian day, chemistry and, finally, wind speed and direction. The wind field was successfully loaded into these models for 5 of the 8 species, although improvements in predictive power were modest. We suspect that the decrease in wind speed has contributed to a change in zooplankton heterogeneity in the lake, and thus a change in bias of lake-wide abundance estimates derived from a single station. Zooplankton are patchily distributed, but most long-term monitoring programs sample only at one station. Our work suggests that we may well be able to correct for any bias emanating from a changing wind field and improve the predictability of abundance. *Keywords: Water currents, Small lake, Distribution patterns, Wind dynamics, Zooplankton, Anthropogenic factors.*

GORDON, M.M. and MCNAUGHT, A.S., Michigan Water Resource Center, Department of Biology, Brooks Hall 151, Mt. Pleasant, MI, 48859. **Effects of Best Management Practices and Agricultural Land Use on Water Quality of the North Branch Chippewa River, Isabella County, Michigan.**

Agriculture can be a large contributor to excess nutrients and sediment in streams. Best management practices (BMPs) have been implemented on streams adjacent to agricultural areas to control nutrient and sediment input. Land use in the North Branch Chippewa River (NB) watershed is primarily agriculture. A baseline study conducted in 1992 before implementation of BMPs showed overall degradation to water quality. The purpose of this study was to determine if water quality has changed 17 years after implementation of BMPs. Water samples and flow measurements were collected approximately biweekly and macroinvertebrate samples biennially from 4 sites on the NB and a nearby reference stream in 2008 and 2009. Nutrient and sediment loads and macroinvertebrate data from the NB and reference stream were compared to previous studies using a Randomized Intervention Analysis. Results indicate that nitrate load increased on the NB. Water quality scores indicated moderate levels of water quality degradation. *Keywords: Watersheds, Macroinvertebrates, Water quality.*

GOUDEY, S.[1], MACKEY, S.D.[2], LEE, M.[3], TEPE, K.[3], CIBOROWSKI, J.J.H.[3], and GARDNER-COSTA, J.[3], [1]University of Windsor & Limnos Ltd., 2768 Signal Hill Dr SW, Calgary, AB, T3H 2L9; [2]University of Windsor & Habitat Solutions NA, 37045 N Ganster Road, Beach Park, IL, 60087; [3]University of Windsor, 401 Sunset Avenue, Windsor, ON, N9B 3P4. **ROVER - A Remotely Operated Vessel for Environmental Research.**

A remotely operated ROVER was developed for shallow-water data collection in remote locations. The ROVER platform is based on an inflatable hull and is powered by a modified electric trolling motor. ROVER uses real-time differential GPS, a recording depth sounder, and shallow-water scanning sonar to collect high-resolution bathymetric data and epibenthic information to assess submerged aquatic vegetation (SAV) distribution and biomass. Real-time positional data are transmitted via wireless technology from the ROVER and plotted on a remote computer. Data are recorded digitally and are post-processed after the survey. ROVER operates in water depths unsuitable for most watercraft, and can collect reliable bathymetric data even where SAV densities are high. Comparison of the 200 kHz primary and 800 kHz sonar data allows us to map both mineral substrate depths and the upper surface of SAV. Conventional sidescan sonar and underwater video data complement the ROVER surveys and can be used to assist with the validation of the ROVER data. *Keywords: Coastal ecosystems, Data acquisition, Water level.*

GRAHAM, A.T. and HODSON, P.V., Queen's University, 99 University Ave., Kingston, ON, K7L 3N6. **Evidence of Pesticide Use at Expo 67 from St. Lawrence River Sediment Core.**

The pesticide DDD was used liberally prior to the World Exposition of 1967 (Expo 67) on Île Sainte-Hélène in Montréal to reduce the density of nuisance trichopteran insects (caddisflies or shadflies). About 16,000 kg were applied over 6 periods in 2 years. Despite

reports by the project leaders that the practice was not detrimental to the ecosystem, and that DDD was not detected downstream in significant concentrations following applications to the river, further investigation was required to determine the persistence of the pesticide, and its concentrations. Furthermore, the behaviour of the compound in fluvial systems is not well understood. A sediment core was obtained from a bay on Île de Grâce at the mouth of Lac St Pierre in the St. Lawrence River, downstream of Montreal. The core was sliced, analysed for DDT compounds using gas chromatography, and dated by measurement of 137Cs, 241Am, and 210Pb to establish dates of sediment deposition. Concentrations of DDT, DDD, and DDE ranged from below the detection limit to 3.3 ppb, below detection limit to 49.6 ppb, and below detection limit to 17.1 ppb, respectively. The findings confirmed a peak of DDD contamination around 1967 and may inform future decisions regarding the management of the St. Lawrence Seaway. *Keywords: Pesticides, St. Lawrence River, Sediments.*

GREEN, S.[3], <u>MEADOWS, G.A.</u>[1], SHUCHMAN, R.A.[2], KERFOOT, W.C.[3], LANG, G.A.[4], and DEAN, D.[2], [1]University of Michigan AOSS, College of Engineering, Ann Arbor, MI, 48103; [2]MTRI, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [3]Michigan Technological University, 1400 Townsend Dr., Houghton, MI, 49931; [4]NOAA GLERL, 4840 S. State Rd,, Ann Arbor, MI, 48108. **A Comparison of Remotely Sensed Lake Superior Upwellings with Buoy and Operational Forecasting.**

Michigan Technological University (MTU) operates two Tidas, automated coastal monitoring Buoys, as part of the Great Lakes Observing System (GLOS). These buoys are located at both the south and north entrances to the Keweenaw Waterway (NOAA / NDBC buoy # 45025 and # 45023) and were used to assess the accuracy of the Lake Surface Temperature (LST) information provided from the MODIS satellite imaging systems. These observations were then compared to NOAA / GLERL's, Great Lakes Coastal Forecasting System (GLCFS) modeled surface temperature and surface current predictions. The approach of combining satellite remotely sensed events with in-situ buoy observations and numerically modeled surface temperature and currents provides a powerful tool for assessing coastal conditions. These data, combined with additional buoy sensed point measurements of water quality parameters and vertical temperature distributions, further enhances the approach. Five Lake Superior, late summer upwelling event are analyzed utilizing this combined approach providing detailed descriptions of the evolution of these events. *Keywords: Buoys, Remote sensing, Lake Superior.*

<u>GREENBERG, T.A.</u>, BINDING, C.E., BUKATA, R.P., RASTIN, S., and GOULD, J., Environment Canada Water Science & Technology, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **Satellite Monitoring of Great Lakes Water Clarity - Trends Emerging from Three Decades of Aquatic Colour Satellite Data.**

The introduction of non-native invasive species, point-source discharges, nutrient loading and resulting eutrophication and harmful algal blooms, as well as mandated programs to reduce phosphorus loadings have all led to notable fluctuations in water clarity in the Great Lakes over the years. Unfortunately, sparse spatial coverage and the discontinuous nature of ground-based monitoring often preclude reliable conclusions regarding long-term lake-wide changes in water

clarity. Earth observation satellites offer regular, high resolution synoptic views of the lakes, providing more robust evidence of spatial and temporal trends in water clarity than point sampling alone. Imagery from the Coastal Zone Color Scanner (CZCS) has been used to produce monthly images of the Great Lakes for the period 1979-1986, offering an historical view of water clarity conditions. By merging this with imagery from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS, 1997-2010) and the Moderate Resolution Imaging Spectrometer (MODIS, 2003-present) it is possible to assess lake-wide changes in water clarity over the last three decades. This time-series shows seasonal and inter-annual variability in bright-water episodes such as phytoplankton blooms, re-suspension of bottom sediments, and whiting events. *Keywords: Water quality, Remote sensing, Turbidity.*

GRIMM, E. [1], TROY, C.D. [1], STEIN, S.[2], ROSWELL, C. [2], HÖÖK, T [2], and WILSON, A. [3], [1]School of Civil Engineering, Purdue University, West Lafayette, IN; [2]Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN; [3]Departments of Fisheries and Allied Aquacultures & Biological Sciences, Auburn University, Auburn, AL. **Field Characterization of River Plumes and Source Water in Southern Lake Michigan.**

River plumes in the Laurentian Great Lakes are an important part of the coastal environment because they can bring sediment, nutrients, and pollution into the lake. River plumes in oceans have been studied extensively, but river plumes in large lakes, such as Lake Michigan, have received less attention. The dynamics of river plumes are especially important in light of restoration efforts because they determine the fate of materials delivered to the lake by riverine sources. A series of field surveys were carried out in southern Lake Michigan n order to characterize the fundamental properties of river plumes. Results from four river systems are presented, with the fundamental river plume properties and composition evaluated as a function of location/watershed and season. Water quality data of four different rivers will be presented to show how plume water can be identified in a river/lake situation based on basic measurements. Additionally, dynamical predictors are presented, and these predictors allow for a quantitative evaluation of the relative importance of wind stress, buoyancy, plume momentum, and other factors. *Keywords: Lake Michigan, Water quality.*

GRONEWOLD, A.D.[1] and WOLPERT, R.L.[2], [1]NOAA (GLERL), 4840 South State Road, Ann Arbor, MI, 48108; [2]Duke University, Department of Statistical Science, 211c Old Chem, Box 90251, Durham, NC, 90251. **Moving Beyond the MPN and CFU: Novel Applications of Statistical Models to Improve Beach Water Quality Monitoring and Modeling.**

The most probable number (MPN) and the number of colony forming units (CFU) serve as a basis for enumerating fecal indicator bacteria (FIB) concentrations in recreational waters (and other waters threatened by fecal contamination). A variety of FIB concentration analysis procedures are commonly used to estimate MPN and CFU values, however each procedure introduces different degrees of bias and variability which are rarely accommodated in conventional water quality sampling protocol, bacterial model calibration and confirmation, or in the development and enforcement of recreational water quality standards. Consequently, perceived waterborne threats to human health based on MPN and CFU values may be either

overly-conservative or may fail to provide adequate protection. Here, we present research focused on using Bayesian analysis procedures to quantify FIB concentration measurement uncertainty and to propagate that uncertainty into water quality models and model-based management decisions. Our results suggest that different modeling schemes (i.e. Bayesian and conventional) might lead to different water quality and human health risk assessments, and that a closer investigation and reconsideration of standard MPN and CFU-based recreational water quality assessment protocol are needed. *Keywords: Water quality, Fecal contamination, Statistical models, Human health.*

GRUNERT, B.K. and TYNER, E.H., School of Freshwater Sciences, UW-Milwaukee, 600 E. Greenfield Ave., Milwaukee, WI, 53051. **Restoring an Urban Wetland: Lessons on Strategy.**

The Grand Trunk wetland is located in the heart of the industrial inner harbor of Milwaukee, WI. Significant perturbations have occurred at the 13.35 ha site, with only 2.6 ha of the brownfield site currently designated as wetland. It is the last remnant seiche wetland within the historic Milwaukee estuary; however, seiche activity within the site is extremely limited due to a blocked culvert. Involvement from students and faculty at the University of Wisconsin-Milwaukee's School of Freshwater Sciences, along with efforts by the City of Milwaukee, have resulted in funding to begin restoration efforts in 2013. The goal is to reconnect the wetland with the Milwaukee River estuary and plant the site with native vegetation to provide functional use as fish spawning habitat and a refuge for local and migrating birds. Restoration will allow for increased public access to the site, as well as serving as an educational tool. The site will broaden public awareness of urban wetlands and act as a model for urban wetland restoration throughout Southeastern Wisconsin. The site will enhance ecological services to the Milwaukee estuary and allow for recreational and educational use upon completion. *Keywords: Coastal wetlands, Restoration, Urban watersheds, Public education.*

GUDIMOV, A.[1], ARHONDITSIS, G.B.[1], O'CONNOR, E.[2], DITTRICH, M.[1], JARJANAZI, H.[3], PALMER, M.E.[3], STAINSBY, E.A.[3], WINTER, J.G.[3], and YOUNG, J.[3], [1]University of Toronto, Department of Physical & Environmental Sciences, Toronto, ON, M1C1A4, Canada; [2]Lake Simcoe Region Conservation Authority, Newmarket, ON, L3Y4X1, Canada; [3]Ontario Ministry of the Environment, Environmental Monitoring and Reporting Branch, Toronto, ON, M9P3V6, Canada. **A Bayesian Network for Studying the Causal Links Between Phosphorus Loading and Plankton Patterns in Lake Simcoe, Ontario, Canada.**

In this study, our thesis is that simple models can offer meaningful first-order approximations until simplicity can be gradually traded for increased explanatory power. Our primary objective is to develop a Bayesian hierarchical network of simple ecological models for Lake Simcoe, Ontario, Canada, aiming to establish a realistic representation of the causal connections among exogenous nutrient loading, ambient nutrient conditions, and epilimnetic plankton dynamics. In particular, we used a spatially-explicit simple mass-balance model forced with idealized sinusoidal loading to predict total phosphorus concentrations. A structural equation model is then used to delineate the interplay among nutrients, ambient light conditions, phytoplankton and herbivorous biomass. Our analysis pinpoints the strength of the causal paths

from total phosphorus and water clarity to phytoplankton as well as the capacity of zooplankton grazing to modulate the algal standing crop. Our Bayesian network model is also used to examine the exceedance frequency of two threshold values for total phosphorus (15 µg L-1) and chlorophyll a (4 µg L-1) concentrations under scenarios of phosphorus loading reduction. Finally, our study also pinpoints directions of future model augmentation. *Keywords: Water quality, Risk assessment, Ecosystem modeling, Bayesian inference, Lake Simcoe, Plankton dynamics.*

GUO, R.[1], REINER, E.J.[2], HELM, P.[2], MARVIN, C.[3], CROZIER, P.[2], MYERS, A.[2], MABURY, S.[1], BHAVSAR, S.P.[2], TOMY, G.[4], and SIMCIK, M.[5], [1]University of Toronto, Department of Chemistry, Toronto, ON, Canada; [2]Ontario Ministry of the Environment, Toronto, ON, Canada; [3]Environment Canada, Burlington, ON, Canada; [4]Fisheries & Oceans Canada, Freshwater Institute, Winnipeg, MB, Canada; [5]University of Minnesota, School of Public Health, Minneapolis, MN, USA. **Perfluoroalkyl Sulfonic Acids, Carboxylic Acids, and Phosphinic Acids, and Polyfluoroalkyl Phosphoric Acid Diesters in Remote and Impacted Sediments from the Great Lakes Region.**

Perfluorosulfonic acids (PFSAs) and carboxylic acids (PFCAs) have been the subject of environmental research and monitoring in the Great Lakes area over the past several years. Recently, other per- and polyfluorinated substances have attracted attention, including the polyfluoroalkyl phosphoric acid diesters (diPAPs) and perfluorinated phosphinic acids (PFPIAs). Following method improvements to enhance extraction efficiencies, we examined sediment cores from Lake Ontario and remote lakes in or near the Great Lakes region for the occurrence and deposition trends of PFSAs, PFCAs, diPAPs and PFPIAs. Organic carbon-normalized concentrations of the PFSAs and PFCAs were greatest in the Lake Ontario core, the system most impacted by urban & industrial inputs. Sedimentation fluxes were generally an order of magnitude or more greater in Lake Ontario than remote sites, indicating the relatively minor role of atmospheric inputs to Lake Ontario for these compounds. In most cases, surface sediments contained the greatest concentrations of PFSAs and PFCAs. The diPAPs were only detected in the Lake Ontario core (80-260 pg/g dw) while low but detectable amounts of the PFPIAs were detected in Lake Ontario and the remote cores. *Keywords: Sediments, Atmospheric transport, Perfluorooctane sulfonate, Perfluoroalkyl substances.*

HAFFNER, G.D.[1], PATERSON, G.[1], HEBERT, C.E.[2], and DROUILLARD, K.G.[1], [1]University of Windsor, Great Lakes Institute for Environmental Research, Windsor, ON, N9B3P4; [2]Environment Canada, Canadian Wildlife Service, Ottawa, ON, K1H 0H3. **Quality of Quantity: Energetic Condition of Great Lakes Rainbow Smelt From 1989 to 2009 and Considerations for Top Predator Bioenergetics.**

This study used long term biomonitoring data for rainbow smelt (*Osmerus mordax*) collected from Lakes Erie, Huron, Ontario and Superior between 1989 - 2009 to investigate trends in growth and condition of this species. For Lakes Huron and Superior, significant declines in smelt average body mass occurred from 1989 - 2009 with energy density also declining from 3.9 - 3.2 kJ/g (p<0.001) in this time. The average size of smelt collected from

Lake Erie increased significantly (p<0.001) from 121 - 139 mm between 1989 - 1999 and 2000 - 2009 biomonitoring periods with Lake Ontario smelt exhibiting a marginal decline in average total length from 125 - 122 mm between these time frames. Prey quality (kJ/fish) demonstrated significant changes between these biomonitoring periods for Lake Huron and Superior smelt with quality declining 50 and 29%, respectively. Bioenergetics predictions indicated that such declines in smelt quality were sufficient to increase daily prey consumption rates for lake trout predators in Lakes Huron and Superior. Combined with declining abundances that have been observed for Great Lakes smelt populations, this research indicates that salmonid top predators in Lake Huron and Superior face both declining quality and quantity of this forage species. *Keywords: Great Lakes, Lipids, Rainbow Smelt.*

HAHN, T.R., Great Lakes Center, Buffalo State College, 1300 Elmwood Avenue, Buffalo, NY, 14222. **Acoustic Remote Sensing of Fish Schools.**

The use of broadband sound to remotely sense schools of swim bladder bearing fish over large areas has received considerable interest in acoustical oceanography for several years. Fish schools insonified at frequencies close to the resonance of their swim bladder have been detected over distances of tens of kilometers or more. Recent advances in the theoretical understanding of multiple acoustic scattering from fish school targets could lead to direct remote measurements of school size, fish densities, and behavioral modes, such as school formation. Theoretical predictions of broadband acoustic cross sections of large fish schools are shown for various scenarios. The model is applied to previously published data from acoustic transmission measurements in the ocean and good agreement is shown. Based on experiences from ocean measurements and models, potential applications to the Great Lakes are discussed. *Keywords: Acoustics, Sound scattering, Fish, Fisheries acoustics, Remote sensing.*

HALEWOOD, C. and COUSINEAU, A.J., University of Toronto, 45 Walmer Rd., Toronto, ON, M5R 2X2. **Natural Curiosity: A Resource for Teachers - Building Children's Understanding of the World through Environmental Inquiry.**

The philosophy at the Dr. Eric Jackman Institute of Child Study is to support the belief that inquiry is central to all learning. In this session, participants will discover how to motivate and engage students personally in the learning process by building on their natural curiosity about the surrounding natural world. We will explore how an environmental focus in a Grade Two classroom supported the development of empathy leading to stewardship. This classroom was involved in the Lake Ontario Atlantic Salmon Restoration Program in which the children hatched, cared for, and released salmon fry. The work they did, during this focus, was integrated across curriculum areas and was pivotal in continuing the development of empathy with the students. Participants will learn strategies for using the outdoors to spark student questioning, through the four-branch framework approach to environmental education, and in turn, use students' questions, ideas, and theories about the natural world as drivers for classroom learning and stewardship development. *Keywords: Salmon, Inquiry, Environmental education, Restoration, Public education.*

HALEY, J.[1], BRAMBURGER, A.H.[1], RIDAL, J.J.[1], MARTY, J.[1], PELOT, A.[2], JOYCE, A.[2], and MAJURY, A.[3], [1]St. Lawrence River Institute of Environmental Sciences, Cornwall, ON; [2]Public Health Ontario Laboratories, Kingston, ON; [3]Public Health Ontario Laboratories and, Department of Biomedical and Molecular Sciences, Queen's University, Kingston, ON.
Bacterial Monitoring at St. Lawrence River Public Swimming Beaches.

Swim advisory postings at some St. Lawrence River public beaches are common throughout the summer due to elevated levels of *Escherichia coli* bacteria. The St. Lawrence River Institute of Environmental Sciences, in collaboration with the Eastern Ontario Health Unit, the Raisin Region Conservation Authority, the St. Lawrence Parks Commission and Public Health Ontario Laboratories, set out to determine the sources, management practices, and site characteristics, as they relate to *E. coli* levels, at four representative beaches along the St. Lawrence River. Comprehensive sampling was conducted over the past two years to evaluate the beaches including sanitary surveys (*E. coli* levels, water temperature, turbidity, specific conductivity) and weather data (precipitation, temperature, relative humidity, wind direction, speed and gust). Microbial source tracking using real time PCR for species specific *Bacteroides fragilis* markers was performed on all *E. coli* positive samples, highlighting the relative impact of both human and watershed (bovine) sources on water quality. Predictive models for *E. coli* incidence using multiple regression and alternate approaches will be described.
Keywords: Human health, St. Lawrence River, Water quality.

HALL, J.D., Hamilton Harbour Remedial Action Plan, 867 Lakeshore Road, PO Box 5050, Burlington, ON, L7R4a6. **The Cootes to Escarpment Park System: Protecting Natural and Cultural Heritage at the Head of Lake Ontario.**

The Hamilton-Burlington region at the south-western edge of Lake Ontario is a hub of considerable urban development and industrialization. It is also one of the most biologically rich areas of Canada, home to more than 50 species at risk, and the last intact ecological connection between Lake Ontario and the Niagara Escarpment. As one of Canada's biodiversity hot spots, the importance of this area has been widely recognized, including as a UNESCO World Heritage Site (Niagara Escarpment), Provincially Significant Wetlands, Important Bird Area of national significance, and Important Amphibian and Reptile Area. In order to protect this remarkable area, ten local government agencies and non-profit organizations have joined together as partners in the Cootes to Escarpment Park System - a collaborative initiative to protect, restore and connect over 3,500 ha of public and private lands and to provide sustainable recreation and education opportunities. This presentation will begin with the science that identified the biodiversity of the terrestrial and wetland communities and explain a community-based planning approach used to develop the vision and strategy for this unique to Ontario park system. It will end with the next steps in collaborative governance and implementation.
Keywords: Conservation, Biodiversity, Planning.

HALPIN, K.E.[1], <u>BOSCARINO, B.T.</u>[1], RUDSTAM, L.G.[1], WALSH, M.G.[2], and LANTRY, B.F.[2], [1]Cornell Biological Field Station, 900 Shackelton Point Road, Bridgeport, NY, 13030; [2]USGS Great Lakes Science Center, 17 Lake Street, Oswego, NY, 13126. **Effect of Light, Prey Density, and Prey Type on the Feeding Rates of the Invasive Mysid Shrimp, *Hemimysis anomala*.**

Hemimysis anomala is a near-shore mysid that has recently invaded Great Lakes ecosystems. We investigated the feeding rates and prey preferences of adult and juvenile Hemimysis in laboratory experiments. For both size classes, we measured feeding rates as a function of prey abundance, prey type (Bosmina longirostris, Daphnia pulex, and Mesocyclops sp.), and two light levels (no light and dim light, ~160 lux). Mean feeding rates on Bosmina longirostris increased with prey density to as high as 13 ind. h^{-1} in the light and 8 ind. h^{-1} in the dark conditions at the highest prey density tested (100 ind. L^{-1}). In these experiments there were no differences between adult and juvenile Hemimysis feeding rates. Both size classes fed at higher rates on Bosmina than on Daphnia or Mesocyclops. Feeding rates of adults were higher than feeding rates of juveniles when feeding on Daphnia and Mesocyclops. When given a choice of all three prey types, juveniles selected Bosmina over Daphnia or Mesocyclops, and adults selected for both types of cladocerans over Mesocyclops. Selection for cladocerans over copepods is common among mysid species. Light levels did not affect feeding rates, suggesting that Hemimysis predominantly use hydromechanical cues to detect prey.
Keywords: Zooplankton, Invasive species, Food chains.

<u>HAMEL, J.</u>, St. Lawrence Global Observatory, 310 Allée des Ursulines, Rimouski, QC, G5L 3A1. **Improving Data Access through Cooperation: A Canadian Inter-jurisdictional Model and Observatory Concept.**

Substantial resources are dedicated to data collection trough routine environmental monitoring and research programs. Over the years, data producers have developed a range of heterogeneous data management and data access solutions. However, substantial work is still required to ensure that the end-users can benefit from effective data discovery tools and system interconnection mechanisms. The St. Lawrence Global Observatory (SLGO) was created in 2005 in order to provide an integrated Web access to timely and accurate data from a network of governmental, academic and community organizations and to support sustainable ecosystem management. SLGO has addressed interoperability issues by developing an inter-institutional governance model as well as an information infrastructure based on current Web technologies.
Keywords: Observing systems, Data access, Web applications.

HAMELIN, S.[1], PLANAS, D.[2], and AMYOT, M.[2], [1]Groupe de Recherche Interuniversitaire en Limnologie et en Environnement Aquatique (GRIL), Université de Montréal, Montréal, QC, H3C 3J7; [2]GEOTOP/Groupe de Recherche Interuniversitaire en Limnologie et en Environnement Aquatique (GRIL), Université du Québec à Montréal, Montréal, QC, H3C 3P8. **Methylmercury Production in the Littoral Zone of the St. Lawrence River: Who is Responsible?**

In aquatic ecosystems, contamination of biota by methylmercury (MeHg) is a subject of concern. Considering the fact that wetlands occupy a large area of aquatic ecosystems and that they are also known to be production sites of MeHg, questions are rising about the significance of this production and the identity of the microorganisms involved. To answer these questions, periphyton biofilms growing on submerged plants (epiphytes) were sampled in Lake St. Pierre (LSP, Qc, Canada) in order to: 1) determine net MeHg production using low-level spikes of ^{199}HgO and Me^{200}Hg stable isotopes as tracers; 2) find out which groups of microorganisms contribute to net MeHg production by addition of specific metabolic inhibitors and characterization of active microbes involved in the process by sequencing of RNA 16S. Our main findings were: 1) Net MeHg production was high in LSP and varied from 1,06 to 7,87 ng/g DW epiphytes/day. 2) Methanogens rather than sulfate reducing bacteria were likely the primary methylators in epiphytes of Lake St. Pierre. *Keywords: Methylation, Mercury, Epiphytes.*

HANNES, I.P.[1], LASKER, H.R.[1], and BURLAKOVA, L.E.[2], [1]University at Buffalo, 411 Cooke Hall, Buffalo, NY, 14260; [2]Buffalo State College, Great Lakes Center, 1300 Elmwood Ave., Buffalo,, NY, 14222. **Proposed Study of Unionid Community Below and Above Escarpments from Lake Ontario and Lake Erie Tributaries.**

Freshwater pearly mussels (Family: Unionidae) are large bivalves that live in the sediments of rivers, streams, and lakes. Approximately 300 species are found in North America including the Great Lakes watershed. Although this group is highly diverse, it is the most imperiled taxa in the United States. Unionid larvae are obligate parasites on fishes, and host fish can transport the larvae great distances. Geographic barriers such as the escarpments that are present along the Lake Erie and Lake Ontario Basins have the potential of isolating mussel populations. However, unionids are present above and below escarpments. The objectives of the proposed study are to determine if unionid communities above and below escarpments of Lake Erie and Lake Ontario tributaries are similar or not and to determine the genetic population structure, genetic diversity and potential hybridization between *Lampsilis siliquoidea* and *L. radiata* populations present in this area. The research will provide baseline data that can be used to develop restoration and conservation efforts to sustain the existing unionid community of Western New York. *Keywords: Genetics, Lake Ontario tributaries, Unionids, Lake Erie tributaries.*

HAPPEL, A.S.[1], RINCHARD, J.[2], CREQUE, S.[1], HÖÖK, T.O.[3], BOOTSMA, H.A.[4], JANSSEN, J.A.[4], and CZESNY, S.J.[1], [1]Lake Michigan Biological Station, Illinois Natural History Survey, University of Illinois, Zion, IL, 60096; [2]Dept. Of Environmental Science and Biology, The College at Brockport- State University of New York, Brockport, NY; [3]Dept. Of Forestry and Natural Resources, Purdue University, West Lafayette, IN; [4]Great Lakes WATER Institute, University of Wisconsin-Milwaukee, Milwaukee, WI. **Exploring Spatiotemporal Trends in Juvenile Yellow Perch Diets through Fatty Acid Signatures and Stomach Contents.**

Lake Michigan's ecosystem has experienced dramatic changes due to various anthropogenic factors. Nuisance species introductions are arguably the most potent among these factors, for they can lead to perturbations in both pelagic (e.g. alewife) and benthic (e.g. dreissenids) communities. Relative to pelagic areas of the lake, coastal regions have been understudied despite several high profile invaders (e.g. round goby) residing in nearshore waters. To better understand Lake Michigan's restructured nearshore food web, we examined foraging patterns of juvenile yellow perch using fatty acid signature (FAS) and stomach content analysis. FAS provide insights into feeding habits based on the degree of similarity between predator's FAS and those of their prey. To assess the spatiotemporal variability in yellow perch foraging, we collected fish at nine coastal locations throughout the lake during three seasons (spring, summer, and fall). Utilizing the FAS and dietary composition of each fish, analysis of similarity tests were performed to determine spatiotemporal trends and non-metric multidimensional scaling plots were used to depict results. Our results provide a time integrated view of juvenile yellow perch trophic ecology throughout Lake Michigan's coastal region and demonstrates FAS utility in studies of freshwater food webs. *Keywords: Yellow perch, Fatty Acid Signature Analysis, Lake Michigan, Fish diets.*

HARGAN, K.E.[1], RÜHLAND, K.M.[1], PATERSON, A.M.[2], KELLER, W.[3], and SMOL, J.P.[1], [1]P.E.A.R.L., Queen's University, Dept. Biology, 116 Barrie St., Kingston, ON, K7L 3N6, Canada; [2]Dorset Environmental Science Centre, 1026 Bellwood Acres Road, P.O. Box 39, Dorset, ON, P0A 1E0, Canada; [3]Cooperative Freshwater Ecology Unit, Laurentian University, 935 Ramsey Lake Road, Sudbury, ON, P3E 2C6, Canada. **Using Diatoms to Assess the Impact of Rapid Mining Development on aquatic Ecosystems in the "Ring of Fire" Region of Ontario's Far North.**

A recent discovery of massive chromite deposits (dubbed the "Ring of Fire") in the James Bay Lowlands (JBL) is poised to become one of Ontario's key drivers of economic growth. Research in this largely unstudied region is necessary as 90% of the JBL landscape is covered by the largest, unconfined, cold peatlands in the North America, and vast stores of carbon. To assess the potential environmental impact of large-scale mining operations, while meeting Ontario's commitment to protect 50% of the northern Boreal forest, knowledge of historical conditions are critical to understand natural environmental variability within the region. In this study, diatom-based paleolimnological techniques are used to compare modern conditions to diatom assemblages preserved in pre-industrial sediments from ~50 lakes in northern Ontario. Previously, the JBL has been known to be part of the circumpolar region that has remained cool relative to the rest of the warming Arctic. However, in the last ~15 years, increases in air temperatures and the thinning and disappearance of sea ice on Hudson Bay have resulted from

unprecedented warming in this region. With these paleolimnological analyses, we hope to describe aquatic ecosystems prior to mining operations, but also to track environmental changes in the JBL resulting from recent climate warming. *Keywords: Arctic, Climate change, Paleolimnology.*

HARPER, L.H.[1], ALKIEWICZ, E.H.[2], SCHOENWIESNER, S.[2], and GERLACH, J.D.[2], [1]Riveredge Associates, 58 Old River Rd, Massena, NY, 13662; [2]New York Power Authority, 123 Main St., White Plains, NY, 10605. **Common Tern Nesting Habitat Improvement Projects on Lake St. Lawrence and in Buffalo Harbor (New York) Successfully Increase the Number of Breeding Pairs of this Threatened Species.**

The New York Power Authority in cooperation with the NYS Dept. of Environmental Conservation, the St. Lawrence Seaway Development Corp., and the U.S. Army Corps of Engineers improved nesting habitat for the threatened Common Tern at 14 sites in Erie and St. Lawrence Co., NY. Sites include three Buffalo Harbor breakwaters and 11 navigation structures on Lake St. Lawrence. These Habitat Improvement Projects (HIPs) are enhancing and creating new nesting habitat. Over 5,500 square feet of pea gravel was placed on Lake St. Lawrence sites and 10,500 square feet was placed on the Buffalo breakwaters. In 2011, there were 1,888 tern nests in Buffalo Harbor. On Lake St. Lawrence there were 803 nests, almost double the 406 nests recorded in 2004 before enhancements began. Breeding success increased through the addition of nesting gravel, fencing, chick shelters, and thinning vegetation. The average number of chicks fledged per nest at each site has increased as compared with pre-enhancement data. In 2011, approximately 2,200 banded tern chicks fledged from Buffalo Harbor and 1,250 banded tern chicks fledged from Lake St. Lawrence. These restoration efforts are the largest of their kind in the Great Lakes. Continued cooperative management efforts such as these will help in restoring this threatened species to the lower Great Lakes. *Keywords: Avian ecology, Common Tern, Breakwaters, Habitat enhancement, Conservation.*

HARRISON, J.W. and SMITH, R.E.H., Department of Biology, University of Waterloo, Waterloo, ON. **Modelling photoinhibition of Photosystem II function of Lake Ontario phytoplankton.**

The efficiency of Photosystem II (PSII) photochemistry has important implications for phytoplankton productivity, and can vary greatly in response to changes in irradiance (PAR and UVR). In this study we used a spectrally-resolved kinetic model and data on incident spectral irradiance and water column optics to predict changes in the efficiency of PSII photochemistry in Lake Ontario at a near-shore site for 6 dates during the ice-free period of 2008. The efficiency of photochemistry at PSII (as $F_V:F_M$) was determined with a Water-PAM fluorometer. Using experimental incubations under various PAR and UVR spectra, the kinetic model of Kok was calibrated with damage and recovery rate constants specific to the phytoplankton assemblages we sampled. Model estimates of $F_V:F_M$ integrated throughout the upper half (0-10 m) of the water column showed good agreement with the diurnal pattern of observed values, but depth-specific predictive accuracy would require the addition of a model for vertical water column mixing. Surface incident irradiance alone explained 98% of the variation in daily integrated in

situ photoinhibition among dates, suggesting that other factors such as temperature or nutrients did not modulate the UVR-response of the phytoplankton at this near-shore site in Lake Ontario.

HAWKINS, S.A., Toronto and Region Conservation, 5 Shoreham Dr., Downsview, ON, M3N 1S4. **Mid-Life Crisis: How the Toronto and Region RAP got its Communications Groove Back.**

In 2009, the Toronto and Region Remedial Action Plan (RAP) launched a renewed communications strategy to improve the access to, and clarity of, science-based information. More than 20 years into the RAP program, the communications strategy sought to re-engage and re-invigorate citizens, stakeholders, and decision-makers following a period of minimal public communication initiatives by the RAP program proper. This presentation will review how the communication strategy is being deployed across multiple programs and media and discuss how its underlying philosophies are integrated into the review and update of Beneficial Use Impairment delisting criteria. A summary of program success, challenges, and the feedback of public and agency stakeholders will also be presented. *Keywords: Decision making, Toronto and Region, Public education, Remedial action plan, Urban areas.*

HAXTON, T.J. and WILSON, C.C., Ontario Ministry of Natural Resources, 2140 East Bank Drive, Peterborough, On, K9J 7B8, Canada. **Bringing Back the Giants: Prospects for Re-establishing Lake Sturgeon in Lake Simcoe.**

Lake sturgeons were extirpated from Lake Simcoe more than 50 years ago through historical overexploitation and habitat loss. Together with increasing awareness of the need for restoration and rehabilitation of aquatic systems, protection under federal and provincial endangered species legislation provides an opportunity to re-establish this iconic species in its former habitat. Lake Simcoe would be an ideal site for evaluating restoration and rehabilitation options for lake sturgeon. Lake Simcoe's bathymetry and productivity provide ideal foraging and growth conditions, and the Talbot River provide suitable spawning habitat. Benefits of re-establishing a population of lake sturgeon in Lake Simcoe would include contributing to the historical native biodiversity of the lake, and restoring a major benthivore and trophic pathway to the native fish community. Re-establishment of this large benthic species might also increase the resilience of the native aquatic community to invasion by exotic species, as lake sturgeon consume several exotics that are now established in Lake Simcoe. An adaptive management approach to assess restoration options and effectiveness for restoring this iconic species to its former home could also provide valuable insights and direction for sturgeon restoration efforts in the Great Lakes and elsewhere. *Keywords: Conservation, Biodiversity, Lake Simcoe.*

HEATON, M.G.[1] and IMHOF, J.[2], [1]Ontario Ministry of Natural Resources, 50 Bloomington Road, Aurora, ON, L4G 0L8; [2]Trout Unlimited Canada, Rm. 114, Textiles Building, University of Guelph, Guelph, ON, N1G 2W1. **Restoring Habitat for Atlantic Salmon in North Shore Tributaries of Lake Ontario.**

The north shore watersheds of Lake Ontario found within the Regional Municipalities of Halton, Peel, Toronto, York and Durham have had over 175 years of settlement affecting aquatic habitats and their fish communities. Declines of heritage species, such as the Atlantic salmon, were first documented before the Confederation in 1867. Declines of this fish in watersheds were linked to over-harvest, the ever growing number of dams in rivers, forest clearing and the pollution of water. Dams disconnected the lake dwelling salmon from necessary riverine spawning and nursery habitats. In more recent decades, water quality and forest cover trends in the watersheds have improved. These old dams, some removed by Hurricane Hazel, are under closer scrutiny as public support builds for restoring connections between Lake Ontario and its tributaries. Habitat condition within the rivers is improving as volunteers, program partners and community groups undertake habitat rehabilitation projects. Restoring and reconnecting fragmented habitats is an integral component of the restoration of the Lake Ontario Atlantic Salmon. Moving forward, it is important that we learn from restoration efforts by collecting baseline project information, developing sound designs, monitoring results, and communicating outcomes. These will be discussed. *Keywords: Salmon, Habitats, Watersheds.*

HEBERT, C.E.[1] and WESELOH, D.V.C.[2], [1]Environment Canada, Science and Technology Branch, National Wildlife Research Centre, Ottawa, ON, K1A 0H3; [2]Environment Canada, Canadian Wildlife Service, Downsview, ON, M3H 5T4. **Multiple Stressor Impacts on Top Avian Predators in the Laurentian Great Lakes.**

Great Lakes food webs have been modified over time, particularly as a result of exotic species introductions. To evaluate how these changes have affected wildlife, we conducted retrospective environmental tracer analysis of archived bird eggs. These samples were collected over the past four decades as part of the Great Lakes Herring Gull Monitoring Program. Changes in the abundance and composition of prey fish communities have led to dietary change in birds. As a result, they are experiencing energetic and nutritional constraints that may be heightening physiological stress in individual birds, reducing resources for reproduction, and contributing to population-level declines. Furthermore, changes in food web structure have altered pathways of disease transfer to aquatic birds resulting in large-scale mortality events. Without Chip's dedication and systematic approach to long-term monitoring the insights developed here would not have been possible. This research has demonstrated that the flow of energy, essential nutrients, contaminants, and disease to predatory aquatic birds has changed over time providing us with a better understanding of how multiple stressors act together to affect wildlife. The methods developed here are being applied in other regions demonstrating the broader significance of this work. *Keywords: Avian ecology, Ecosystem health, Food chains.*

HELM, P.[1], MUSCALU, A.[1], SHEN, L.[2], REINER, E.J.[1], TENCIC, A.[1], KOLIC, T.[1], BODEN, A.[1], MORSE, D.[1], MACPHERSON, K.[1], and BRINDLE, I.[2], [1]Ontario Ministry of the Environment, Toronto, ON, Canada; [2]Brock University, Department of Chemistry, St. Catherines, ON, Canada. **Monitoring for Hydrophobic Contaminants in Urban-Impacted Nearshore Waters of the Great Lakes Using Polyethylene Passive Samplers.**

Urban areas contributors of environmental contaminants to adjacent waterways through atmospheric contributions, direct stormwater discharge, urban tributary inputs, and municipal wastewater discharges. The wide variety of chemicals present represent both the legacy of past-use of PBT industrial chemicals and pesticides (e.g. PCBs) and of current-use chemicals related to use in consumer products (e.g. flame retardants). Passive polyethylene (PE) samplers were deployed in urban streams in the Toronto, Ontario area and in Lake Ontario in nearshore waters adjacent to urban areas from Hamilton Harbour in the west to waters off Pickering, Ontario, east of Toronto. PE sampler extracts were analyzed for PCBs, organochlorine pesticides, PAHs, and brominated flame retardants. The distribution of amounts of these compounds sequestered in PE agreed well with distributions for water and sediments. Multi-dimensional gas chromatography (GCxGC)-electron capture detection (ECD) was used as a broad screening tool for halogenated compounds and indicated the presence of a large number of compound classes at several stations, including chlorinated paraffins and halogenated PAHs. The greatest concentrations, and number and diversity of substances were observed at locations more influenced by municipal wastewater and urban/industrial development. *Keywords: Urban watersheds, Passive sampling, Lake Ontario, Priority pollutants.*

HENEBRY, M.L.[1], FOLEY, C.J.[1], BOOTSMA, H.A.[2], CZESNY, S.J.[3], JANSSEN, J.A.[2], and HÖÖK, T.O.[1], [1]Department of Forestry and Natural Resources, 195 Marsteller Street, West Lafayette, IN, 47907; [2]Great Lakes Water Institute - University of Wisconsin Milwaukee, 600 E. Greenfield Avenue, Milwaukee, WI, 53204; [3]Illinois Natural History Survey - Lake Michigan Biological Station, 400 17th Street, Zion, IL, 60099. **Spatio-temporal Variation of Round Goby Diets and Tissue δ^{13}C and δ^{15}N in Nearshore Lake Michigan.**

Invasive species have dramatically restructured the Lake Michigan ecosystem over the past 100 years and will likely continue to disrupt this system well into the future. Understanding trophic roles of non-native species is key to elucidating potential impacts of current and potential future invaders. Round goby were first detected in Lake Michigan in 1994, and have since increased dramatically in abundance. While past studies of round goby in Lake Michigan have primarily focused on specific regions and habitats, Lake Michigan is a large, diverse system and round goby trophic interactions may vary across regions and over time. During 2010, we collected round goby and their potential prey at ten sites throughout Lake Michigan. At each site, gobies were collected during May, July, and September at three depths (3m, 7-9m, and 14-16m) via 2-hr bottom set, micromesh gillnets. In the laboratory, we identified and enumerated diet items, and homogenized gobies for subsequent δ^{13}C and δ^{15}N quantification. Diet selectivity and multivariate analyses will be used to quantify variability of diets and stable isotopes and relate resulting patterns to characteristics of individual fish and environmental conditions (prey availability, substrate type, depth, and season). *Keywords: Lake Michigan, Diets, Stable isotope, Round goby.*

HENNING, B.F. and FARRELL, J.M., 104 Illick Hall, 1 Forestry Dr., Syracuse, NY, 13210.
Does Physical Habitat Influence Fish Assemblage Structure in Open and Protected Embayments within the Thousand Islands Region of Upper St. Lawrence River?

We contrasted open and protected embayments within the Thousand Islands region of the upper St. Lawrence River to examine how fish-habitat associations and fish community structure relate to habitat affinity and tolerance to dissolved oxygen and temperature regimes. We sampled nearshore fish assemblages as well as measured a suite of physical habitat variables in 8 littoral embayments. Fish assemblages ordinated in principal component analysis (PCA) and nonmetric multidimensional scaling illustrated two distinct patterns of fish assemblages; a protected embayment assemblage and an open embayment assemblage. The PCA suggests that the open embayment assemblage inhabit firmer substrates, with less submersed aquatic vegetation (SAV) and higher dissolved oxygen while the protected embayment assemblage was associated with dense SAV and lower dissolved oxygen. Canonical correspondence analysis of fish abundance and environmental variables identified SAV complexity and chl-a as the most influential variables in protected embayments while firmer substrates coincided with open embayments. We also applied the Wetland Fish Index to our data to assess the quality of coastal wetlands within the Thousand Islands region and the results suggest that wetlands are of higher quality on average than lower Great Lakes wetlands. *Keywords: St. Lawrence River, Habitats, Fish populations.*

HENRY, A.[1], SCHERPEREEL, G.[1], BAUDART, J.[2], SERVAIS, P.[3], and CHARNI BEN TABASSI, N.[1], [1]VERI, 1, place de Turenne, Saint Maurice, 94417, France; [2]LOMIC, Avenue de Fontaulé, Banyuls sur Mer, 66650, France; [3]ULB, Campus de la Plaine, Boulevard du Triomphe, Bruxelles, 1050, Belgique. **Bathing Water Quality Monitoring: "Which Method for what Application?".**

The European directive published in 2006 introduces the concept of active management of bathing water and suggests the setting up of several actions like: i) assessing the bathing area and its potential faecal sources of contamination; ii) performing regular and high frequency analyses of water, iii) informing in real time the public. In Europe, the culture based methods ISO 9308-3 and ISO 7899-1 used to evaluate bathing water quality required 2 days of analysis and are not complying with 2006 Directive recommendations. Then, rapid methods in recreational waters are needed to assess health risk and provide real time management. Thus, new technologies have been proposed in the scientific art, but nowadays the question is: "Which method for what application?". Our group was led to compare a number of different tools based on enzymatic detection (COLIPLAGE®), PCR signal (qPCR), and automated culture methods (impedancemetry, TECTA B16®). The presentation provides a non-exhaustive inventory of tools tested in term of specificity, sensibility, delay, viability, cost, implementation..., to conclude on their applicability on the bathing sites managed by Veolia. In conclusion, enzymatic based method such as COLIPLAGE® appears to be the more accurate method to detect faecal pollution (E. coli) in less than an hour. *Keywords: Bathing water, Water quality, Monitoring.*

HENSHAW, B.[1], TU, C.L.[2], and GAETZ, N.[2], [1]Beacon Environmental, 144 Main St.N., Markham, ON, L3P 5T3, Canada; [2]Toronto and Region Conservation Authority, 5 Shoreham Dr., Downsview, ON, M3N 1S4, Canada. **Developing a Tool to Assess the Risk of Climate Change to Natural System Elements in the Greater Toronto Area.**

The Toronto and Region Conservation Authority (TRCA) plays a major management role in watershed health in the Greater Toronto Area. TRCA has developed, in consultation with Beacon Environmental, a risk assessment framework intended to identify relative risks to natural system elements from potential affects of climate change. The project team used projections of future climate change from an ensemble of global climate models combined with understanding of potential ecological impacts from existing literature, and expert knowledge of southern Ontario ecosystems. This review and synthesis produced the first version of a risk assessment using the principal drivers of climate change as ˜5%-6% annual increase in precipitation and ˜2.5 C mean annual increase in air temperature to 2050. Important secondary drivers (e.g., increase in surface water temperature, decrease in groundwater discharge, decrease in seasonal precipitation, etc.) are essentially potential consequences of the predicted changes in temperature and precipitation. These secondary drivers are considered through the risk assessment process, though the decision rigour may be limited by subjectivity. Preliminary 'testing' of the tool is based on 2 indicators: urban tree species and Brook Trout *(Salvelinus fontinalis)*.
Keywords: Climate change, Risk assessment, Urban watersheds.

HICKEY, M.B.C., St. Lawrence River Institute of Environmental Sciences, 2 St. Lawrence Drive, Cornwall, ON, K6H 4Z1. **Distribution and Breeding Biology of the Threatened Cutlip Minnow.**

The Cutlip Minnow is considered a threatened species in Ontario. Published records of this species' occurrence in the St. Lawrence River are scarce and most are represented by captures of small numbers of individuals, often a single fish. In 2008 and 2009 we surveyed sites where Cutlip Minnow had been previously reported as well as at randomly chosen reference sites. We captured Cutlip Minnows at only 3 of the historical sites. At 5 of the historical sites, we failed to find evidence of Cutlip Minnows. At two of our randomly selected sites we captured Cutlip Minnows. These sites represent new locations for this species in the St. Lawrence River. The largest population was located in an artificially constructed creek near the city of Cornwall. At this site, we made detailed observations of the breeding behaviour of Cutlip Minnow and report what we believe is an example of alternate reproductive strategies in male Cutlip Minnow. Some males build and defend nests while others adopt a sneaker or satellite breeding strategy.
Keywords: Fish, Fish behavior, Conservation.

HILL, R.B. and KLAWUNN, P., Environment Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **Long-term Monitoring at Wolfe Island: 18 Years of Water Quality Data on the Upper St. Lawrence River.**

In 1976, Environment Canada established a monitoring station on the St. Lawrence River at Wolfe Island, near Kingston, Ontario as part of a commitment to the Canada/United States Great Lakes Water Quality Agreement (GLWQA). The monitoring program was intended to assist in the evaluation of the effectiveness of pollution control programs carried out in the Great Lakes Basin in order to improve water quality. Since that time, data generated from this sampling station have been used to assess current water quality conditions, identify exceedences of water quality guidelines, and to evaluate trends. Environment Canada recently completed an assessment of long term trends in Wolfe Island water quality by examining organic contaminants, trace metals, nutrients, and major ions in water and solids using sample data from 1989 to 2007. Results indicate significant decreases in concentrations for most compounds; however, a small number of analytes exhibit increasing trends over this time period and others continue to exceed the strictest agency water quality criteria. *Keywords: St. Lawrence River, Water quality, Monitoring.*

HIRIART-BAER, V.P.[1], BINDING, C.E.[1], and HOWELL, E.T.[2], [1]Environment Canada, 867 Lakeshore Road, Burlington, ON, L7R4A6; [2]Ontario Ministry of the Environment-EMRB, 125 Resources Road, Toronto, ON, M9P3V6. **Characterizing DOC in Lake Simcoe.**

In this study, the optical properties of dissolved organic carbon were characterized in Lake Simcoe using three-dimensional excitation-emission-matrix (EEM) fluorescence spectra as well as absorbance. Samples were collected across Lake Simcoe and its watershed in the spring, summer and fall of 2009. Four fluorophores were identified in Lake Simcoe, two humic-like, one analogous to anthropogenic sources and a fourth linked to autochthonous production. Preliminary analysis suggests that these data can be used to inform on the biogeochemical processing of DOM in Lake Simcoe including the phases of biological production. Comparisons across lakes of various trophic levels will be made. *Keywords: Carbon, Carbon cycle, Trophic level.*

HIRIART-BAER, V.P., Environment Canada, 867 Lakeshore Road, Burlington, ON, L7R4A6. **Characterizing Organic Phosphorus Composition in Lake Simcoe sediments.**

In this study, the historical change in organic phosphorus composition in Lake Simcoe was assessed. Phosphorus in these sediments were extracted with NaOH-EDTA and analyzed by solution 31P-nuclear magnetic resonance spectroscopy. Enzyme digestion assays were also conducted. The extracts were typically dominated by inorganic orthophosphate, orthophosphate monoesters (e.g. phytate), orthophosphate diesters (eg. deoxyribonucleic acid) and pyrophosphate. Concentrations varied with sediment depth and core location. The use of the organic phosphate composition as a paleo-limnological marker of ecosystem change will be explored. *Keywords: Eutrophication, Sediments, Phosphorus.*

HLADYNIUK, R. and LONGSTAFFE, F.J., The University of Western Ontario, 1151 Richmond Street, London, ON, N6A3K7, Canada. **The Paleoproductivity of Lake Ontario Since >12.3 ka BP.**

We have examined the organic carbon (OC) and nitrogen (TN) contents, C/N ratios (7-10) and stable carbon and nitrogen isotopic compositions of Lake Ontario organic matter (OM) since 12.3 ka BP. These data indicate low primary productivity during glacial times (12.3-10.8 ka BP), consistent with the cold/dry period proposed by Lewis et al. (2008). That said, the carbon isotopic compositions of OM in glacial sediments display different upward variations in cores from across the Basin: Niagara sub-basin, an increase from -29 to -27 per mil (VPDB); Mississauga sub-basin, a decrease from -27 to -28.5 per mil. This difference likely arises from greater contributions of terrestrial OM in the west as glacial meltwater entered the lake via the Niagara River. Upon cessation of meltwater supply to Lake Ontario at 10.5 ka BP, the carbon isotope composition of OM decreased to -29.5 per mil across the basin. With hydraulic closure of Lake Ontario during the early Holocene, rising aquatic primary productivity is indicated progressively rising OC and TN concentrations and OM carbon isotopic compositions. Return of upper Great Lakes water during the Nipissing Rise at 5.0 ka BP correlates well with a lake-wide drop in productivity, followed shortly by a return to rising OC, TN and OM carbon isotopic compositions as modern Lake Ontario emerged. *Keywords: Lake Ontario, Productivity, Isotope studies.*

HLEVCA, B. and WELLS, M.G., Department Physical and Environmental Sciences, University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C1A4. **Man-made Influences upon the Water Exchange Driven by Lake Seiches in a Coastal Wetland of the Great Lakes.**

The residence time of water in many shallow coastal wetlands of the Great Lakes is partially controlled by the exchange of water due to rapid water level fluctuations associated with lake seiches. We describe how the flushing of wetlands and coastal embayments is related to their physical geometry; in particular how man-made changes to connecting channels have to ability to increase or reduce flushing rates and hence the residence time of water within these wetlands and coastal embayments. The water level response of many coastal wetlands can be modelled as a forced Helmholtz harmonic resonator, whereby the flushing response of a wetland or coastal embayment depends upon how close the frequency of the seiche is to the resonant frequency of the coastal wetland. We present a comparison between this model and data of water levels from two embayments in Lake Ontario and from previously published observations of coastal wetlands in Lake Superior. In all cases there is good agreement between the observed water level fluctuations and with those predicted by our model. Our model could support future efforts to design artificial coastal wetlands and to improve existing wetlands water quality, by explaining the influence of the channels' geometry upon the hydraulic residence time of water and chemicals within coastal wetlands. *Keywords: Water level fluctuations, Residence times, Lake Ontario.*

HOAR, T.[1], <u>MOORE, D.J.</u>[2], CUTHBERT, F.J.[3], WESELOH, D.V.C.[1], and WIRES, L.R.[3], [1]Environment Canada, Canadian Wildlife Service, 4905 Dufferin Street, Toronto, ON, M3H 5T4; [2]Environment Canada, Canadian Wildlife Service, 867 Lakeshore Road, Burlington, ON, L7R 4A6; [3]Dept. Fisheries, Wildlife and Conservation, University of Minnesota, 1980 Folwell Ave., St. Paul, MN, 55108. **Colonial Waterbirds Nesting on the Connecting Channels of the Great Lakes, 1976-2011.**

Abundance and distribution data were collected for 9+ species during the Bi-national Great Lakes (GLs) Decadal Colonial Waterbird Survey, 1976-2009. Here, we report population trends of waterbirds nesting on the Detroit (DR), Niagara (NR) and St. Lawrence (SLR) rivers. In the most recent census (2007-9), 55,159 nests of 7 species were recorded: 93% Ring-billed Gulls (RBGU), 5% Double-crested Cormorants (DCCO), 0.9% Black-crowned Night-Herons (BCNH) and 0.8% Herring Gulls (HEGU). The relative importance of river nesting sites (% of GLs total) varied among species: HEGU=1.4%, Common Terns=3.7%, DCCO=4.6%, Great Blue Herons=8.5%, RBGU=18.2%, BCNH=32.0%, Great Black-backed Gull=37.5%. Caspian Terns and Great Egrets were never recorded nesting on GLs connecting channels. Abundance was greatest on DR (29,289 nests of 3 species; 99.7% were RBGUs) while diversity was highest on SLR (24,364 nests of 7 species). Numbers and diversity were relatively low on NR (915 nests of 3 species), but it was an important area for BCNHs (20.9% of all GLs nests). Population trends were similar for rivers and adjoining large water bodies; exceptions were faster growth rates for BCNHs on NR and SLR, and DCCOs on SLR. For some species, the rivers connecting the GLs are important for maintaining overall waterbird diversity. *Keywords: Avian ecology, St. Lawrence River, Detroit River, Species diversity, Niagara River.*

<u>HODSON, P.V.</u>[1], KENNEDY, S.[1], RIGAUD, C.[2], BYER, J.D.[1], COUILLARD, C.M.[2], ALAEE, M.[3], PELLERIN, J.[4], LEGARÉ, B.[2], CASSELMAN, J.M.[1], and BELPAIRE, C.[5], [1]Queen's University, Kingston, ON, K7L3N6; [2]Fisheries and Oceans, Mont-Joli, QC, G5H2C9; [3]Environment Canada, Burlington, ON, L7R4A6; [4]U. de Québec à Rimouski, Rimouski, QC, G5L3A1; [5]Research Institute for Nature and Forest, Groenendaal-Hoeilaart, B-1560, Belgium. **Spatial and Temporal Patterns of Embryotoxicity of Contaminants Extracted from American Eel (*Anguilla rostrata*).**

Dioxin-like compounds (DLCs) are a possible cause of the decline of American eel recruitment to the upper St. Lawrence and L. Ontario since the 1980s. Eels in L. Ontario accumulate DLCs to the same extent as lake trout, whose reproductive failure has been tied to DLC accumulation. The eel reproduces only once after migrating from L. Ontario to the Sargasso Sea, during which lipid stores, including their contaminants, are transferred to oocytes. Thus, embryotoxicity may result from maternally-derived DLCs. Juveniles recruiting to L. Ontario in the 1980s-90s were spawned from parents that integrated the contaminant history from the 1960s-70s, the period of highest contamination. Contaminants extracted from frozen archived L. Ontario eels captured in 1988 and 1998 caused craniofacial malformations, reduced body length and prey capture ability and induced EROD activity when injected into the eggs of mummichog. However, extracts from eels captured in 2008 caused EROD induction only in embryos of mummichog and no morphological changes or mortality in Japanese medaka. In 2008, extracts of eels from other locations on the St. Lawrence River and estuary, and from

Gaspé and Maritime rivers, were also non-toxic to medaka, in contrast to extracts of Hudson R. eels and European eels from a highly contaminated site in Belgium. *Keywords: Endangered species, Environmental contaminants, Recruitment, Fish populations, Toxic substances, American eel.*

HOLDEN, C.V. and CASSELMAN, J.M., 116 Barrie St., Kingston, ON, K7L3N6. **Otolith Isotopic Analysis of the American Eel (*Anguilla rostrata*): Investigating the Role of Activity and Otolith Growth in Estimating Otolith $\delta^{18}O$ Thermal History.**

American eel (Anguilla rostrata) populations are declining dramatically, best documented by recruitment decreases in the St. Lawrence River. Increasing water temperatures have been implicated. Otolith isotopic ratios of oxygen are a unique way to study thermal, environmental, and ecological associations of eels. Whole otolith solution chemistry and gas source mass spectrometry were used to examine otoliths of young stocked eels collected in 2008-2011 from the upper St. Lawrence River. Otolith temperatures were examined as predictors of estimated habitat temperatures. The first annual increment had a significantly lower temperature (-1.5oC) than habitat temperature; second and third increments were significantly higher (+2.1oC and +3.3oC). The fourth increment was unexpectedly lower (-12.8oC) and variable; this difference could not be explained by known habitat temperature or otolith growth. This was examined by comparing an essentially sedentary group with a group of the same cohort that had moved 39 km from the stocking location, controlling for for age, year class, and similar riverine thermal history. There is some evidence that activity could affect these isotopic ratios. Understanding the role of activity and otolith growth is critical in interpreting thermal history from stable isotopes of oxygen to study fish ecology. *Keywords: Otoliths, Stable isotopes, American Eel.*

HOLECK, K.T.[1], RUDSTAM, L.G.[1], LANTRY, J.R.[2], CONNERTON, M.J.[2], MCCULLOUGH, R.D.[3], PRINDLE, S.E.[4], SANDERSON, M.J.[5], and TROMETER, B.[6], [1]Cornell Field Station, 900 Shackelton Point Rd, Bridgeport, NY, 13030; [2]NYSDEC Cape Vincent Fisheries Research Station, 541 East Broadway, Cape Vincent, NY, 13618; [3]NYSDEC Region 6, 317 Washington St, Watertown, NY, 13634; [4]NYSDEC Region 7, 1285 Fisher Ave, Cortland, NY, 13045; [5]NYSDEC Region 8, 6274 Avon-Lima Rd, Avon, NY, 14414; [6]USFWS Lower Great Lakes Fish & Wildlife Conservation Office, 405 N French Rd, Suite 120A, Amherst, NY, 14228. **Lake Ontario's Nearshore Zooplankton Community: Response to Invasion by Non-native Species and Changes in Lake Productivity.**

We compared lower trophic level parameters from seven nearshore (10-15 m bottom depth) sites along Lake Ontario's south and east shores from 1995 - 2010 to examine spatial and temporal changes in the nearshore zooplankton community. Zooplankton density and biomass declined significantly at sites closest to the St. Lawrence River but not at sites near the mouth of the Niagara River. Declines were most evident in July and October--times of peak *Cercopagis* and *Bythotrephes* biomass. July and October zooplankton density and biomass declined significantly due to declines in bosminids, daphnids, and cyclopoids. There was no trend in either spring TP or seasonal Secchi depth, but summer cholorphyll *a* increased significantly. Change points were detected in cholorphyll *a*, and July and October zooplankton density and

biomass, at times corresponding to the arrival of *Cercopagis* and increase in *Bythotrephes*. Nearshore patterns are similar to published findings for offshore waters.
Keywords: Zooplankton, Lake Ontario, Invasive species.

HOLMAN, K.D.[1], NOTARO, M.[2], ZARRIN, A.[3], and FLUCK, E.[4], [1]Center for Climatic Research, Dept. Atm. and Ocn. Sciences, UW-Madison, 1225 W. Dayton St., Madison, WI, 53706; [2]Center for Climatic Research UW-Madison, 1225 W. Dayton St., Madison, WI, 53703; [3]Ferdowsi University of Mashhad, Mashhad, Iran; [4]University of Bourgogue, Dijon Cedex, France. **Influence of the Laurentian Great Lakes on Regional Climate.**

We investigate the influence of the Great Lakes on regional climate using two decade-long regional climate model simulations with the lakes either present or absent. The analysis includes output from the regional climate model, ICTP RegCM4, for 1980-1989. In the presence of the lakes, the amplitude of the seasonal cycle of temperature and the diurnal temperature range are reduced. The lakes produce enhanced (reduced) stability during the warm- (cold-) season. Average monthly turbulent fluxes of sensible and latent heat are reduced (enhanced) during the warm- (cold-) season with the lakes present. The lakes reduce (increase) average monthly precipitation and evaporation in the region during April-August (September-March). During the cold-season, the lakes induce an increase in average monthly evaporation that is roughly 2-3 times larger than the corresponding increase in precipitation, indicating net divergence out of the region in the presence of the lakes. Finally, the presence of the Great Lakes influences synoptic systems that track through the basin by strengthening wintertime cyclones and summertime anticyclones and weakening summertime cyclones and wintertime anticyclones.
Keywords: Atmospheric circulation, Model studies, Climates.

HOOD, J.L.A., TAYLOR, W.D., and SCHIFF, S.L., 200 University Av, Waterloo, ON, N2L 3G1. **Long-term, Seasonal and Spatial Changes in N and P in the Grand River: Implications for Assimilative Capacity and Downstream Transport of Watershed-derived Nutrients.**

Rivers can act as nutrient sources and sinks, transforming and detaining nutrients as well as transporting them to downstream environments. The importance of rivers in Great Lakes coastal eutrophication has long been identified, and their role depends both on their internal nutrient cycling processes as well as the various nutrient sources in their catchments. The connection between lake and watershed processes resides in the context of riverine nutrient cycling, but watershed scale analyses of these processes are not common. Using N and P data obtained from 1965 to 2009 by the Provincial Water Quality Monitoring Network for the Grand River, ON, seasonal, long term and spatial patterns were examined using descriptive and statistical methods. TP and SRP declined over the monitoring period, with the greatest response found downstream of the largest nutrient point source and after the detergent P ban in mid-1970s. Results also indicate the lower river is an apparent sink for TP and SRP, likely releasing P at times and in forms where it is not detected. Nitrate/nitrite steadily increased over the monitoring period, and with distance downstream. Nutrient concentrations are greatest in late winter/early

spring indicating the importance of non-point sources, despite the known high loading associated with current WWTP operation. *Keywords: Nutrients, Nitrate, Watersheds, Phosphorus.*

HOSSAIN, M.[1], ARHONDITSIS, G.B.[1], KOOPS, M.A.[2], and MINNS, C.K.[2], [1]University of Toronto, Department of Physical & Environmental Sciences, Toronto, ON, M1C1A4, Canada; [2]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, ON, L7R4A6, Canada. **Towards the Development of an Ecosystem Model for the Hamilton Harbour, Ontario, Canada.**

Our main objective is to undertake a synthesis of the Hamilton Harbour ecosystem and to elucidate the relative importance of the underlying trophic relationships using the mass-balance modeling software Ecopath with Ecosim (EwE). Our first step was to design a conceptual model comprising all the essential biotic components that effectively depict the food web dynamics of the Harbour and to subsequently parameterize that model using local and literature-based information. Among the trophic relationships considered by the Hamilton Harbour ecosystem model, our analysis highlights the central role of the cyprinids and round goby which demonstrate a wide range of effects on a number of functional groups at both higher and lower trophic levels. The aggregation of the ecosystem into discrete trophic levels suggests that most of the trophic flows are concentrated within the first two trophic levels and were practically insignificant at the higher components of the food web. The fairly low ecotrophic efficiency values for both carnivorous and herbivorous cladocerans are indicative of low zooplanktivory levels in the system. Finally, our study identified knowledge gaps and critical next steps to rigorously assess the credibility of the model and to consolidate its use for predictive purposes. *Keywords: Risk assessment, Fish management, Ecopath model, Ecosystem modeling, Invasive species.*

HOUDE, A.L.S.[1], WILSON, C.C.[2], and NEFF, B.D.[1], [1]Department of Biology, University of Western Ontario, London, ON, N6A 5B7; [2]Aquatic Research and Development Section, Ontario Ministry of Natural Resources, Trent University, Peterborough, ON, K9J 7B8. **The Effect of Non-Native Salmonids on the Performance of Atlantic Salmon During the Juvenile Life Stage.**

Atlantic salmon (*Salmo salar*) were extirpated from Lake Ontario by 1900 primarily as a result of habitat degradation. While the habitat has improved enabling ecologically-similar salmonids to establish, reintroduction efforts of Atlantic salmon have largely been unsuccessful. Competition with non-native salmonids has been suggested as an impediment to the restoration of Atlantic salmon. Here we examine juvenile Atlantic salmon of two strains (LaHave River and Sebago Lake) within semi-natural streams containing 50% juvenile non-native salmonids, i.e. rainbow trout (*Oncorhynchus mykiss*), brown trout (*S. trutta*), coho salmon (*O. kisutch*), and chinook salmon (*O. tshawytscha*). Both Atlantic salmon strains had reduced growth and body condition in treatments with rainbow trout, brown trout, and all four non-native species. Atlantic salmon also displayed changes in microhabitat preferences when in a competitive environment. We discuss these findings in the context of stream selection for Atlantic salmon stocking and for habitat remediation. *Keywords: Salmon, Fish behavior, Trout.*

HOWELL, E.T.[1] and MAKAREWICZ, J.C.[2], [1]Ontario Ministry of the Environment, 125 Resources Road, Toronto, ON, M9P 3V6; [2]Department of Environmental Science and Biology, State University of New York, Brockport, NY, 14420. **Features of Water Quality in the Nearshore of Lake Ontario in 2008.**

The nearshore of Lake Ontario is stressed due to anthropogenic development of watersheds and ecological perturbation of the littoral zone. In 2008 a cross-border study of the nearshore surveyed 160 km of shoreline (seven regions of varied landuse). Steep shoreside to nearshore gradients in nutrients, major ions, fecal indicators and turbidity, ascribed to runoff and physical disturbance, were widespread; gradients into the lake were wider over the US (up to 4 km offshore) than Canadian (< 1 to 2 km offshore) shores. Phosphorus was elevated in tributary discharge areas, and more generally in shallow water near the shoreline, yet levels of TP over the broader nearshore were generally similar to the open lake. Distinct spatial patterns were attributable to circulation features including thermal fronts, upwelling and alongshore flow. Regional differences in water quality were hard to interpret due to interrelated effects of quantity of runoff as a function of watershed size and quality of runoff as affected by landuse. Only limited evidence of effects of dreissenid mussel filtration on water column features was inferred from spatial patterns in chlorophyll and water clarity. The study findings illustrate the strongly scale dependent nature of land-based effects on nearshore water quality. *Keywords: Lake Ontario, Water quality, Coastal ecosystems.*

HOYLE, J.A., Ontario Ministry of Natural Resources, 41 Hatchery Lane, Picton, ON, K0K 2T0. **Fish Community Status in North Eastern Lake Ontario--Indicator of an Ecosystem in Change.**

Bottom set gill nets were used to monitor the fish community in north eastern Lake Ontario from 1988-2011. Six fixed, depth-stratified transects, spread roughly evenly from the mouth of the St. Lawrence River in the Kingston Basin to Brighton in central Lake Ontario, were sampled twice annually during mid-summer. The balanced sampling design provided a broad picture of the warm, cool and coldwater fish community inhabiting open-coastal waters out to about 30 m water depth. Results were summarized and presented graphically to illustrate abundance trends of the major nearshore (Yellow Perch, Round Goby, Walleye, Rock Bass and Smallmouth Bass), offshore pelagic (Alewife, Chinook Salmon, Brown Trout and Lake Herring) and offshore benthic (Lake Trout, Lake Whitefish, Burbot and Round Whitefish) fish species. Nearly all species showed peak abundance levels in the late-1980s or early 1990s followed by dramatic abundance declines. Recent abundance trends varied among species in the nearshore zone but all species remain at moderate abundance levels. Offshore pelagic species all tended to show increasing abundance levels very recently. Alewife, in particular, currently appear to be undergoing a major change in their abundance and/or distribution. Offshore benthic species all remained at extremely low abundance levels. *Keywords: Ecosystems, Nearshore, Fish populations, Fish community, Lake Ontario, Offshore pelagic and offshore benthic.*

HRYCIK, A.R.[1], SIMONIN, P.W.[1], RUDSTAM, L.G.[1], PIENTKA, B.[2], and PARRISH, D.L.[3], [1]Cornell University, Department of Natural Resources, Tower Road, Ithaca, NY, 14853; [2]Vermont Department of Fish and Wildlife, 111 West Street, Essex Junction, VT, 05402; [3]US Geological Survey, VT Cooperative Fish and Wildlife Unit, University of Vermont, Burlington, VT, 05405. **Ecology of the Opossum Shrimp, *Mysis diluviana*, in Lake Champlain.**

This study examines the ecology of the opossum shrimp, *Mysis diluviana*, as a planktivore in Lake Champlain. *Mysis diluviana* (formerly *Mysis relicta*), is an omnivore whose diet, consumption, growth rate, and generation time differs between lakes depending on what resources are available. We used hydroacoustics, diet analysis, and cohort analysis techniques to determine mysid abundance, consumption, and growth rates. Hydroacoustic surveys reveal that there are approximately 22-31 mysids per m^2 in deeper parts of the lake. Diets were examined using both gut content analysis and stable isotope analysis, which revealed that mysids consume a large biomass of cladoceran zooplankton, with a relatively small contribution from phytoplankton. Mysid cohorts were measured at various points throughout the year, and a growth curve was fitted to the data in order to determine sizes and growth rates throughout the lifespan. These data were used to fit a bioenergetics model to determine the importance of *Mysis diluviana* in the ecosystem. *Keywords: Bioenergetics, Mysis diluviana, Plankton, Populations.*

HU, H.[1] and WANG, J.[2], [1]4840 South State Road, Ann Arbor, MI, 48108, USA; [2]4840 South State Road, Ann Arbor, MI, 48108, USA. **Simulation of Seasonal Phytoplankton Variation in the Bering Sea.**

A NPZD biological model was integrated into an ice-ocean model and then applied to the Bering and Chukchi Sea in 2007-2008. The model results were compared with the measured nutrients and chl-a on the Bering shelf (July 4-23, 2008) and the Chukchi shelf (August 5-12, 2007). Results show the spatial evolution of phytoplankton was basically controlled by the sea ice retreat and the water temperature. The seasonal variations of the phytoplankton are reasonably simulated. *Keywords: Ecosystem modeling, Algae, Harmful algal blooms.*

HUANG, H.A.[1], RAO, R.Y.[2], and ZHANG, Z.W.[2], [1]No.22 Hankou Road, Nanjing; [2]867 Lakeshore Rd, Burlington. **On Recent Trends in Atmospheric and Limnological Variables in Lake Ontario.**

The surface air and water temperatures increased at all seasonal and annual time scales during the last 40 years in Lake Ontario. The annual mean air and surface water temperatures have increased by 1.43±0.39˚C and 1.26±0.32˚C over 1970-2009, respectively. The air temperature increased at a faster rate than surface water temperature in winter and autumn, whereas in spring and summer the surface water temperature warmed faster than air temperature. The length of summer stratified season has increased by 12±2 days since early 1970s due to the increase in water temperature. The decline of surface wind speed over Lake Ontario resulted in shallower surface mixed layer and enhanced the summer thermal stratification, which increased summer surface water temperature more rapidly than air temperature. *Keywords: Atmosphere-lake interaction, Atmosphere-lake interaction, Air-water interfaces.*

HUDON, C., Environment Canada, 105 McGill St, Montreal, QC, H2Y 2E7. **Wetlands Services: An Overview of Diversity, Productivity and Aesthetics of Lake Saint-Pierre (St. Lawrence River, Quebec, Canada).**

The wide range of highly valuable services provided by St. Lawrence River (SLR) wetlands is reviewed, with an emphasis on Lake Saint-Pierre (Biosphere World Reserve, Ramsar site). Since the XVIIth century, Abenakis natives of Odanak have been fishing and farming near Lake Saint-Pierre, later joined by French and British settlers. This large fluvial lake (about 300 km2) comprises over 15 000 ha of emergent marshes and swamps (76% of remaining SLR wetlands). Wetland plants and associated algae produce about 32 500 tonnes of carbon/year, sustained by the daily assimilation of about 20 t of N and 3 t of P. During the growth season, Lake Saint-Pierre wetlands thus assimilate daily N and P loads which are roughly equivalent to amounts released by Montreal-area wastewater outflows. In addition, wetland plants and associated micro-organisms incorporate and transform various inorganic (metals, Hg) and organic (PCB, HAP) contaminants. SLR wetlands support nearly 400 species of plants, amphibians (21), reptiles (17), fish (105) and nesting birds (72). Wildlife resources attract thousands of tourists, bird watchers, hunters and fishers each year, contributing substantially to local economy and regional employment. The beauty of natural surroundings inspires visual artists and writers, celebrating this unique environment. *Keywords: Ecosystems, St. Lawrence River, Wetlands.*

HYDE, R.[1], RODRIGUEZ, K.[2], STADLER-SALT, N.A.[1], and HORVATIN, P.[2], [1]867 Lakeshore Road, Burlington, ON, L7R 4A6; [2]77 W. Jackson Blvd. (G-17J), Chicago, IL, 60604-3511. **State of the Great Lakes in Ten Minutes.**

People with the most influence on Great Lakes restoration and protection often have the least amount of time to search for information about the latest conditions and trends. At the same time, these decision-makers often want and need to know it all - how are the lakes doing, why should I care, what is causing it, and what can I do? In response to this dual reality, ten, one minute messages have been prepared for individuals wanting an overview of Great Lakes conditions and trends. These messages are based on the results of over fifty indicator reports prepared by scientists from over two dozen different organizations, for the 2011 State of the Lakes Ecosystem Conference (SOLEC), lead by Environment Canada and the United States Environmental Protection Agency. These messages cover the biological, physical and chemical integrity of the Great Lakes ecosystem, and were originally delivered over one and a half hours at SOLEC 2011. The corresponding State of the Great Lakes reports will be publicly released in 2012. *Keywords: Decision making, Ecosystem health, Indicators.*

IACARELLA, J.[1], DICK, J.T.A.[2], ALEXANDER, M.[2], and RICCIARDI, A.[1], [1]Redpath Museum, McGill University, Montreal, QC, H3A 2K6; [2]School of Biological Sciences, Queen's University Belfast, Belfast, Northern Ireland, U.K.. **Functional Responses of Invasive Mysids at Different Temperatures.**

We measured predation rates of the Ponto-Caspian mysid shrimp *Hemimysis anomala* and the North American opossum shrimp *Mysis diluviana* to (1) gain insight on the potential impact of *H. anomala* by comparing it to a larger mysid that has a proven ability to disrupt food webs, and (2) test the hypothesis that predation rates across a range of temperatures reflect the different physiological optima of the two species. Functional responses of both mysids to *Daphnia pulex* were measured at 5, 10, and 15°C for 12hrs. *H. anomala*'s functional response was further measured at 20, 24, and 28°C to compare its impact across its known temperature tolerance range. All functional responses fit a Type 2 curve. Species and temperature had significant interaction effects on attack rate and handling time (2-way MANOVA, $p<0.001$). From 5-15°C, prey were generally more rapidly consumed by *M. diluviana*, although low densities of prey were more vulnerable to *H. anomala* at 10°C and 15°C. Furthermore, *H. anomala*'s functional response was relatively constant over a broad range of temperatures, but it had the greatest impact on prey at 24°C (MANOVA, $p<0.001$). Our results suggest that *H. anomala* is a more voracious predator with respect to its size than *M. diluviana*. *Keywords: Invasive species, Predation, Zooplankton.*

IACOBELLI, T.[1], DEL GIUDICE, L.[2], and STANFIELD, L.W.[3], [1]City of Vaughan, 2141 Major Mackenzie Drive, Vaughan, ON, L6A 1T1; [2]Toronto and Region Conservation Authority, 5 Shoreham Drive, Toronto, ON, M3N 1S4; [3]Ministry of Natural Resources, 41 Hatchery Lane, Glenora Fisheries Station, Picton, ON, K0K 2T0. **Can Municipal Planners Realistically Consider Cumulative Effects in Land Use Decisions?**

Workshops convened in the spring of 2011 regarding cumulative impacts to streams identified the need for a decision support system (DSS) to facilitate science-based decision-making on cumulative effects. Implementation of provincial policies regarding water resources has emphasized the use of surrogates, such as minimum buffers, rather than an evaluation of effectiveness. We consider practical aspects of a DSS in terms of the planning scale, time steps for evaluation and the necessary qualifications of practitioners. The evaluation considers these aspects of DSS delivery with respect to several cumulative effects approaches: landscape modelling using priority valued environmental components (VECs) to quantify existing conditions relative to the reference state and to develop predictive models for scenario testing; measuring threats to the aquatic ecosystem that can be used to objectively link decisions on the threats to stream conditions; and a spatial analysis to identify areas of high biodiversity that are sensitive to development, priority areas for restoration (cusp of a threshold) and/or areas with low resiliency to pulse stresses (e.g. climate events above a threshold). Finally, we provide a frank assessment of the barriers to implementation and offer suggestions for timely development and implementation of a DSS. *Keywords: Monitoring, Decision making, Planning.*

ISLAM, M.S., BONNER, J.S., FULLER, C., OJO, T., and KIRKEY, W., 8 Clarkson Avenue, Potsdam, NY, 13699. **Use of an Environmental Observatory to Characterize Contaminant Transport in a Riverine Superfund Site.**

Real-time in-situ data from the River and Estuary Observatory Network (REON) are analyzed to characterize the physical processes affecting particle and particle bound contaminant transport in a river resulting from both remedial dredging activity and an extreme flow event. Continuous monitoring data showed dramatic and coincident increases in sediment flux (22 metric ton/hr to 2400 metric ton/hr), water current (25 cm/s to 90 cm/s), and stream flow (85 m3/s to 480 m3/s) on August 28, 2011 following Hurricane Irene. In addition, in-situ particle size measurements suggest that significant amounts of small particles (<70 μm diameter) were transported during the flood event. Smaller particles have a higher capacity for contaminant mobilization in the water column, compared to larger particles, due to relatively higher surface area/ particle volume ratio and longer retention time in the water column. Mobile monitoring surveys conducted on July 29, 2011 showed that suspended particle concentrations decreased with distance from dredging activities during normal flow conditions (85 m3/s). The combined use of both fixed-continuous and event-based-mobile monitoring technology provides data at the required temporal and spatial resolutions required for constituent transport modeling in dynamic aquatic systems. *Keywords: Assessments, Environmental contaminants, Observing systems.*

IVAN, L.N.[1], RYAN, D.J.[2], RODE, R.A.[3], BROWN, P.B.[3], and HÖÖK, T.O.[3], [1]CILER, 4840 S. State Rd., Ann Arbor, MI, 48108; [2]Pennsylvania Fish and Boat Commission, 450 Robinson Lane, Bellefonte, PA, 16823; [3]Purdue University, 195 Marsteller, West Lafayette, IN, 47907. **Potential Influence of Body Size, Stock, and Overwinter Prey Consumption on Egg Size and Fecundity of Yellow Perch.**

Great Lakes Yellow Perch support commercial and recreational fisheries and, in some areas, have been dramatically impacted by high exploitation rates, leading to population declines. High fishing pressure often removes older, larger females, which may reduce recruitment success as these females may produce more and larger eggs than younger, smaller females. Fishing-induced changes to adult size and age structure, along with strain type, feeding and growth history, may lower yellow perch recruitment success. To compare the influence of female size, strain type and feeding history on fecundity and egg size of yellow perch, we ran an experiment in which two strains of perch of two different sizes were fed at either maximum consumption rate (Cmax) or 25%*Cmax from fall through spring. We manually spawned females, weighed and measured eggs to estimate fecundity, diameter and mass. Fish fed at Cmax grew more than fish feed at 25%*Cmax, but there were no differences in egg size among treatments. Fecundity varied among perch sizes, strains and feeding levels: small Ohio-strain females on lower ration had lower fecundity than other females. Our results support the hypothesis that alterations in population characteristics may have reduced Yellow Perch populations throughout the Great Lakes. *Keywords: Yellow perch, Recruitment, Life history studies.*

IVES, J.T.[1], MARTY, J.[2], KOOPS, M.A.[3], POWER, M.[1], and DE LAFONTAINE, Y.[4], [1]University of Waterloo, Dept of Biology, 200 University Ave. W., Waterloo, ON, N2L 3G1; [2]St. Lawrence River Institute, 2 St. Lawrence Dr., Cornwall, ON, K6H 4Z1; [3]Department of Fisheries and Oceans, Canadian Centre for Inalnd Waters, Burlington, ON, L7R 4A6; [4]Centre St Laurent, Environnement Canada, Montreal, QC. **Spatial Variability in Food Sources of the Invasive Shrimp, *Hemimysis anomala*, Within Lentic and Lotic Systems.**

Hemimysis anomala (HA) is the latest known invader of the Great Lakes basin, having first been recorded in lakes Michigan and Ontario in 2006. Since then HA have been found in all of the Great Lakes except Superior, as well as in several locations along the St. Lawrence River. High densities found in both lentic and lotic ecosystems suggest the ability of HA to integrate into contrasting food webs. As of yet, the pattern of spatial variability in HA diets is unknown, particularly variation between lentic and lotic sites. Nevertheless, such information is necessary to accurately assess the impacts of HA on the Great Lakes ecosystem. Samples of HA and concurrent food web items were collected between 2008 and 2011 from several sites in lakes Ontario, Erie, and the St. Lawrence River. Samples were processed for carbon and nitrogen stable isotope analyses to evaluate the main food sources and trophic position of HA. Mixing models were used to evaluate the importance of benthic versus pelagic food sources entering the diet of HA at each site. Trophic levels were also compared using baseline corrected delta15N values for each site. Results have shown significant differences in food sources between lakes and the river, highlighting the importance of considering spatial scales when studying the ecology of HA. *Keywords: Spatial distribution, Stable isotopes, Invasive species.*

JABBARI SAHEBARI, A.[1], SCALO, C.[2], BOEGMAN, L.[1], and PIOMELLI, U.[2], [1]Ellis Hall, Queen's University, 58 University Avenue, Kingston, ON, K7L 3N6, Canada; [2]McLaughlin Hall, Queen's University, Kingston, ON, K7L 3N6, Canada. **Oscillating Boundary Layers in Lakes and Coastal Oceans.**

Near-bottom currents in lakes and oceans, such as those generated by surface and internal gravity waves, internal tides, seiches, and inertial motions, are oscillatory. Tide and seiche currents result in strong mixing and turbulence production in bottom boundary layers, which are significant for basin scale vertical transport and mixing. The properties of oscillatory flows are not well understood and commonly adopted models such as log-law of the wall and Stokes' second problem are not applicable transient flows at high Reynolds number. Furthermore, there is no quantification of the limits for applicability of the available models. This study is a numerical investigation of an oscillating free-stream flow with a sinusoidal velocity variation by means of Direct Numerical Simulation and Large Eddy Simulation. Using a Reynolds number, based on the Stokes thickness, the results show that the bottom boundary layer thickness increases with increasing the Reynolds number. In addition, the integrated values of turbulent dissipation and production, inside the bottom boundary layer, are evaluated as a function of the phase of oscillation. Finally, the numerical results are compared to available analytical models to determine their limits of applicability. *Keywords: Boundaries, Coastal engineering, Lake model.*

JANUSKA, B., MINNIEFIELD, C., <u>SIMOLIUNAS, S.</u>, and GOGINENI, P., Detroit River Remedial Action Council, 665 W. Warren Avenue, Detroit, MI, 48201, USA. **The Need for Technological Advancement in Wastewater Treatment.**

There is a dire need to upgrade the wastewater treatment plants in the Great Lakes Basin. For example, Detroit Wastewater Treatment Plant has no tertiary treatment, uses incineration for sewage sludge, uses elemental chlorine for disinfection. It is also one of the largest plants in the region. The new GLWQA should demand technological innovation for old wastewater treatment plants. *Keywords: Great Lakes basin, Environmental policy, Water quality.*

<u>JASIM, S.Y.</u>[1], KLECKA, G.M.[2], ARVAI, A.T.[1], and LAITTA, M.T.[3], [1]IJC Great Lakes Regional Office, 100 Ouellette Ave, 8th Floor, Windsor, ON, N9A 6T3; [2]The Dow Chemical Company, 1083 Building, Midland, MI, 48674; [3]International Joint Commission, 2000 L Street, NW, Washington DC, 20440. **Assessing the Effectiveness of Wastewater Treatment for the Removal of Chemicals of Emerging Concern.**

The Great Lakes and their connecting channels form the largest fresh surface water system on earth and are an integral part of municipal, agricultural and industrial activities. In spite of their size, the Great Lakes are sensitive to the potential effects of a variety of pollutants. Focus on environmental monitoring has shifted from legacy pollutants to recently discovered compounds known as "chemicals of emerging concern" (CEC). The term CEC has come to characterize the increasing awareness of the presence in the environment of the multitude of chemicals used by society, and the risk they may pose to ecosystems and humans. These chemicals are in products used daily in households, businesses, agriculture and industry, such as pharmaceuticals and personal care products. Wastewater treatment plants (WWTPs) are among the important pathways by which CEC enter the Great Lakes. In 2009-2011, the International Joint Commission addressed the need to assess the effectiveness of existing WWTP technologies in the basin to remove CEC. This assessment encompassed (1) development of an inventory and map of municipal WWTPs that discharge in the basin, (2) a survey of detailed operational data for selected wastewater facilities, and (3) a literature review and analysis of the effectiveness of various WWTP technologies to remove CEC. *Keywords: Chemicals of emerging concern, Wastewater, Great Lakes basin.*

<u>JOBST, K.J.</u>[1], BACKUS, S.[2], MCCARRY, B.E.[3], HELM, P.[1], TAGUCHI, V.Y.[1], and REINER, E.J.[1], [1]Ontario Ministry of the Environment, 125 Resources Road, Toronto, ON, M9P 3V6; [2]Environment Canada, 867 Lakeshore Road, Burlington, ON, L7S 1A1; [3]McMaster University, 1280 Main Street West, Hamilton, ON, L7S 1X6. **Non-targeted Screening of (Unknown) Environmental Contaminants using Ultrahigh Resolution Mass Spectrometry.**

There are ~ 100,000 chemicals used in industry and commerce, but relatively few of these have been investigated for their persistence and toxicity. Thus, a major challenge in analytical chemistry is the development of fast, non-targeted methods for the identification of new environmental contaminants as well as products of their reaction and degradation. Fourier Transform Mass Spectrometry (FTMS) is a powerful screening tool for (unknown)

environmental contaminants. A prime example concerns the analysis of fallout from fires, in this case samples from the 1997 'Plastimet Fire' in Hamilton, Ontario. Ultrahigh resolution mass spectra obtained using FTMS show that the combustion of chlorinated and brominated plastics gave rise to a myriad of chloro-, bromo- and mixed chloro/bromo- polycyclic aromatic hydrocarbons, furans, dioxins and thiophenes, many of which have not been previously characterized. The number of possible isomeric substances is enormous. Strategies to assess the toxicities and bioaccumulative properties of these compounds using FTMS will be discussed. FTMS is also an ideal platform for the analysis of petroleum derived contaminants in the environment. One example deals with BNST (products of N-phenylbenzeneamine, styrene and 2,4,4,-trimethylpentene), a widely used additive in consumer petroleum products. *Keywords: GC/HRMS, Environmental contaminants, Mass spectrometry.*

JOHNSON, J.H., Tunison Laboratory of Aquatic Science USGS - Great Lakes Science Center, 3075 Gracie Road, Cortland, NY, 13045. **New York's Lake Ontario Atlantic Salmon Program: A Review of Opportunities, Constraints, and Management Actions.**

Atlantic salmon once a major component of the Lake Ontario fish community have been extirpated for over a century. Efforts to restore Atlantic salmon as a viable component of the fish community have, until recently, met with limited success. Three encouraging signs, an increase in angler catches in the lake, an increase of adult returns to tributaries, and three consecutive years of documented natural reproduction in the Salmon River suggest that environmental events and/or management actions are having positive effects. Reasons for increased survival and natural reproduction are unknown but could be associated with changing lake conditions, reduced reliance on alewife in the diet, or the strain(s) of Atlantic salmon now being stocked. In the tributaries several limiting factors still exist including high stream temperatures, competition for spawning sites, and competition for juvenile rearing habitat, especially with steelhead. In New York, most Atlantic salmon stocking now uses the Sebago strain and most of the effort is directed at the Salmon River. I will review recent findings and discuss planned activities directed at achieving the New York State Department of Environmental Conservation goal of increasing Atlantic salmon returns, recreational catches, and continued study of natural reproduction in the Salmon River system. *Keywords: Atlantic Salmon Restoration, Native Fish Restoration.*

JOHNSON, L.B.[1], KOVALENKO, K.E.[2], HOWE, R.W.[3], BHAGAT, Y.[2], CIBOROWSKI, J.J.H.[2], GATHMAN, J.P.[4], BRADY, V.J.[1], BRENEMAN, D.[1], BROWN, T.N.[1], DANZ, N.P.[5], HOST, G.E.[1], REAVIE, E.D.[1], and NIEMI, G.J.[1], [1]Natural Resources Research Institute, University of Minnesota Duluth, Duluth, MN; [2]Department of Biological Sciences, University of Windsor, Windsor, ON; [3]Department of Natural and Applied Sciences, University of Wisconsin Green Bay, Green Bay, WI; [4]Department of Biology, University of Wisconsin River Falls, River Falls, WI; [5]Department of Natural Sciences, University of Wisconsin Superior, Superior, WI. **A Comparison of 4 Analytical Methods to Derive a Composite Bioindicator of Fish Condition Relative to Anthropogenic Stress at Great Lakes Coastal Margins.**

We assessed the fidelity, sensitivity and discriminatory ability of 4 methods to develop a fish-based bioindicator of land-based stress using data consisting of 48-h fyke net catches from

136 coastal margin locations stratified across the Great Lakes US coastline. Fish abundances were used to construct 1) probability-based indicators of ecological condition (Howe et al. Ecological Indicators 2007); 2) composite measures using taxa whose relatives abundances change at environmental thresholds (derived from Threshold Indicator Taxa Analysis, Baker & King, Methods in Ecology & Evolution 2010); 3) a composite measure using taxa identified from weighted-average transfer functions (Reavie et al. Journal of Great Lakes Research 2006); 4) novel extension of the BEAST multivariate approach (Reynoldson et al. Austral. J. of Ecology 1995) - the Reference-Degraded Continuum. All methods identified similar taxa contributing most to the indices' discrim¬inatory abilities, indicating indices' capacity to detect species-specific indicators of equivalent-to-reference and degraded locations. Thresholds at approxi¬mately the same point along the stressor gradient by each method, but with differing precision. Better discriminatory functions were derived for the less disturbed northern ecoprovince than the more highly developed southern region. *Keywords: Bioindicators, Fish, Great Lakes basin.*

JOHNSON, T.B.[1], CARREON-MARTINEZ, L.[2], and TARABORELLI, A.C.[1], [1]Ontario Ministry of Natural Resources, Glenora Fisheries Station, Picton, ON, K0K 2T0; [2]University of Windsor, Great Lakes Institute for Environmental Research, Windsor, ON, N9B 3P4. **Resolving Fish Predation on *Hemimysis anomala*: Gut Contents, Digestion Rate, and Species Specific Molecular Primers.**

Hemimysis anomala, the bloody red shrimp, is one of the most recent invaders to the Laurentian Great Lakes. North American and European literature is varied with respect to the degree to which fish predate on *Hemimysis* making accurate prediction of impacts on newly invaded systems difficult. We describe a series of analyses to document the occurrence of *Hemimysis* in the guts of Lake Ontario fish. Laboratory analyses were conducted to determine the rate of digestion of *Hemimysis* relative to size and water temperature. In addition, we developed *Hemimysis* specific molecular primers to improve our detection success. Our results suggest low frequency of occurrence in fish guts, likely a consequence of very rapid digestion rates; the molecular genetic technique does reveal a higher frequency of occurrence than from visual observation. The molecular genetic technique provides a cost effective tool for detecting the presence of *Hemimysis* in fish guts, enabling researchers to estimate the frequency of occurrence by different fish species consuming this small, but locally abundant invasive plankton. *Keywords: Diets, Hemimysis, Invasive species, Predation.*

JONES, L.A. and RICCIARDI, A., Redpath Museum, McGill University, 859 Sherbrooke St. W., Montreal, QC. **Exotic Species Replacement in Relation to Small-Scale Environmental Heterogeneity.**

Quagga mussels (*Dreissena bugensis*) are replacing zebra mussels (*D. polymorpha*) as the dominant exotic species in areas of the Great Lakes-St. Lawrence River system. This replacement has occurred asymmetrically over large depth gradients resulting in a zonation pattern where quagga mussels dominate deeper waters, but zebra mussels persist in marginal shallow waters. Such patterns are likely due to differences in life history and physiology played

out across an environmental gradient. We examined the patterns and mechanisms of this replacement in the Soulanges Canal, a shallow waterway connected to the St. Lawrence River. We discovered a similar replacement and zonation pattern as that seen over large depth gradients. Furthermore, population structure, body condition and growth were lower in the deep zone for both species, yet zebra mussels were more negatively affected. These results reveal the deep zone to be a sub-optimal habitat, even though temperature, dissolved oxygen and food levels did not vary with depth. We conclude that exposure to acute turbidity in the deep zone is imposing a higher metabolic cost, particularly for zebra mussels. This suggests gradients previously thought to be important are not necessary to generate the patterns of replacement and zonation. *Keywords: Dreissena, Exotic species, St. Lawrence River.*

KANAVILLIL, N., <u>MITCHELL, D.</u>, WEEL, K., and KURISSERY, S., 500 University Avenue, Lakehead University Orillia Campus, Orillia, ON, L3V0B9. **Studies on the Variation of Protozoa in Natural Biofilms: A Study from NW Lake Simcoe and Lake Couchiching.**

The species dynamics of benthic protozoa in relation to diatoms in natural biofilm communities have been studied in four inland water locations at NW Lake Simcoe and Lake Couchiching during summer 2011. Cleaned glass slides were used as experimental substrata for the development of biofilms. Replicate slides were removed at fixed time intervals. They were immediately observed under a microscope for diatom and protozoa density and species diversity. Lake Couchiching recorded the maximum number of protozoa and species diversity in biofilms as compared to other localities. Members belonging to Sarcomastigophora dominated the protozoa community followed by Ciliophora in all sampling locations. The sampling location at the City of Orillia's waste water treatment plant recorded the maximum density of protozoa as well as diatoms. The results of PCA analysis showed the sampling location besides the wastewater treatment plant differed significantly from the other sampling locations during the study. The composition and density of protozoa and diatoms also varied significantly between sampling locations. However, a significant positive correlation between diatom and protozoa densities in biofilms indicated the existence of a strong predator-prey relationship between these groups of organisms in biofilm community. *Keywords: Diatoms, Populations, Biofilm.*

<u>KANE, D.D.</u>[1], CONROY, J.D.[2], and THOMAS, M.A.[3], [1]Defiance College, Division of Natural Sciences and Mathematics, Defiance, OH, 43512; [2]Division of Wildlife, Ohio Department of Natural Resources, Hebron, OH, 43512; [3]F. T. Stone Laboratory, Put-In-Bay, OH, 43456. **Morphometry, Meteorology, and Metalimnetic Oxygen Maxima: Monitoring Dissolved Oxygen Dynamics in the Sandusky Subbasin of Lake Erie.**

To (1) document dissolved oxygen (DO) spatial and temporal dynamics and (2) determine factors that affect formation of hypoxic/anoxic hypolimnia (a.k.a., "Dead Zones"), we quantified DO and other limnological parameters (i.e., temperature, chlorophyll concentration) weekly in the Sandusky subbasin during at least June-July since 2005. We found that basin morphometry (i.e., depth, proximity to organic matter loading sources), weather (i.e., temperature, wind), and photosynthesis (i.e., Metalimnetic Oxygen Maxima) greatly influence the timing and spatial extent of low DO events. Further, although we found evidence for

consistent patterns in the timing and spatial extent of hypoxia/anoxia, stochastic weather-related processes, such as wind speed and direction, forced low DO dynamics in this region of Lake Erie. Since these processes largely remain outside of lake manager control, watershed remediation of nutrient and algal loading to the lake becomes even more critical to moderating low DO beneficial use impairments in the Sandusky subbasin. While such management actions may not prevent "Dead Zone" formation, they may lessen the temporal and spatial extent of low DO, thereby ameliorating its negative effects on biota and human users. *Keywords: Oxygen, Hypoxia, Lake Erie, Anoxia.*

KAPUSCINSKI, K.L. and FARRELL, J.M., State University of New York College of Environmental Science and Forestry, 1 Forestry Drive, Syracuse, NY, 13210. **Selective Feeding among Species of Submerged Aquatic Vegetation by a Non-native Cyprinid, the Rudd.**

We conducted an experiment to determine if a non-native cyprinid, the rudd (*Scardinius erythrophthalmus*), fed selectively among species of submerged aquatic vegetation (SAV) common to nearshore areas of the Great Lakes. Previous research indicated that the rudd comprised 49% of all fishes captured in spring trap-netting surveys of the Buffalo Harbor (northeastern Lake Erie) and upper Niagara River during 2007-2008, and that SAV dominated the diets of rudds during May-November of 2009. We tested a null hypothesis of non-selective feeding by rudds using five species of SAV: *Ceratophyllum demersum*, *Elodea canadensis*, *Najas flexilis*, *Stuckenia pectinata*, and *Vallisneria americana*. Four rudds were placed in 15 tanks, presented with known quantities of each SAV species, and each SAV bundle was weighed on six dates during a 13 d experiment. Selective feeding by rudd was apparent, with the order of SAV removal (from highest to lowest) being: *N. flexilis > S. pectinata = E. canadensis > V. americana > C. demersum*. Our results suggest that the rudd has the potential to alter SAV assemblages through selective feeding, which may jeopardize habitat restoration projects seeking to establish SAV at nearshore sites of the Buffalo Harbor and Niagara River. *Keywords: Exotic species, Fish diets, Vegetation.*

KARATAYEV, A.Y.[1], BURLAKOVA, L.E.[1], and MASTITSKY, S.E.[1], [1]1300 Elmwood Avenue, Science Bldg. 261, Buffalo, NY, 14222, USA; **Predicting the Zebra Mussels Spread: What Can We Learn From 200 Years of Continuous Invasion.**

Of the 1,040 glacial lakes in the Republic of Belarus (Europe), 553 have been examined for the presence of zebra mussels. In spite of 200 years of continuous invasion, by 1996 zebra mussels were found in only 16.8% of all lakes studied. The initial rate of spread of zebra mussels was very slow and did not exceed 4 lakes per 50 years during the first 150 years of invasion, but then increased to 23 lakes per every 10 years. At least 70% of all lakes have been predicted to be colonized with zebra mussels in the future. The prediction was checked in 1997-2008 years when 80 lakes free of zebra mussels during the initial survey were re-examined. Zebra mussels were found for the first time in 34 lakes, all of which were classified initially as suitable for zebra mussels. Using data on 15 environmental variables, Random Forests classification algorithm was employed to develop a model predicting potential occurrence of zebra mussel. In addition to the

calcium content and water pH, certain lake morphology parameters appeared to be strong predictors in this model. *Keywords: Dreissena, Lake model, Zebra mussels.*

KARATAYEV, V.A.[1], KARATAYEV, A.Y.[2], RUDSTAM, L.G.[3], and BURLAKOVA, L.E.[2], [1]University Honors College, University at Buffalo, Buffalo, NY, 14260; [2]Great Lakes Center, Buffalo State College, 1300 Elmwood Ave., Buffalo, NY, 14222; [3]Department of Natural Resources, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY, 14853. **A Century of Change in Molluscan Community in Lake Oneida: Evidence of Recovery?**

Freshwater molluscs are among the most endangered groups of animals, and at the same time, represent the most diverse group of invaders in North American freshwaters. The local extinctions and introductions of invaders have dramatic effect on the diversity and community structure of molluscs. In the early 20th century, Lake Oneida hosted an abundant and diverse molluscan community of 41 species, excluding unidentified Sphaeriidae. However, due to habitat loss, introduction of invasive species, and other aspects of human activity, the diversity of molluscs has dramatically declined. By the mid-1990s, 20 species of molluscs found in the lake in 1918 had disappeared, indicating a 50% decline in the diversity. At the same time, at least 11 species of molluscs have been introduced, including the zebra mussels that had devastating effect on the native unionids. During our preliminary study of molluscs of Lake Oneida in 2010 we found 19 species, including 6 species that were previously listed as lost, suggesting at least partial recovery in the molluscan community. A detail study of the lake's molluscs is planned for the coming growing season to determine the scale of this recovery. *Keywords: Lake Oneida, Biodiversity, Mollusks.*

KATRIB, L.T.[1], BASKARAN, M.[2], MILLER, C.J.[1], and BRATTON, J.F.[3], [1]Civil and Environmental Engineering, Wayne State University, 5050 Anthony Wayne Dr., Detroit, MI, 48202; [2]Department of Geology, Wayne State University, 0224 Old Main Building, Detroit, MI, 48202; [3]GLERL, NOAA, 4840 S. State Rd., Ann Arbor, MI, 48108. **Tracer Studies in the Exchange of Water and Material between Sub-reservoirs in Great Lakes System.**

Short- (223Ra and 224Ra) and long-lived (226Ra and 228Ra) isotopes of radium that occur in nature, derived from the alpha-decay of thorium isotopes in the 238U-235U-232Th-series, have been widely used in a variety of applications such as determining transport time scales of river plumes in coastal marine environments, and in quantification of submarine groundwater discharge. Although a large body of data exists for marine environments, only limited comparable data have been generated for freshwater systems. A suite of surface water samples collected from the Clinton and Detroit Rivers, and Lake St. Clair and groundwater samples from Metro-Detroit area were analyzed using a RaDeCC counting system (223Ra and 224Ra) and gamma-ray spectrometer (226Ra and 228Ra). Activities of 223Ra and 224Ra vary in the Clinton River over time, possibly indicating temporal changes in their sources. The higher (3-4 times) 226Ra and 228Ra activities in the Clinton River compared to those in Lake St.Clair is attributed to excess Ra derived from the phosphate fertilizer used in golf courses in the Clinton River watershed. Finally, the activities of all radium isotopes measured in groundwater samples is about 4-11 times higher than those of surface water samples, thus allowing us to quantify and

trace plumes of groundwater discharge to surface water. *Keywords: Mass balance, Lake St. Clair, Radioisotopes.*

KEITEL, J.[1] and VIS, C.[2], [1]248 Big Tub Road, Tobermory, ON, N0H 2R0; [2]111 Water Street, Cornwall, ON, K6H 6S3. **Restoring the Ecological Integrity of a Large Coastal Wetland in Point Pelee National Park; use of Remote Sensing and Modeling Tools to Measure Cattail Encroachment and Guide Restoration.**

The majority of Point Pelee National Park is comprised of a large Great Lakes coastal wetland, which was designated as a RAMSAR wetland of international importance because of its high biodiversity. However, nearby intensive agriculture, urban development, and changes in Lake Erie through time ,have contributed towards a decline in ecological integrity. Likely due to changes in hydrology and water quality, a dominance of cattails has occurred in the wetland. In this study, we measured cattail (Typha sp.) encroachment in the wetland between 1959 and 2010, using remote sensing. Spatial variations in encroachment rates were found as small open water patches decreased through time in the interior of the marsh, but the size of large ponds remained unchanged. Overall, the wetland has decreased in both open water (-25%) and number of patches (-93%) between 1959 to 2010. Maintaining a healthy wetland for all species, requires diversity in habitats, including both vegetated and open water, and interspersion between them. Cattail encroachment in the wetland has lead to a loss of habitat diversity and presents a restoration opportunity. To guide potential restoration action, a state and transition model was developed, and various management scenarios simulated will be presented. *Keywords: Habitats, Restoration, Coastal wetlands, Model studies.*

KELLER, R.P.[1], DRAKE, J.M.[2], DREW, M.B.[3], LODGE, D.M.[3], and CHADDERTON, W.L.[4], [1]Loyola University Chicago, Department of Environmental Science, Chicago, IL, 60660; [2]University of Georgia, Odum School of Ecology, Athens, GA, 30602; [3]University of Notre Dame, Department of Biological Sciences, Notre Dame, IN, 46556; [4]The Nature Conservancy, Great Lakes Project, Notre Dame, IN, 46556. **Linking Environmental Conditions and Ship Transport to Estimate Invasive Species Transport to the Great Lakes Across the Global Shipping Network.**

Some nations, and the International Maritime Organization, are moving towards requirements for managing ballast water to reduce the number of alien species transported and released. These and other measures will be most efficient when targeted at ships posing the greatest risks. Here, we analyze world-wide ship movements and port environmental conditions to explore how these risk components differ across ships entering the Laurentian Great Lakes. Based on a global database of ship movements we show that ships regularly enter the Great Lakes from all major coastal, and many inland, regions of the world. Most global ports, and thus the species in them, are separated from the Great Lakes by no more than two ship voyages. Next, we collected or estimated the salinity and temperature of all global ports to determine which are most environmentally similar to conditions in the Great Lakes. Combined with data about ship movements, this allows us to estimate those ports and ship routes most likely to be the source for future invasions to the Great Lakes. Additionally, the risk from some high profile global invaders

can be estimated. These results could be used to prioritize ships entering the Great Lakes for management actions. *Keywords: Risk assessment, Ballast, Invasive species.*

KENDALL, S.T., HOLCOMB, T., GEREAUX, L., WEINKE, A., SNIDER, M., LONG, S., and BIDDANDA, B., Grand Valley State University, 740 W. Shoreline Dr., Muskegon, MI, 49441, US. **Lessons Learned from Management, Quality Control, and Dissemination of Buoy Observatory Data.**

Muskegon Lake Buoy Observatory located in Muskegon, MI (43.23824, 86.28052) monitors surface meteorological and subsurface water quality and hydrologic parameters throughout 14 m of water depth. The mooring includes a 5 ft. dia. surface buoy as the main platform to which two submerged moorings are connected, one for water sensors and one for a bottom-mounted ADCP. Data collected at 5 min. (meteorological) and 15 min. (water) intervals is streamed to a local computer and the internet. Data is quality controlled in part by retrieving sensors semi-monthly and performing bench testing of un-cleaned sensors against known standards. During the 2011 deployment, quality control checks have been conducted on 5 YSI 6600/6920 sensors, a Turner C3 sensor, a Satlantic SUNA (nitrate), and 6 Nexsens T-nodes. Other sensors include a LICOR PAR, LUFFT meteorological, and a TRDI ADCP. Accuracy and precision data from the quality control checks will be reviewed. A web site has been developed that enables the user to manipulate the data in novel ways including the ability to compare any two parameters to observe inter-relationships in the data (www.gvsu.edu/buoy). The goal of data distribution is not only for science, but also education. Student active learning projects are being developed. *Keywords: Buoys, Quality assurance, Data storage and retrieval, Observing systems.*

KERETZ, K.R.[1], MICHEL, M.[2], WIRICK, R.E.[1], and KOCOVSKY, P.M.[1], [1]U S Geological Survey, Great Lakes Science Center, Sandusky, OH, 44870; [2]Oberlin College, Oberlin, OH, 44074. **The Biological Status of the Silver Chub, *Macrhybopsis storeriana*, within Lake Erie's Western Basin.**

The silver chub, *Macrhybopsis storeriana*, is one of the largest native minnow species in the central United States, however little is known about its life history within Lake Erie. Between 1960 and 1995, silver chub abundance was low in western Lake Erie, but an increase in abundance was observed between 1997 and 1999. After this increase, silver chub quickly declined to a lower abundance until 2011 when another increase was observed. To better understand these fluctuations in abundance and the current population status of this species, we examined growth, condition, and diet of silver chub from Ontario and Michigan waters of Lake Erie's Western Basin. We compared our values to a study from the 1950's and examined relationships between silver chub catch-per-unit-effort and several biotic (e.g., abundance of exotics) and abiotic (e.g. water clarity) variables. Our results will provide insights to the possible population level responses of silver chub to recent invasions (e.g. dressenid mussels, round goby) and highlight the need to develop information on low abundance species to manage and conserve biodiversity. *Keywords: Fish populations, Lake Erie, Life history studies.*

KHAIRY, M.[1], <u>LOHMANN, R.</u>[1], ADELMAN, D.[1], and MUIR, D.[2], [1]URI Graduate School of Oceanography, South Ferry Road, Narragansett, RI, 02882; [2]Environment Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **Trends of PBTs in Air and Water across Lakes Erie and Ontario.**

Passive polyethylene samplers were deployed from April - October 2011 in lower atmosphere and surface water of Lakes Erie and Superior to (i) enhance the measurements of the spatial variability of atmospheric concentrations of persistent bioaccumulative toxics (PBTs) around the Lake; (ii) assess whether the lakes are volatilizing or absorbing gas-phase PBTs to derive fluxes and loading to the lakes; and (iii) detect emerging contaminants of concern. Initially, we focused on polycyclic aromatic hydrocarbons and polychlorinated biphenyls. A total of ~75 samplers were deployed along the U.S. and Canadian shore and in-lake in paired air-water deployments. Strong west-to-east gradients were observed for PAHs and PCBs, wich eastern sites cleaner in Lake Ontario than in Lake Erie. By using the same sampling matrix (in our case polyethylene, PE) in air and water, activity gradients across the air-water interface were derived. Air-water exchange ratios indicated heterogeneous results across Lake Ontario.
Keywords: Spatial distribution, Air-water interfaces, PBTs.

<u>KHAN, I.U.H.</u>[1], EDGE, T.A.[1], JARJANAZI, H.[2], LEE, D.Y.[3], PALMER, M.E.[2], MUELLER, M.[2], NOWAK, E.[1], SCHOP, R.[2], WEIR, S.[2], and WINTER, J.G.[2], [1]Aquatic Ecosystem Protection Research Division, National Water Research Institute, Environment Canada, Burlington, ON; [2]Ontario Ministry of the Environment, 125 Resources Road, Toronto, ON, M9P3V6; [3]University of Guelph, Guelph, ON. **Investigation of Thermophilic Campylobacter Species Occurrence at Lake Simcoe Beaches.**

Thermophilic Campylobacter species have been implicated in gastrointestinal infections in humans, and can occur in agricultural run-off, sewage discharges, and the feces of animals. The aim of this study was to investigate the occurrence of Campylobacter at five beaches on Lake Simcoe. In 2010, a bi-weekly sampling program was carried out across two depth zones (ankle depth and chest depth waters) from July to November. In 2011, sand porewater samples were also collected and sampling was from May to November. To identify potential sources of contamination, samples were also collected from four neighboring rivers and fresh bird fecal droppings. Samples were processed for Campylobacter isolation and detection using a minimum probable number culture enrichment protocol. The putative culture isolates were further confirmed by culture-based genus- and species-specific multiplex polymerase chain reaction assays. The results indicate that Campylobacter occurred infrequently and generally at low concentrations. Campylobacter was detected in 11% of beach samples and 15% of river samples. At the beaches, Campylobacter occurred more frequently in sand porewater and ankle depth water than chest depth water. The study suggests that sand, rivers and birds could be potential sources of Campylobacter contamination. *Keywords: Lake Simcoe, Pathogens, Beaches.*

KIM, T.Y.[1], NORTH, R.L.[2], DILLON, P.J.[2], and SMITH, R.E.H.[1], [1]200 University Avenue West, Waterloo, ON, N2L 3G1; [2]1600 West Bank Dr., Peterborough, ON, K9J 7B8. **Spatial and Temporal Dynamics of Phytoplankton Production and Size Distribution in a Large Mesotrophic Lake (Lake Simcoe).**

Lake Simcoe (mesotrophic) has received a substantial amount of attention in recent years due to concerns over water quality, depletion of hypolimnetic oxygen and invasive species (notably dreissenids). Phytoplankton are directly connected with water quality, hypoxia and food web function but their primary production rates have never been reported for Lake Simcoe. From August 2010 to July 2011 including winter, the spatial and temporal patterns of production were determined by a ^{14}C technique. The epilimnetic daily areal production (P_{int}) ranged from 0.1 to 1115.9 mg C m^{-2} d^{-1} and volumetric production (P_{opt}) from ~0 to 150.2 mg C m^{-3} d^{-1}. Phytoplankton were at times highly abundant under ice, but P_{int} was nonetheless lower in winter than in other seasons. Areal production was on average higher at offshore (>20m depth) than nearshore sites but the statistical significance of spatial differences varied by season and among different nearshore areas. Total chlorophyll a concentration and its size distribution varied seasonally and among regions of the lake. Autumn appeared to be an important season for primary production in Lake Simcoe. *Keywords: Size fractionation, Productivity, Seasonal distribution, Phytoplankton, Spatial distribution.*

KING, L.E.[1], DE SOLLA, S.R.[2], ARTS, M.T.[2], QUINN, J.S.[1], and SMALL, J.M.[2], [1]Department of Biology, McMaster University, Hamilton, ON; [2]Environment Canada, Canada Centre for Inland Waters, Burlington, ON. **Microsatellite DNA Mutations Associated with PAH Exposure in Double-Crested Cormorants, *Phalacrocorax auritus*.**

Hamilton Harbour, Ontario, Canada is one of the most polluted sites on the Great Lakes and affected by airborne and sedimentary contamination as a result of both heavy vehicle traffic and industrial steel emissions. Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous mutagenic byproducts of incomplete organic combustion; they are present at very high concentrations in the air and sediment of Hamilton Harbour. We used five highly variable DNA microsatellites to screen for mutations in 97 families of Double-crested Cormorants (*Phalacrocorax auritus*) from three wild colonies, two in Hamilton Harbour and one in cleaner northeastern Lake Erie. Mutations were identified in all five microsatellites at low frequencies, with the significant majority of mutations found in chicks from the Hamilton Harbour site closest to industrial sources of PAH pollution. A metabolite of the PAH benzo[a]pyrene identified by LC-MS/MS in bile and liver from Hamilton Harbour cormorant chicks suggest that these cormorants are exposed to, and metabolizing, PAHs. Fatty acid analysis indicates that cormorant diets at the two Hamilton Harbour sites are extremely similar. This suggests that contamination is less likely to result through diet and more likely to result from the high levels of genotoxic airborne particulate found in Hamilton Harbour. *Keywords: Cormorants, Lake Erie, Genetics, PAHs, Lake Ontario, Fatty acids.*

KINZELMAN, J.L.[1], ANAN'EVA, T.L.[2], KURDAS, S.R.[1], MUDD, D.I.[3], and MEDNICK, A.C.[4], [1]730 Washington Avenue, Racine, WI, 53403; [2]1200 Pennsylvania Ave. NW, Washington, DC, 20004; [3]45 S. National Ave., Fond du Lac, WI, 54935-4699; [4]101 S. Webster Street, Madison, WI, 53707. **Success in Employing New Analytical Methods, Without Site-Specific Epidemiological Studies, for the Regulation of Great Lakes Beach Water Quality - A Case Study from Racine, WI.**

The USEPA recently released proposed recreational water quality criteria. Relationships between health effects and qPCR were evaluated to determine if molecular assays could enhance predictive accuracy and health protection. Criteria for enterococci are proposed, subject to site-specific performance characterization. Criteria for models, non-analytical estimations of indicators, are not specified. Great Lakes beaches are regulated using an E. coli standard and, although models and qPCR assays exist, they weren't included in EPA's temperate, freshwater epi studies. Culturable E. coli for fresh water quality is still recommended but qPCR assays or models are considered alternative criteria, subject to scientific defensibility. In 2011, Racine (WI) conducted a comparative study of E. coli (culture, Virtual Beach, qPCR) and enterococci (culture, qPCR) to demonstrate site-specific applicability. No significant difference in E. coli concentration existed, regardless of method (culture or qPCR, $p = 0.08 - 0.98$); accurate model prediction was >90% (qPCR and culture). E. coli and enterococci were correlated (qPCR/culture, $r = 0.36 - 0.65$). Regulatory agreement (STV = 235 cfu/100 ml E. coli) was 98%. This relationship has been predictable/consistent (Lavender and Kinzelman, 2009), demonstrating equivalent protection of recreational use. *Keywords: Human health, Indicators, Lake Michigan, Water quality, Predictive models, Monitoring.*

KLING, H.J.[1] and MUNAWAR, M.[2], [1]Algal Taxonomy and Ecology Inc, Winnipeg, MB, R3T 2X8; [2]Fisheries & Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **A Detailed Taxonomic Assessment of Potentially Toxic Cyanobacteria in the Bay of Quinte, Lake Ontario, 2010.**

Phytoplankton composition in the Bay of Quinte has been routinely assessed to the genus level since the 1970s, however detailed species identifications have been lacking. These long term data have indicated a general decrease in the biomass of several genera of cyanobacteria especially *Aphanizomenon* following the establishment of Dreissenid mussels during the mid 1990s while other taxa have increased, notably *Microcystis*. Fisheries & Oceans Canada conducted extensive spatial surveys during the summer of 2010 as part of its long term monitoring. Detailed taxonomic analysis showed the occurrence of several species known to produce algal toxins including *Microcystis novacekii, M. botrys, M.viridis, M. aeruginosa, Dolichospermum crassa, D.lemmermannii, D. ellipsoidea, Aphanizomenon flos aquae complex (A. klebahnii, A. yezoense), A. gracile, Sphaerospermopsis aphanizomenoides, Cuspidothrix issatchenkoi,* and *Cylindrospermopsis raciborskii*. In this paper an attempt is made to describe and clarify the morphological taxonomy of the known toxin-producing species of cyanobacteria in the bay. This kind of detailed taxonomic research is badly needed and will be very useful for the assessment of Beneficial Use Impairments in the Great Lakes. *Keywords: Algae, Algal toxins, Eutrophication, Microcystis.*

KLUMP, V.[1], BRAVO, H.[1], WAPLES, J.[1], FERMANICH, K.[2], DOLAN, D.M.[2], BAUMGART, P.[2], VIMONT, D.[3], LORENZ, D.[3], VALENTA, T.J.[4], and KENNEDY, J.A.[4], [1]Great Lakes WATER Institute, UW-Milwaukee School of Freshwater Sciences, Milwaukee, WI, 53204; [2]University of Wisconsin-Green Bay, Green Bay, WI, 54311; [3]Center for Climatic Research, UW-Madison, Madison, WI; [4]Green Bay Metropolitan Sewerage District, Green Bay, WI. **Hypoxia and Biogeochemical Cycling in Green Bay, Lake Michigan.**

Hypereutrophication and seasonal hypoxia have been major water quality problems in Green Bay, Lake Michigan for decades. A multidisciplinary, collaborative project is being undertaken to quantify the interactions among oxygen biogeochemistry, organic carbon cycles, hydrodynamics, and nutrient loading. The areal extent of hypoxia varies, but stations in the southern portion of the bay experience concentrations < 2 mg/L over 50% of the time. During the summer, circulation, water mass mixing and stratification are driven largely by the wind shear and the prevailing wind field conditions. These appear to have shifted basin-wide in the last 2 decades altering circulation and increasing particle trapping and retention in the bay. Future climate scenarios for the Green Bay region project warmer and wetter conditions with shorter winters, reduced ice cover, increased runoff and frequency of heavy precipitation events, and an extended stratified period, all of which can impact hypoxia. Models of watershed loading, biogeochemical cycles, and hydrodynamics are being coupled to downscaled regional climate scenarios to assess both current and future conditions in the bay and the efficacy of nutrient abatement strategies to mitigate hypoxic events under changing climate and ecosystem conditions. *Keywords: Green Bay, Hypoxia, Eutrophication, Biogeochemistry.*

KOLICH, L.A., ROWE, M.T., and ZANATTA, D.T., Central Michigan University, Institute for Great Lakes Research, Biology Department, Mount Pleasant, MI, 48859. **Effects of the *Dreissena* Invasion on the Genetic Structure of *Lasmigona costata* (Bivalvia: Unionoida) in the Lake St. Clair Delta and Surrounding Tributaries.**

Freshwater mussels of the family Unionidae are an important and imperiled part of North American freshwater ecosystems. In the Great Lakes region, there are over 50 native mussel species but the invasive *Dreissena polymorpha* and *D. rostriformis bugensis* have devastated their populations in the open waters of the Great Lakes; notably in Lake Erie and Lake St. Clair. However, refuges can be found in some, coastal wetlands, deltaic environments, and tributaries. *Lasmigona costata*, the flutedshell, is one species that continues to thrive in the region. With the use of 7 microsatellite DNA loci, it appears that gene flow is occurring among the populations located in the delta and tributaries. There is strong evidence of demographic effects of the dreissenid invasion including population crashes and community shifts, however a genetic bottleneck was not observed in the results. The findings of this study suggest that the refuge populations are connected and that further conservation efforts should be uniform across the lake and its tributaries. *Keywords: Dreissena, Molecular ecology, Unionids, Lake St. Clair.*

KOOPS, M.A.[1], MUNAWAR, M.[1], RUNDSTAM, L.[2], and STEWART, T.J.[3], [1]Fisheries and Oceans Canada, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Burlington, ON; [2]Cornell University, Cornell Biological Field Station, Bridgeport, NY; [3]Ontario Ministry of Natural Resources, Lake Ontario Management Unit, Picton, ON. **Emerging Issues, Challenges and Future Directions for Research and Monitoring on Lake Ontario.**

In preparation for the upcoming Lake Ontario intensive monitoring year in 2013, researchers from agencies around Lake Ontario met to discuss the current research on Lake Ontario. A number of emerging issues for the Lake Ontario ecosystem were identified as well as challenges for the research and monitoring needed to address these issues. Here we present the results of these discussions and attempt to synthesize these issues and challenges in a way that will provide some cohesive direction for the monitoring of Lake Ontario.
Keywords: Monitoring, Lake Ontario, Management.

KOVALENKO, K.E.[1], AXLER, R.P.[2], BRADY, V.J.[2], BROWN, T.N.[2], CIBOROWSKI, J.J.H.[1], DANZ, N.P.[3], GATHMAN, J.P.[4], HOST, G.E.[2], HOWE, R.W.[5], JOHNSON, L.B.[2], NIEMI, G.J.[2], and REAVIE, E.D.[6], [1]University of Windsor, Windsor; [2]Natural Resources Research Institute, University of Minnesota Duluth, Duluth; [3]University of Wisconsin-Superior, Superior; [4]University of Wisconsin River Falls, River Falls; [5]University of Wisconsin-Green Bay, Green Bay; [6]Natural Resources Research Institute, University of Minnesota Duluth, Ely. **Invertebrate, Fish, Diatom and Bird Community Responses to Anthropogenic Stress in the Laurentian Great Lakes Coastal Wetlands: Threshold Analysis.**

The biological attributes of aquatic ecosystems change nonlinearly as a function of anthropogenic stress. Often, the resident communities exhibit break-point changes that occur at environmental thresholds. Despite the potential importance of recognizing such points along a stress gradient, there are no studies examining these responses across different taxa at the scale of the entire Laurentian Great Lakes. We surveyed invertebrate, fish, diatom and wetland bird communities across a geospatially referenced gradient of anthropogenic stress. Guild-specific thresholds in ecological community response were identified using Threshold Indicator Taxon Analysis (TITAN) and piecewise quantile regression. Our results show surprising congruency in community thresholds among different taxonomic groups. The consistency with which different taxa respond to particular degrees of stress suggests that the information provided by different guild-specific monitoring programs is comparable. In addition, we analyze uncertainty associated with the community-specific change-points to understand the ability of different assemblages to predict stress We also discuss assemblage sensitivity to specific stressors and the relevance of observed stressor thresholds for identifying reference condition boundaries and informing management and policy decisions. *Keywords: Community thresholds, Bioindicators, Coastal wetlands.*

KRANTZBERG, G. and MCLAUGHLIN, C., McMaster University, 1280 Main St. W., Hamilton, ON, L8S 4K1. **From Remedial Action Plans to a Nearshore Governance Framework.**

This workshop formatted session will begin with short presentation by provocateurs on the strengths and challenges of RAP development and implementation, based on years of program experience. The presentations are to be followed by an interactive panel of expert who, interacting with the participants, intend to dissect what features and characteristics of Remedial Action Plans enabled development and then implementation to proceed, what impeded progress. The purpose is to help the Great Lakes experts and RAP practitioners uncover lessons that can be transferred from 25 years of RAPS to the process of designing a new governance framework to address the nearshore waters being emphasized in a renewed Great Lakes Water Quality Agreement. Central findings from the workshop will be made available to government agencies who will be looking to determine the definition, form and function of nearshore science and governance frameworks. *Keywords: Public participation, Remedial action plan, Environmental policy, Nearshore zone, Management.*

KRAUS, R.T. and ROGERS, M.W., US Geological Survey, Great Lakes Science Center, Sandusky, OH, 44870. **Role of Large Vessels in Lake Erie Fisheries Research.**

Large research vessels (>26' LOA) represent a significant financial investment for Lake Erie fishery managers and scientists. Simply by the number of these vessels currently operating on the lake, these investments are justified as an essential part of the research and monitoring required in managing the largest and most valuable fisheries in the Great Lakes basin. But, from the perspective of Lake Erie as an ecosystem, how well does this fleet sample fish populations and what are its capabilities and limitations? Against a background of bathymetry, habitat mosaic, and political boundaries, we will consider these questions from two perspectives. Survey results on vessel characteristics, manning requirements, and agency organizational structure will be compared to the spatial coverage, type, intensity, and duration of sampling effort. In addition, we will examine how current research priorities and the role of large vessels are perceived by researchers who conduct work on these boats versus the larger community of researchers with interests in Lake Erie fisheries. The results potentially highlight areas where additional field research is needed, and should also be useful for evaluating cost-benefit trade-offs of proposed survey modifications. *Keywords: Lake Erie, Research vessels, Fisheries.*

KUMAR, A.[1], BASKARAN, M.[1], MILLER, C.J.[2], SELEGEAN, J.P.[3], and CREECH, C.T.[3], [1]Department of Geology, Wayne State University, Detroit, MI, 48202; [2]Department of Civil and Environmental Engineering, Wayne State University, Detroit, MI, 48202; [3]US Army Corps of Engineers, 477 Michigan Avenue, Detroit, MI, 48226. **Sediment Dynamics in Three Dams in Michigan and Indiana Using excess ^{210}Pb and ^{137}Cs as Chronometers.**

The sediment accumulation behind the network of dams built over the past 100 years in the Great Lakes region have significantly reduced the available storage in the reservoirs of these dams. The accelerated soil erosion rates during vegetational changes in the watershed, from

forestland to agricultural land, is expected to be preserved in the sedimentary record. In order to investigate how the sediment storage capacity has changed over time, we utilized excess 210Pb (210Pbxs) and 137Cs in a suite of sediment cores collected from three dams in Michigan and Indiana to determine the sediment accumulation and mixing rates and sediment erosion/focusing. From the dating of about 2 dozen sediment cores from 3 dams, we report the following: i) There have been accelerated soil erosion in some of these watersheds resulting in significantly higher sedimentation rates and inventories of 137Cs and 210Pbxs; ii) The inventories of 137Cs and 210Pbxs in two of the three dams studied varied by factors of 5 and 7 respectively; iii) the sediment accumulation rates at different sites in a given dam varied by as much as a factor of 5; and iv) there were temporal variations in sedimentation rates recorded in some of the sedimentary records. *Keywords: Watersheds, Sediment load, Radioisotopes.*

LABEAU, M.B.[1], ROBERTSON, D.M.[2], MAYER, A.S.[1], PIJANOWSKI, B.C.[3], and SAAD, D.A.[2], [1]Michigan Technological University: Department of Civil and Environmental Engineering, 1400 Townsend Drive, Houghton, MI, 49931; [2]United States Geological Survey: Wisconsin Water Science Center, 8505 Research Way, Middleton, WI, 53562; [3]Purdue University: Department of Forestry and Natural Resources, 715 West State Street, West Lafayette, IN, 47907. **Projected Changes in Phosphorus Export to the Laurentian Great Lakes Associated with Future Changes in Land use.**

Anthropogenic changes, agricultural and urban activities, have significantly increased phosphorus (P) loading in tributaries to the Great Lakes, and have resulted in eutrophication. To understand the factors influencing phosphorus delivery to aquatic systems and their potential harmful effects, models that predict P export need to account for these changes. The Great Lakes region is expected to experience a doubling of urbanized areas along with a 10% increase in agricultural use (biofuels) over the next 40 years. HydroSPARROW, a forecasting tool that enables SPARROW (SPAtially Referenced Regression On Watershed attributes) to simulate the effects of various land-use and climate scenarios, was developed to describe changes in land use and nutrient sources, including altering sources of fertilizer intensity and point source intensity. The Land Transformation Model, a spatially explicit land change model provided future land projections across the Great Lakes. Land use patterns to 2040 were inputted into the models. This work focuses on understanding the effects of how specific future agriculture and urbanization activities will affect P loading to the Laurentian Great Lakes. The results are useful in forthcoming management and monitoring strategies to reduce the extent and severity of future eutrophication in aquatic systems. *Keywords: Water quality, Watersheds, Land use, Phosphorus.*

LABENCKI, T.L. and BOYD, D., 125 Resources Road, Toronto, ON, M9P3V6. **Intensive Event-Based Monitoring of Tributaries in the Hamilton Harbour Watersheds to Improve Nonpoint Source Nutrient Loading Estimates.**

Urban tributaries are undoubtedly affected by surrounding landuse, including impacts to both water quality and peak quantity of flow during precipitation events. In order to better understand the role of urban, and to some extent, agricultural nonpoint source loading to Hamilton Harbour, a Great Lakes Area of Concern (AOC), four ISCO autosamplers were

installed in July 2010 at three tributary stations close to the Harbour, and one station representative of the wetland inputs to the Harbour. Results of the 24-hour flow weighted samples illustrate clear differences between dry and wet weather nutrient concentrations, demonstrating the clear need for strategic sampling design when generating studies to estimate nutrient loads. Further, grab samples representing conditions during rising limb, peak, and falling limb of the hydrograph emphasize the magnitude in variability during an event, which given the short term variability, may be missed without the aid of automatic samplers. By gaining more accurate nonpoint source nutrient loading estimates, it is intended that mitigation measures can be better assessed and modified where necessary for further improvements to water quality. *Keywords: Phosphorus, Nonpoint sources, Watersheds, Hamilton Harbour AOC, Nutrients, Wet weather events.*

LAKE, C. and HOYLE, J.A., Ontario Ministry of Natural Resources, 41 Hatchery Lane, Picton, ON, K0K 2T0. **First Occurrence of Chain Pickerel (*Esox niger*) in Ontario: Possible Range Expansion from New York Waters of Eastern Lake Ontario.**

In this poster, we describe our recent observations of Chain Pickerel (*Esox niger*) in Ontario waters. Since the spring of 2008, sixteen individuals were confirmed and sampled. Several additional, anecdotal reports of Chain Pickerel captures were also received. These fish represent the first Chain Pickerel collected in Ontario and the first on the northwestern side of the St. Lawrence River in Canada. We hypothesize that the appearance of Chain Pickerel in the Ontario waters of eastern Lake Ontario and the upper St. Lawrence River may signal an expansion in the range of this species from New York state waters. *Keywords: Esox niger, St. Lawrence River, Chain Pickerel, Lake Ontario, Range expansion.*

LANTRY, B.F.[1], KRAUS, R.T.[2], and STRACH, R.M.[3], [1]USGS Lake Ontario Biological Station, 17 Lake St., Oswego, NY, 13126; [2]USGS Lake Erie Biological Station, 6100 Columbus Ave, Sandusky, OH, 44870; [3]USGS Great Lakes Science Center, 1451 Green Rd., Ann Arbor, MI, 48105. **Planning, Construction and Science Programs for the New US Geological Survey (USGS) Research Vessels on Lakes Erie and Ontario.**

The USGS Great Lakes Science Center (GLSC) operates deepwater science programs on all of the Laurentian Great Lakes each relying on large (45-110ft) research vessels. The Department of the Interior has had vessels operating on the Great Lakes more or less continuously since the 1930's and has had to replace aging vessels on several occasions. The latest replacements were for Lake Erie's 45ft steel hull RV Musky and Lake Ontario's 65 ft steel hull RV Kaho. These two vessels were over 50 years old, past their functional life span and are being replaced with twin 70ft aluminum hull boats. These new boats represent the first time the GLSC has entered the aluminum boat arena. Compared to their replacements, the new vessels are faster, shallower in draft and equipped with modern state-of-the-art outfitting. The construction of these boats was complicated by the choice of material, the demand for multi-use, state-of-the-art platforms and because the funding source placed rigorous time schedules upon the shipyard where the vessels were built. Despite these issues, the research vessels will be exceptional sampling platforms, and will be put into full-time operation in 2012. In this presentation we will

examine their capabilities, lessons learned from the design and build process and heightened opportunity for collaboration. *Keywords: Research Vessel Construction and collaboration.*

LARSON, D.L.[1], <u>MCNAUGHT, A.S.</u>[1], and ROSEMAN, E.F.[2], [1]Central Michigan University, Mount Pleasant, MI, 48859; [2]USGS Great Lakes Science Center, Ann Arbor, MI, 48105. **Assessment of Nursery Habitat Use by Larval Fishes in the St. Clair River Delta, MI.**

Recruitment of fish into wetland nursery areas is critical during the larval stage; however habitat factors responsible for good recruitment have been little studied. We surveyed twenty wetlands in the North and Middle Channels of the St. Clair River Delta between May and July 2010 and 2011. Larval fish were collected weekly with a 0.5-m conical net and quatrefoil light traps to assess community composition and abundance. We measured a wide range of abiotic and biotic factors to establish differences between nursery areas. Nursery area use was quantified by number of individuals of each species and total abundance of fish collected. We used multivariate techniques to reduce abiotic variables to a simple variable, lotic input. We then compared that variable to the general community composition using non-metric multidimensional scaling (NMDS). Community composition correlated very strongly (0.696, $p < 0.001$) with lotic input. This suggests that nursery habitat use by different species depends on how different the habitat is from the main channel. Community composition also showed a relationship with relative submerged aquatic vegetation (SAV) density (MRPP, $p = 0.003$). Thus, nursery area habitat use varies by species and is a product of the density of SAV and proximity to the main body of flowing water. *Keywords: St. Clair River, Larval fish, Habitat use.*

<u>LARSON, J.H.</u>, RICHARDSON, W.B., VALLAZZA, J.M., and NELSON, J.C., Upper Midwest Environmental Sciences Center, U.S. Geological Survey, 2630 Fanta Reed Road, La Crosse, WI, 54603. **Relationships Between Elemental Composition and Watershed Characteristics in Caddisflies and Dreissenid Mussels.**

Macroinvertebrates are important components of aquatic ecosystems, forming a link connecting nutrient supply from upstream habitats to the economically and ecologically important upper trophic levels. Although there is evidence for strong relationships between watershed characteristics and elemental composition of the detrital and autotrophic base of aquatic food webs, no studies have linked these changes to the elemental composition of macroinvertebrates. Heterotrophic consumers are thought to be strongly homeostatic, which suggests relationships between elemental composition of consumers and watershed land cover would be mediated by changing species composition. Here we report on relationships between watershed land cover and the elemental composition of two groups of aquatic filter feeders (Hydropsychid caddisflies and Dreissenid mussels). With caddisflies, these relationships may be mediated by changing species composition, but changes in dreissenid elemental composition reflect changes in the elemental composition of tissues. We hypothesize that species occupying habitats with a high diversity of closely related competitors are inherently less likely to exhibit in situ variation in elemental composition, whereas species with few close competitors might exhibit far more variation in elemental composition. *Keywords: Nutrients, Watersheds, Benthos.*

LAUENSTEIN, G.G.[1], JOHNSON, W.E.[1], KIMBROUGH, K.L.[1], JACOB, A.P.[1], SERVEISS, V.B.[2], and ANTONETTE, A.[3], [1]NOAA, 1305 East West Highway, Silver Spring, MD, 20910; [2]International Joint Commission, Washington, DC, 20440; [3]Inetrnational Joint Commission, Windsor, ON, N9A6T3. **What Mussels Tell us of the Water Quality in the Great Lakes: Results from Two Decades of Contaminant Monitoring by NOAA's Mussel Watch Program.**

Abstract: Bivalves are widely used as bioindicators to monitor and assess coastal environmental quality. NOAA's Mussel Watch Program has been using bivalves to track spatial and temporal trends of chemical contamination in U.S. coastal waters since 1986. Contaminant monitoring in the Great Lakes using dreissenid mussels began in 1992 and monitors a suite of more than 150 contaminants at 25 long-term sites on a biennial basis. The program participates in specimen banking, allowing for retrospective analysis of contaminants as needed. Our long-term dataset reveals the continuing presence of both organic contaminants and heavy metals in the Great Lakes. A majority of the sites in the Great Lakes show neither increasing nor decreasing trends for many contaminants, mainly because the concentrations are at baseline levels. The legacy organic contaminants such as PCBs and DDT exhibit declining trends in all the lakes whereas majority of the metals show no discernible trend. The long-term monitoring data provides baseline data for less contaminated areas of the Lakes, which is currently being leveraged to support decision making for delisting Areas of Concern in the Great Lakes. Continued contaminant monitoring and surveillance are crucial to the overall restoration and protection of the Great Lakes. *Keywords: Monitoring, Contaminants, Mussels.*

LEBLANC, J., LEBEL, P., and GALLAGHER, C., Chalk River Laboratories, Chalk River, ON, K0J 1J0. **Monitoring of Chalk River Laboratories Effluents to the Ottawa River.**

The Environmental Protection Program maintains a comprehensive effluent and environmental monitoring program of more than 600 sampling locations with approximately 60,000 analyses performed on air and liquid effluent parameters each year at our Chalk River Laboratories (CRL). Monitoring of a variety of radiological and non-radiological parameters is regularly conducted on various media, including surface water and groundwater, at a variety of locations on and off the site. The purpose of the program is to verify compliance with applicable regulations and to confirm the monitored processes are operating within expected performance objectives. It also supplies valuable information on the effectiveness of AECL's Environmental Protection Program with regards to the minimization of emissions to the Ottawa River. Effluent and environmental monitoring data have been collected at Chalk River Laboratories for over 60 years. This paper presents some of the results of the effluent and surface water sampling, the observed trends, the challenges in dealing with legacy practices, and the path forward for the future. *Keywords: Environmental contaminants, Ottawa River, Radioisotopes.*

LEBLANC, J.P.M. and CHOW-FRASER, P., 1280 Main St. West Rm. LSB 224, McMaster University, Hamilton, ON, L8S 4K1, Canada. **Muskellunge (*Esox masquinongy*) Spawning and Nursery Habitat Use in Spatially Distinct Regions of Georgian Bay with Emphasis on Water Level Declines.**

Georgian Bay, Lake Huron, has experienced substantial sustained low water levels since 1999 that have structurally altered many coastal wetlands. The productivity of altered coastal wetlands as spawning and nursery sites has yet to be assessed for many fish species. Thus, we are commencing a research initiative to examine the effects of sustained low water levels on muskellunge (*Esox masquinongy*) population dynamics in spatially distinct regions of Georgian Bay. Muskies have a narrow range of environmental parameters required for successful reproduction. This suggests that structurally altered coastal wetlands may have a detrimental effect on musky population dynamics. Circumstantial evidence from southeastern Georgian Bay appears to support this contention. By surgically implanting radio-transmitters into adult muskies, we plan to identify musky spawning sites to determine how sustained low water levels may limit musky reproductive success. Once identified, spawning locations will be rigorously sampled for age-0 muskies to infer productivity. Multiple biological, chemical and physical parameters will be measured and compared among musky spawning sites to determine the factors most limiting to musky reproduction. In addition, we will model how continued water level declines may impact future musky reproductive potential. *Keywords: Population dynamics, Georgian Bay, Water levels, Habitats, Muskellunge, Coastal wetlands.*

LEGER, W.P.[1] and READ, J.[2], [1]Environment Canada, 876 Lakeshore Road, Burlington, ON, L7R 4A6; [2]Great Lakes Observing System, 229 Nickels Arcade, Ann Arbor, MI, 48104. **An Adaptive Management Approach for Addressing Future Extreme Water Levels and Flows for the Great Lakes-St. Lawrence River.**

Science indicates that the climate is changing, but in ways we can only partially anticipate. There is considerable uncertainty in how climate changes will manifest themselves in precipitation and evaporation, and how, in turn, these changes will impact net basin water supplies, water levels and flows in the Great Lakes-St. Lawrence River region. Recent studies have found that most high and low water level-related impacts on the Great Lakes-St. Lawrence River cannot be addressed solely by regulating Lake Superior and Lake Ontario outflows. Yet, analyses of climate change impacts under a wide variety of possible scenarios has shown that neither future high lake level scenarios, nor very low water level scenarios can be readily dismissed. In order to reduce uncertainty about expected results and mitigate risk, a systematic process of adaptive management has been proposed that would feature more effective sharing and on-going monitoring and modelling of water level, climate, and geophysical information for the Great Lakes-St. Lawrence River so that decisions can be adjust and "adapted" as more is learned and/or as conditions change. This paper will outline the proposed adaptive management strategy covering the Great Lakes-St. Lawrence River system. *Keywords: Climate change, Adaptive management, Water level fluctuations, Great Lakes basin.*

LENTERS, J.D.[1], VAN CLEAVE, K.[1], LESHKEVICH, G.[2], and HUNTER, T.S.[2], [1]School of Natural Resources, University of Nebraska-Lincoln, Lincoln, NE, 68583; [2]NOAA Great Lakes Environmental Research Laboratory, 4840 S. State Rd., Ann Arbor, MI, 48108. **Rapid Warming of the World's Largest Lake: Do the Offshore Buoys Provide a "Whole-lake" Perspective?**

In terms of surface area, Lake Superior is the largest freshwater lake on Earth. Recent studies have also shown it to be one of the most rapidly warming lakes in the world, based on both buoy- and satellite-based estimates of surface water temperature. However, the long-term temperature record for Lake Superior is primarily based on data from three NDBC buoys deployed in the western, central, and eastern basins of Lake Superior. While providing a reliable record of "mid lake" temperatures, the buoys are not very representative of the nearshore zone. This is particularly true in late spring and early summer, when strong thermal contrasts exist between the nearshore and offshore regions. In the current study, we present an intercomparison of NDBC buoy data since 1979 with lake-wide estimates of mean surface temperature from remote sensing observations (NOAA CoastWatch program) and the GLERL 1-D thermodynamic model. The results show more rapid early-season warming in the western basin, and consistently warmer lake-wide temperatures from June to October (as compared to the NDBC buoys). Long-term warming rates are found to be strongest during the months of July, August, and October (on the order of 0.9-1.3 °C/decade), while May and June show significantly reduced warming in the offshore zone, as compared to whole-lake estimates. *Keywords: Lake Superior, Remote sensing, Climate change.*

LEON, L.F., MCCRIMMON, C., BOOTY, W.G., WONG, I., YERUBANDI, R.R., and ZHAO, J., Environment Canada, 867 Lakeshore Rd., Burlington, ON, L7R 4A6. **Watershed & Lake Water Quality Modeling in Lake Winnipeg.**

In recent years Lake Winnipeg has experienced an increase in the rate of eutrophication, mainly as a result of human activities, in particular due to nonpoint source pollution from farms and municipal wastewaters. Estimating non-point source pollution from watersheds and the effects of mitigation measures (e.g. beneficial management practices or BMPs) is an important step in managing and protecting water quality, not only at the basin level where it originates, but also at the receiving waters such as reservoirs, lakes or oceans. Simulation models at the watershed level have been applied to aid in the understanding and management of surface runoff, nutrients and sediment transport processes. Similarly, models with different degrees of complexity are used to simulate the aquatic ecology and water quality in the lake. We apply SWAT to three pilot watersheds in order to investigate the impacts and uncertainties of different BMPs on nutrient loading in the targeted watersheds. We also explore avenues for scaling and propagating such loads and uncertainties into the receiving lake models. In order to integrate with the watershed simulations, we used 3D and 2D hydrodynamic and ecological models (ELCOM-CAEDYM and OneLay-PolTra) which include processes to describe nutrient cycling, sediment transport and phytoplankton dynamics. *Keywords: Watersheds, Lake Winnipeg, Model studies.*

LESHKEVICH, G.[1] and LIU, S.[2], [1]Noaa/Great Lakes Environmental Research Laboratory, 4840 South State Road, Ann Arbor, MI, 48108; [2]Univ. of Michigan/Cooperative Institute for Limnology and Ecosystem Research, 4840 South State Road, Ann Arbor, MI, 48108. **Delivering Environmental Satellite and In Situ Data to the Great Lakes User Community - New Great Lakes CoastWatch Server.**

CoastWatch is a nationwide National Oceanic and Atmospheric Administration (NOAA) program within which the Great Lakes Environmental Research Laboratory (GLERL) functions as the CoastWatch Great Lakes regional node. In this capacity, GLERL obtains, produces, and delivers environmental data and products for near real-time monitoring of the Great Lakes to support environmental science, decision making, and supporting research. This is achieved by providing Internet access to near real-time and retrospective satellite observations, in-situ data, and derived products to Federal and state agencies, academic institutions, and the public via the CoastWatch Great Lakes web site (http://coastwatch.glerl.noaa.gov). A new CoastWatch server running THREDDS (Thematic Real-time Environmental Distributed Data Services) for accessing and publishing scientific data in a convenient fashion will soon be available. Utilities such as JAVA GIS and Google Earth® allow interactive retrieval of physical parameters such as surface temperature, ice cover, and surface winds at a given location. Plans include enhancing the present product suite with new near real-time satellite derived image products such as wind fields, ice types, turbidity, and chlorophyll and new in situ data sets such as a Great Lakes Inherent Optical Properties geospatial database. *Keywords: Remote sensing, Environmental data, Satellite technology, Spatial analysis.*

LESSARD, C.R.[1], RIDAL, J.J.[2], POULAIN, A.J.[1], and BLAIS, J.M.[1], [1]30 Marie-Curie, University of Ottawa, Ottawa, ON, K1N 6N5; [2]2 Belmont Street, St. Lawrence River Institute of Environmental Sciences, Cornwall, ON, K6H 4Z1. **Predicting and Hindcasting Mercury Dynamics in the St. Lawrence River, Cornwall, Ontario.**

The St. Lawrence River near Cornwall, Ontario was designated an Area of Concern by the International Joint Commission in 1985, due in large part to mercury contamination along the northern shore. Several studies have been conducted to determine concentrations and fluxes of mercury in the air, water, sediments, and biota of the St. Lawrence River. My project was designed to integrate the results of these studies to create a multi-species mass balance model of mercury in the St. Lawrence River near Cornwall to determine the principal sources and sinks of mercury. The model was developed using the software Stella to predict and hindcast mercury dynamics. The dominant mercury source was found to be the river inflow at 0.42 mol/month (95.5%). The dominant mercury sinks were river outflow at 0.28 mol/month (63.6%) and sediment accumulation at 0.12 mol/month (27.3%). Sediments are a net sink for mercury because sediment resuspension and diffusion fluxes are low, reducing the amount of mercury being released from sediments to the water column and accumulated in the food web. The emission rate of mercury from historical local industries prior to 1970 estimated by the model was approximately 400 kg/year. This model provides a holistic view of mercury dynamics in this complex system and will have applications for future research. *Keywords: Ecosystem modeling, Mercury, St. Lawrence River.*

LETCHER, R.J.[1], WESELOH, D.V.C.[2], CHEN, D.[3], HEBERT, C.E.[1], GEBBINK, W.A.[1], and GAUTHIER, L.T.[1], [1]EWHD, Wildlife and Landscape Directorate, Science and Technology Branch, National Wildlife Research Centre, Carleton University, Ottawa, ON, K1A 0H3; [2]Canadian Wildlife Service, Environment Canada, Downsview, ON, M3H 5T4; [3]Deaprtment of Chemistry, Carleton University, Ottawa, ON, K1S 5B6. **The Great Lakes Herring Gull Monitoring Program (GLHGMP): The Complex Cocktail of Emerging Contaminants and Comparative Spatiotemporal Changes, Sources and Fate across the Great Lakes.**

Environment Canada's GLHGMP has been ongoing for over 30 years. Under Chip's leadership, herring gull (*Larus argentatus*) eggs have been collected annually from colony sites across the Great Lakes. Chip's long term monitoring of legacy contaminants such as PCBs, organochlorine pesticides and dioxins/furans has been profoundly important in increasing our understanding of exposure and changes over time and as bioindicators of chemical stress on the health of Great Lakes wildlife. Emerging substances include replacement and current-use, halogenated flame retardants (FRs; brominated and organophosphate FRs) and perfluoroalkyl acids. Gulls feed mainly on an aquatic diet, but have been shown over the last several decades to be feeding increasingly on terrestrial food sources as indicated by chemical tracers such as stable carbon and nitrogen isotopes. With Chip's collaboration, archived GLHGMP and newly collected eggs continue to be screened for new persistent and bioaccumulative chemical substances. We continue to find an increasingly complex cocktail of emerging (chlorinated, brominated or fluorinated) organohalogen contaminants in gulls (eggs), and that assessing spatiotemporal changes requires consideration of dietary changes and thus the influence of aquatic food web and terrestrial sources of accumulation and exposure. *Keywords: Biomonitoring, Herring gulls, Organic compounds, Emerging chemical substances, Bioindicators, Laurentian Great Lakes.*

LEVESQUE, D.[1], CATTANEO, A.[1], and HUDON, C.[2], [1]GRIL et Département des Sciences Biologiques, Université de Montréal, C.P. 6128, Montreal, QC, H3C 3J7; [2]Water Science and Technology Branch, Environment Canada, 105 McGill st., Montreal, QC, H2Y 2E7. **Factors Controlling *Lyngbya wollei* Biomass in Lake St. Louis (St. Lawrence River).**

Harmful proliferations of the benthic cyanobacterium *Lyngbya wollei* have been reported with increasing frequency in the last 30 years in North America. The environmental variables controlling the abundance and distribution of *L. wollei* at a fine spatial scale (100 m - 1 km) was assessed in Lake St. Louis, a large fluvial lake of the St. Lawrence River. We surveyed 11 sites located along a transect perpendicular to the north shore, in water masses originating from the Great Lakes (2 sites), mixed waters (3 sites) and the Ottawa River (6 sites). Physical (conductivity, temperature, color, light extinction coefficient), chemical (TP, TDP, TN, DIN, NO_3, NH_4, Fe, Ca) and biological (Vegetation biomass) were sampled regularly between spring 2009 and fall 2011. *L. wollei* biomass was highest (maximum 58 g DM m^{-2}) near shore, in brown waters coming from the Ottawa River, influenced by polluted urban storm overflow. High *L. wollei* biomass coincided with low current velocity and low % of incident light on the bottom. Biomass steadily increased from May to November but dropped in the spring, following discharge increase and stormy conditions. *L. wollei* occurs at sites unfavorable for competing

autotrophs and its biomass is primarily controlled by physical conditions. *Keywords: Lyngbya wollei, St. Lawrence River, Cyanophyta.*

LEWCHANIN, T.[1], CHERRY, T.[2], FAIRBANKS, A.[3], EINHOUSE, D.[4], CHICOINE, J.[5], KEIR, M.[6], and LANTRY, B.F.[1], [1]USGS Lake Ontario Biological Station, 17 Lake St., Oswego, NY, 13126; [2]USGS Lake Erie Biological Station, 6100 Columbus Ave., Sandusky, OH, 44870; [3]NYSDEC Cape Vincent Fisheries Station, 541 E. Broadway, Cape Vincent, NY, 13618; [4]NYSDEC Dunkirk Fisheries Station, 178 Point Dr. N., Dunkirk, NY, 14048; [5]OMNR Glenora Fisheries Station, 41 Fish Hatchery Ln., Picton, ON, K0K 2T0; [6]Canada Centre for Inland Waters, 867 Lakeshore Rd., PO Box 5050, Burlington, ON, L7R 4A6. **Research Vessels and their Capabilities in the Lower Great Lakes.**

Because the Laurentian Great Lakes are large with much of their habitat offshore over deepwater, scientific sampling often requires the use of large (>45ft) research or support vessels. Not only are the vessels relatively large in size, the budgets and infrastructure required to operate and maintain them are also sizable especially when compared to other field sampling platforms. The size, cost and personnel required to operate these vessels properly and safely contribute to their short supply and busy schedules. Despite their limited availability, these vessels continue to be in great demand both within the entities that own and operate them as well as from other organizations that are involved in research, management or other operations (e.g., search and rescue, enforcement, etc.). In this presentation we identify the vessels currently operating on the lower Great Lakes, their arrangement and capability, their schedules, and opportunities for collaboration. *Keywords: Assessments, Planning, Organizations.*

LI, J., DROUILLARD, K.G., and HAFFNER, G.D., GLIER, University of Windsor, 401 Sunset Avenue, Windsor, ON, N9B 3P4, Canada. **Mercury in the Sediments and Food Web of the Detroit River.**

A river-wide sediment monitoring program for the Detroit River was implemented during 2007-2009 to determine if Hg concentration in sediment has changed in the past decade by comparison of the results with the 1999 sediment quality survey. The survey deployed a stratified random sampling method that divided the river into three fragments, upper, middle, and lower, and two subdivisions, U.S. and Canada. The overall river-wide geometric mean for total Hg concentration was 0.14ug/g dry weight (range 0.01 to 1.84 µg/g) in 2007-2009 and 0.12 µg/g dry weight (range ND to 2.03 µg/g) in 1999.Since there were no significant changes in total Hg sediment concentrations in the Detroit River as a whole, by strata or by country, over the two time periods, this suggests the 2000-2003 Detroit River Hg food web data is still applicable now. Total Hg was determined using 166 samples of 25 species from five monitoring stations along the Detroit River during 2000-2003. Hg concentration of the samples ranged from 0.01 to 1.68 µg/g wet weight. The Hg concentration in aquatic biota was positively correlated with the animal mass, but there was no evident correlation with collection location. The relationship between Hg levels in the sediment and fish is still unclear due to lack of information about mercury bioavailability in Detroit River water and sediment. *Keywords: Sediment load, Area of concern, Food chains, Mercury.*

LIZNICK, K. and BRANFIREUN, B., Department of Biology, Western University, London, ON. **Mercury Bioaccumulation in Benthivorous Compartments of Lake Erie.**

Long-term monitoring has revealed a recent increasing trend in mercury (Hg) levels in the top predatory fish of Lake Erie, despite the decline in regional atmospheric Hg emissions since the early 1970s. Although organismal concentrations of mercury are expected to decrease concurrently, the bioavailability of Hg in some unique areas is complicated by many factors beyond emission rates. My project aims to determine the role that recently introduced invasive species, such as the round goby as well as zebra and quagga mussels, have played in the bioconcentration and bioaccumulation of Hg and MeHg throughout the lake-wide food web. I will examine the change in trophic status using δ15N and δ13C isotope ratios, coupled with Hg analysis of biotic and abiotic lake components. These procedures will be used to determine the effects of food chain lengthening and complexity on the transfer of Hg through the food web to higher organisms. Spatial patterns and temporal trophic changes associated with these introductions may prove to be the key to understanding this unique increasing trend in fish Hg. *Keywords: Mercury, Bioaccumulation, Benthos.*

LLOYST, M.H.M.[1], PRATT, T.C.[2], FOX, M.G.[1], and REID, S.M.[3], [1]Trent University, East Bank Drive, Peterborough, ON, K9J 7B8; [2]Fisheries and Oceans Canada, 1219 Queen Street East, Sault Ste Marie, ON, P6A 2E5; [3]Ministry of Natural Resources, East Bank Drive, Peterborough, ON, K9J 7B8. **Distribution and habitat associations in stocked American Eels, Anguilla Rostrata, in the Bay of Quinte and Upper Saint Lawrence River.**

The abundance and distribution of American Eels (*Anguilla rostrata*) have significantly decreased since the 1970's from freshwater and coastal habitats of eastern North America. The importance of eels in the Bay of Quinte and the Upper St. Lawrence River as a commercial fishery and as an integral part of the food web has lead to the initiation of an experimental stocking program in these areas. As part of a post-stocking monitoring program initiated by Fisheries and Oceans Canada, I characterized nearshore patterns of eel abundance and size and indentified microhabitat associations. In the spring and fall of 2010 and 2011, night time boat electrofishing was conducted at predetermined 100 meter long transects in the Bay of Quinte and Upper Saint Lawrence River. Water depth, vegetation density, and substrate composition were assessed at each transect as a measure of habitat type. We also collected biological data from captured eels which included weight and length. I will present eel habitat associations and abundances for the different sampling seasons and relate these finding to the biological data collected. Generally, eels were associated with shallow depths and cobble and rubble substrate types and avoided sandy habitats. The results of this study will help assess the suitability of current stocking locations. *Keywords: American Eel, Bay of Quinte, St. Lawrence River.*

LOFGREN, B.M., NOAA/Great Lakes Environmental Research Lab, 4840 S. State Rd., Ann Arbor, MI, 48108. **Seasonal Characteristics of Climate Change Projections in the Great Lakes Basin Using CHARM.**

The Coupled Hydrosphere-Atmospere Research Model (CHARM) is a model of climate that couples the atmosphere, land surface, and lake surface for the Great Lakes region. We have applied it to climate change scenarios, and have found that the response to climate change in terms of air temperature, precipitation, and other model variables depend on the season of the year. In particular, the air temperature response over the lakes is much less than over the land during the spring, while this phenomenon is much reduced in other seasons. Also, winter precipitation is enhanced over and downwind of the lakes (the lake effect zones), while this pattern tends to be reversed during the summer. Consequences for the water budget of the Great Lakes system will be discussed. *Keywords: Climate change, Air-water interfaces, Hydrologic budget.*

LOH, P.S.[1], MOLOT, L.A.[1], and NURNBERG, G.K.[2], [1]Faculty of Environmental Studies, York University, Toronto, ON, M3J 1P3; [2]Freshwater Research, 3421 Highway #117, RR 1, Baysville, ON, P0B 1A0. **Release Rates of Phosphorus and Iron from Deep and Shallow Sediments in Lake Simcoe, Winnipeg and Hamilton Harbour During Anoxic Incubation.**

Sediment cores collected from Lake Simcoe, Lake Winnipeg and Hamilton Harbour were incubated intact under anoxic conditions and surface sections were fractionated using the dithionite method. Phosphorus release rates ranged from 4 to 11 mg/m2/day in Simcoe, 8 to 22 in Winnipeg and 2 to 3 in Hamilton Harbour. Fe release rates ranged from 4 to 11 mg/m2/day in Simcoe, 37 to 87 in Winnipeg and 3 to 38 in Hamilton Harbour. An empirical model of release rates will be developed as a function of sediment chemistry, sulfate and loss on ignition. *Keywords: Sediments, Phosphorus release, Lake Simcoe, Iron release, Nutrients.*

LOZANO, S.J.[1], BIRKET, K.M.[2], SCHAROLD, J.V.[3], and WATKINS, J.M.[4], [1]DOC NOAA/GLERL, 4840 South State Road, Ann Arbor, MI, 48108; [2]University of Michigan/CILER, 440 Church Street, Ann Arbor, MI, 48109; [3]U.S. EPA/MED, 6201 Congdon Blvd., Duluth, MN, 55804; [4]Cornell University, 900 Shackelton Point Road, Bridgeport, NY, 13030. **The Expansion of *Dreissena* and Long-Term Shifts in Benthic Macroinvertebrate Community Structure in Lake Ontario, 1998-2008.**

The introduction of *Dreissena* to the Great Lakes has profoundly impacted benthic ecosystems, resulting in the decline of native species and dramatic restructuring of the community. In Lake Ontario, long-term monitoring has yielded a wealth of detailed information regarding both the expansion of *Dreissena* and the changes it has wrought on the benthos. From 1998 to 2008, the rapid proliferation of *D. bugensis* has been accompanied by an increase in the number of deposit feeders such as oligochaetes and chironomids, as well as marked decreases in populations of *Diporeia*, sphaerid clams, and gastropods. A significant decrease in benthic species richness has also been observed. Continued monitoring is necessary in order to fully

understand the long-term repercussions of *Dreissena*'s impact on native benthic fauna. *Keywords: Benthos, Biodiversity, Lake Ontario.*

LU, X., BADE, D.L., LEFF, L., and <u>MOU, X.</u>, Department of Biological Sciences, Kent State University, Kent, OH, 44242. **Microbially Mediated Nitrogen Removal Processes in Hypoxic Water of Lake Erie.**

Seasonal hypoxic conditions are common in the central and western basins of Lake Erie in summer, which may profoundly affect the biogeochemical cycle of nitrogen in the water column. Denitrification and anaerobic ammonium oxidation (anammox) are two anaerobic processes that lead to removal of fixed nitrogen (N) under oxygen-limited condition. While anammox has been suggested as a major N removal process in many marine environments, its importance in freshwater systems remain unclear. To examine the existence and potential importance of anammox, water samples were taken from Lake Erie in 2010 and 2011 and analyzed for their potential N gas production using a 15N-incubation assay. Results from both years generally resemble each other. Anammox was measured at low potential activates in samples of Sandusky Bay (~150 nM N2/day), but not in the Sandusky Subbasin or the Central Basin. In contrast, denitrification was measured at examined samples with a much higher potential activities (~200-400 nM N2/day). This pattern was in accordance with qPCR results of anammox and denitrification bacterial genes in the same samples. Our results indicate that anammox activity may exist in LE but is less important than denitrification in N removal. *Keywords: Microbiological studies, Biogeochemistry, Nutrients.*

<u>LUO, L.</u>[1] and WANG, J.[2], [1]Cooperative Institute for Limnology and Ecosystems Research, University of Michigan, Ann Arbor, MI, 48109; [2]Great Lake Environmental Research Laboratory, NOAA, Ann Arbor, MI, 48108. **Simulating the 1998 Spring Bloom in Lake Michigan Using a Coupled Physical-biological Model.**

A coupled physical-biological model is used to simulate the ecosystem characteristics in Lake Michigan. The physical model is the Unstructured Grid, Finite-Volume Coastal Ocean Model (FVCOM) driven by the observed hourly meteorological forcing in 1998. The biological model is a NPZD model, including phosphorus as the nutrient, which is the limiting element in Lake Michigan, phytoplankton, zooplankton and detritus. The model is calibrated by the satellite and in situ data. The main phenomena in the spring of 1998 are captured. During March to May, a circle-like phytoplankton bloom appears in South Lake Michigan, which looks like a 'doughnut'. The formation and mechanisms of spring bloom are simulated. It is confirmed by sensitivity studies that the bloom is forced by rapid growth of phytoplankton due to increasing temperature and light intensity in spring. The thermal front developed in spring inhibits the transport of bloom and nutrients from the nearshore to the deeper waters, and the wind-driven gyre circulation in south Lake Michigan induces the significant offshore, both of which contribute to the establishment of circle-formation bloom. *Keywords: Model testing, Spring bloom, Lake Michigan, Thermal front, Transportation, Circulation.*

MACINTYRE, S., Department of Ecology, Evolution and Marine Biology, University of California at Santa Barbara, Santa Barbara, CA. **Mixing Dynamics in Lake Victoria, East Africa - Will Changes in Climate alter Contemporary Patterns?**

The mixing dynamics of lakes are critical for ecosystem function as they determine rates of nutrient supply, persistence of anoxia, and inshore- offshore exchanges. Predicting changes in future states of lakes requires a mechanistic understanding of the dominant processes causing exchange and then an assessment of how changes in meteorological forcing will modify these patterns. Latent heat fluxes in tropical lakes can be large, and temperature differences between the upper and lower water column are small. Hence, stratification can be induced by horizontal differences in temperature and the resulting gravity currents. Wind forcing can induce upwelling and non-linear internal waves. Here, via measurements and scaling analyses, the dominant processes enabling exchange are identified for inshore and offshore waters of Lake Victoria. The frequency of key exchange processes are identified in three 2 year long time series measurements of temperature from Lake Victoria and placed in context using meteorological measurements from the 1950s until the present in order to lay a framework for future predictions.

MACKEY, S.D.[1], CIBOROWSKI, J.J.H.[1], GARDNER-COSTA, J.[1], and SHERMAN, K.[2], [1]University of Windsor, Department of Biological Sciences, Windsor, ON, N9B 3P4; [2]Severn Sound Environmental Association, 67 Fourth Street, Midland, ON, L4R 3S9. **Shallow Water Bathymetry and SAV Distribution in Penetang Bay, Lake Huron, ON: Demonstration of a Remotely Operated Vessel for Environmental Research (ROVER).**

Lake margins are especially sensitive to coastal alteration by humans. Yet, limited technology exists to survey shallow waters. We developed the remotely operated ROVER to collect high-resolution bathymetric data and assess submerged aquatic vegetation (SAV) distribution and biomass. Penetang Bay is a former AOC with a complex shoreline, organic substrates, and dense submerged macrophyte beds. ROVER uses real-time differential GPS, a recording depth sounder, and shallow-water scanning sonar to collect high resolution bathymetric and epibenthic data, supplemented by underwater video and conventional sidescan sonar data. The ROVER data are post-processed upon completion of the survey. ROVER was able to operate in water depths unsuitable for most watercraft, and collected bathymetric data even where SAV densities were high. Comparison of the 200 kHz and 800 kHz sonar data allowed us to map both mineral substrate depth and the upper surface of SAV. Conventional sidescan sonar data complemented the ROVER surveys and identified areas where SAV extended to the water surface. Data on SAV distribution, volume, and density provide a way to map the distribution of aquatic habitats, assess potential nutrient loading sources, and estimate productivity in Penetang Bay. These data are fundamental when quantifying ecosystem services. *Keywords: Acoustics, Remotely operated vessel, Submerged plants, Substrate mapping, Bathymetric data collection.*

MACKINTOSH, S.M.[1], ZIMMERMAN, L.R.[1], PACEPAVICIUS, G.[2], CLAPSADL, M.[3], ALAEE, M.[2], PEREZ-FUENTETAJA, A.[3], and AGA, D.S.[1], [1]Department of Chemistry, University at Buffalo, State University of New York, Buffalo, NY, 14260; [2]Aquatic Ecosystem Protection Research Division, Water Science and Technology Directorate, Environment Canada, Burlington, ON, L7R 4A6; [3]Department of Biology and Great Lakes Center, The State University of New York College at Buffalo, Buffalo, NY, 14222. **Analysis of Brominated Flame Retardants in the Lake Erie Food Web: Levels, Bioaccumulation, and Trophic Transfer.**

Polybrominated diphenyl ethers (PBDEs) are used globally in many applications as flame retardants. The occurrence of PBDEs in sediment from the Great Lakes is well documented and more recent studies show that levels in fish have been increasing in the last decades. In this study, PBDE concentrations in the Lake Erie food web were examined. Fish, invertebrate, sediment, and water samples were collected (2009-2011) and analyzed for PBDEs. All biota samples analyzed contained PBDE congeners. Mean concentrations of ΣPBDEs (sum of 26 congeners) ranged from 0.30 ng/g ww in dreissenid mussels to 31.44 ng/g ww in walleye. Total PBDE levels in fish were correlated with their stable isotope $\delta 15N$ value (r=0.772, p<0.0001), thus the trophic level of the fish is a good indicator of their PBDE loads. Comparison of the PBDE congener profiles detected in the species analyzed shows a similarity in concentrations of various congeners in those species that occupy the same trophic level. These profiles are effective tracers of food web connections. Our results also provide evidence for bioaccumulation of PBDEs with fish growth as illustrated by our analysis of different size-classes of smelt, shiners and gobies. *Keywords: Environmental contaminants, Chemical analysis, Lake Erie.*

MACRITCHIE, S.M.[1], STAINSBY, E.A.[1], and DOUGLAS, A.G.[2], [1]Ontario Ministry of the Environment, 125 Resources Road, Toronto, ON, M9P 3V6, Canada; [2]Ontario Centre for Climate Impacts and Adaptation Resources, 935 Ramsey Lake Road, Sudbury, ON, P3E 2C6, Canada. **Implementation Frameworks for Climate Change Vulnerability Assessment.**

Implementation Frameworks for Climate Change Vulnerability Assessment Scott MacRitchie, Eleanor Stainsby Environmental Monitoring and Reporting Branch, Ontario Ministry of the Environment, Toronto, Ontario, Canada M9P 3V6 Al Douglas Ontario Centre for Climate Impacts and Adaptation Resources, 935 Ramsey Lake Road, Sudbury, Ontario, Canada P3E 2C6 Vulnerability assessment is a fundamental step for developing a climate change adaptation plan or strategy. The various frameworks for conducting vulnerability assessment are reviewed with an emphasis on those frameworks that have been implemented in Ontario. An evaluation of the applicability of the frameworks for assessing the vulnerability of water resources in particular and natural resources in general will be presented. How vulnerability assessment can fit within an adaptive management framework will also be presented *Keywords: Climate change, Vulnerability, Watersheds, Assessments.*

MAHMOOD, M.[1], ARHONDITSIS, G.B.[1], and BHAVSAR, S.P.[2], [1]University of Toronto, Department of Physical & Environmental Sciences, Toronto, ON, M1C1A4, Canada; [2]Ontario Ministry of the Environment, Water Quality Monitoring & Surveillance Division, Toronto, ON, L7R4A6, Canada. **Temporal Mercury Trends in Lake Erie Fish Communities: A Dynamic Linear Modelling Analysis.**

We performed dynamic linear modeling analysis on fish contaminant data collected from the Ontario Ministry of the Environment and Environment Canada to examine long-term trends of total mercury (THg) in Lake Erie. Several sport fish species (walleye, smallmouth bass, rainbow trout) with differences in their diet habits, food competition strategies, and foraging patterns are characterized by weakly increasing trends of their THg levels in Lake Erie after the mid- or late 1990s. The systematic shifts in energy trophodynamics along with the food web alterations induced from the introduction of non-native species, the new role of the sediments as a net contaminant source, and the potentially significant fluxes from the atmosphere stand out as some of the hypotheses proposed to explain the limited Lake Erie response in recent years to the various contamination mitigation strategies. Our study concludes with the illustration of a novel Bayesian framework that is suitable for guiding fish advisories. *Keywords: Lake Erie, Bayesian inference, Biomagnification, Dynamic linear modeling, Mercury, Trend analysis.*

MAHOOTCHI, M.[1], PONNAMBALAM, K.[2], and BURN, D.H.[3], [1]Department of Industrial Engineering,, Amirkabir University of Technology, Tehran, Iran; [2]Department of Systems Design Engineering, University of Waterloo, Waterloo, ON, N2L 3G1, Canada; [3]Department of Civil and Environmental Engineering, University of Waterloo, Waterloo, ON, N2L 3G1, Canada. **Great Lakes Water Level Regulation Using Risk-Based Optimization Methods.**

Great Lakes water level regulation is a challenging problem because of the large range of numerical values, the number of variables, uncertainty, and nonlinearity. Risk-based optimization methods are even less used to solve for such problems. Stochastic programming models are normally used but are difficult as it increases the original size of the problem exponentially. In this paper we compare the stochastic programming method with a recently developed method using statistical moments of storage levels for solving the regulation problem considering risk. *Keywords: Management, Optimization, Model testing, Uncertainty, Water level, Fletcher-Ponnambalam model.*

MAJARREIS, J.M.[1], BEECRAFT, L.[1], WATSON, S.B.[2], and SMITH, R.E.H.[1], [1]University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1; [2]Canadian Centre for Inland Waters, 867 Lakeshore Road, Burlington, ON, L7S 1A1. **Are Variable Fluorescence Metrics a Good Indication of Phytoplankton Nutrient Status?**

Lake Erie is considered a phosphorus (P)-limited lake, following the classical paradigm of single-nutrient limitation for phytoplankton. However, physiological indicators, such as alkaline phosphatase assay (APA), N- and P-debt, suggest there are instances of co-deficiency that may shape phytoplankton dynamics. This study was designed to assess previous indications that variable fluorescence (especially Fv/Fm) can quantify instantaneous nutrient deficiency in

Lake Erie. Stations in the West, Central, and East Basins of Lake Erie were sampled in July and September 2011. 1m water was analyzed to determine APA, N- and P-debts, and particle stoichiometry. Dark adapted Fv/Fm and rapid light curves (RLCs) were measured on three kinds of variable fluorescence instrument: PhytoPAM, WaterPAM and DivingPAM. Only DivingPAM Fv/Fm values correlated with deficiency indicators in bivariate analysis; PhytoPAM and WaterPAM did not. Nutrient indicators suggested that there was P or N deficiency, and occasionally co-deficiency in the same sample. This suggests that variable fluorescence response to nutrient deficiency is instrument-specific and that single nutrient limitation models may not be completely accurate. *Keywords: Phytoplankton, Variable fluorescence, Lake Erie, Nutrients.*

MANNY, B.A.[1], DALEY, B.A.[1], BOASE, J.C.[2], and HORNE, A.N.[2], [1]USGS Great Lakes Science Center, 1451 Green Rd., Ann Arbor, MI, 48105; [2]U.S. Fish and Wildlife Service, 7806 Gale Rd., Waterford, MI, 48327. **Occurrence of the Endangered Northern Madtom in the Detroit River.**

The northern madtom (NOM) is a small catfish, native to North America and to the Detroit River. It is listed as globally vulnerable and endangered in both Ontario and Michigan. NOM were found in 1994 and 1996 near the northern limit of its range in the southern St. Clair River and in southeast Lake St. Clair, respectively. However, its occurrence in the Detroit River had not been documented since 1978. Here we report catches of 304 NOM, at 4 locations, in the headwaters and middle reach of the Detroit River from 2003 to 2011. In head waters of the Detroit River, we found adult NOM, including 2 spermiating males near Belle Isle in Michigan waters and both adult and 4 juvenile NOM near Peche Island in Ontario waters. In 2009, adult NOM were captured for the first time near Fighting Island in Canadian waters. Mark-recapture data showed that NOM moved 1.0-1.5 km within two months, from Michigan waters near Belle Isle across the deep, fast-moving Fleming Channel of the Detroit River to Canadian waters near Peche Island and, in Michigan waters across the deep channel north of Belle Isle to Conners Creek. Our findings of their ability to migrate relatively long distances, sexually mature males, as well as juveniles, support the hypothesis that a population of NOM is reproducing and sustaining itself in the Detroit River. *Keywords: Fish populations, Northern Madtom, Detroit River.*

MANNY, B.A.[1], BENNION, D.H.[1], BOASE, J.C.[2], BOUCKAERT, E.[3], CRAIG, J.[1], DROUIN, R.[4], FRANCIS, J.[5], GEORGE, E.[1], IRELAND, S.[1], KENNEDY, G.W.[1], MCLEAN, M.[1], ROSEMAN, E.F.[1], SUTHERLAND, J.[1], and THOMPSON, P.[1], [1]USGS Great Lakes Science Center, 1451 Green Rd., Ann Arbor, MI, 48105; [2]U.S. Fish and Wildlife Service, Waterford, MI; [3]Michigan Technological University, Houghton, MI; [4]Ontario Ministry of Natural Resources, Windsor, ON; [5]Michigan Department of Natural Resources, Southgate, MI. **Fish Habitat Assessment and Restoration In The Huron-Erie Corridor.**

The international Huron-Erie Corridor includes southern Lake Huron, the St. Clair River, Lake St. Clair, the Detroit River, and western Lake Erie. Conflicting uses of HEC waters for waste disposal, water withdrawals, shoreline development, shipping, recreation, and fishing have resulted in a number of environmental changes to this system including loss and impairment of

fish spawning and nursery habitat. As part of the HEC Initiative developed in 2004, a collaborative, science-based adaptive management approach was developed to address natural resource issues in complex and ever-changing environments. Goals of the HEC initiative include: 1) Restore/improve the ecological function and resilience of the HEC ecosystem, 2) Maintain healthy, diverse, and productive aquatic ecosystems throughout the HEC that will in turn provide societal, economic, and environmental benefits to the Great Lakes region and throughout the U.S. and Canada. Activities of the HEC Initiative include: creation of two fish spawning reefs in the Detroit River and documentation of their use by native fishes; assessment of larval fish distribution and abundance in the Detroit River and western Lake Erie to explore connectivity between spawning and nursery areas; and identification of candidate sites for spawning habitat restoration in the St. Clair River. *Keywords: Fish, Habitats.*

MANOLIDIS, M.[1] and KATOPODES, N.[1], [1]G.G. Brown Building, 2350 Hayward, Mechanical Engineering Department, University of Michigan, Ann Arbor, MI, 48109; [2]G.G. Brown Building, 2350 Hayward, Civil and Environmental Engineering, University of Michigan, Ann Arbor, MI, 48109. **Modeling the Release of River Ice Jams and their Impact on Riverbed Scouring.**

Measurements show that the depth of St. Clair River increased during the 80s and 90s, and this increase in depth would determine an increase in river conveyance and a drop in the water level of Lakes Huron and Michigan. Such an increase in depth may have been caused by the release of ice jams. Considering the strategic importance of Lakes Huron and Michigan, as one of the greatest freshwater reservoirs on the Planet, as well as their economic significance in commerce, tourism and commercial fishing, much attention is needed on factors that may affect the integrity of these valuable assets. The goal of the proposed work is to investigate by numerical methods the potential impact of ice jam releases on the depth and conveyance of St. Clair River, as it would affect the water level of Lakes Huron and Michigan. A computational model is presented, that will be able to simulate the release of an ice jam, as well as any ensuing riverbed scouring and change in riverbed morphology, due to increased flow velocities after the release. *Keywords: Computer models, Ice jam release, St. Clair River, Riverbed scouring, Ice.*

MARKLE, C., CHRISTENSEN, R.J., and CHOW-FRASER, P., McMaster University, Department of Biology, Hamilton. **Changes in Habitat Use by the Blanding's Turtle (*Emydoidea blandingii*) over an Active Season on Beausoleil Island, Georgian Bay Islands National Park.**

The Blanding's turtle (*Emydoidea blandingii*) is a semi-aquatic species that requires a variety of habitat types to meet both physical and biological needs; however, the combination of habitat loss and degradation have negatively affected their population and it is now listed as a species-at-risk by federal and provincial agencies. A key step in generating effective recovery strategies for the Blanding's turtle is to identify critical habitat for populations under a variety of geographic settings. Since little information on critical habitat for this species exist for the many islands of Georgian Bay, which is the largest freshwater archipelago in the world, we completed an intensive study on turtle movements on Beausoleil Island to identify critical habitat for 12

turtles. We used radio telemetry and GPS loggers to determine habitat use over the 2011 active season and quantified habitat availability using aerial imagery. Using compositional analyses, we determined that males and females use a variety of different coastal and upland wetlands over the course of an active season and exploit small pools and wet forest for use as movement corridors. Our research highlights the importance of protecting wetlands and the surrounding upland matrix to ensure population persistence, and provides insight for management strategies.
Keywords: Georgian Bay, Blanding's Turtle, Conservation, Radio Tracking, Coastal wetlands, Habitat Use.

MARKLEVITZ, S.A.C. and MORBEY, Y.E., University Of Western Ontario, 1151 Richmond St., London, ON, N6A 5B7. **Niche Overlap between Hatchery and Wild Origin Adult Chinook salmon in Lake Huron.**

The introduction and continued stocking of non-native Chinook salmon into Lake Huron has been an important management program that has maintained a vibrant sport fishery and rehabilitated the ecosystem. With 85% of the fishery originating from natural spawning Chinook populations, concerns of impacts on native species restoration efforts, and a decline of prey species, management agencies have questioned the importance of continued non-native salmonid stocking. However, little is known about the abundance and distributions, or niches, of the hatchery and wild sub-components of the fishery. My research uses a combination of otolith chemistry and field based observations to investigate the hatchery/wild niche overlap of Chinook salmon during the foraging (in the lake) and spawning (in a river) phase of their life history. Preliminary results demonstrate differences in the foraging niches of Chinook salmon from the varying wild populations and hatcheries. Furthermore, there are significant returns of both hatchery and wild fish to a stocked stream with significant spawning niche overlap. These results suggest that reductions or the complete cessation of the hatchery stocking have the potential to disproportionately affect the regional Chinook salmon fisheries in the lake and impact natural reproduction in stocked spawning streams. *Keywords: Fisheries, Spatial distribution, Ecosystems.*

MARTIN, S., MORIN, J., and CHAMPOUX, O., Environnement Canada, SMC, 801 - 1550, avenue d'Estimauville, Québec, QC, G1J 0C3, Canada. **Real-Time and Mid-Term Predictive Application of Habitat Models of the St. Lawrence River.**

St. Lawrence River discharge and levels during spring and early summer of 2010 were extremely low and mid-term predictions were showing a continued low discharge period to come: the impacts on the ecosystem were worrying. Environment Canada (EC) was mandated to adapt its habitat modelling system (IERM2D) with the goal of providing managers with information on the impacts of such low levels on fauna and flora habitats of the St. Lawrence. The IERM2D is an integrated habitat modelling (physics-vegetation-fauna) system that uses long time discharge series as input and produces different metrics needed to compute habitat models. Here, combinations of Measured and Predicted water level time series were built. All models (wetlands, submerged macrophytes, etc.) has been modified to use the rebuilt water level time series, use measured water levels for the determination of spatialized water levels and integrate

measured wind speed and direction in the wave effect calculation. Models were calculated from 1965 to 2011 and for some Measured-Predicted time series for 2010. Results vary in function of the Predicted time series when compared to the Measured one. In the context of bringing hydrodynamic and habitat models to EC operationnalisation (daily hydrodynamic simulations), modifications presented here is a mandatory step. *Keywords: Habitats, Model studies, St. Lawrence River.*

MARTINEZ, A.[1], REIBLE, D.[2], and <u>HORNBUCKLE, K.C.</u>[1], [1]Department Civil and Environmental Engineering, Iowa City, IA, 52242; [2]Department of Civil, Architectural, & Environmental Engineering, Austin, TX, 78712. **Measurement and Estimation of PCB Pore Water Concentrations and their Effect in the Release of PCBs from Sediment to Water in Indiana Harbor and Ship Canal.**

Sediments contaminated with persistent, bioaccumulating and toxic compounds (PBTs) are an important source of these chemicals to the environment. PBTs release from sediments is caused by both episodic resuspension and continuous soluble release from the bed sediment. The latter is a predictable function of the sediment pore water concentration, although this is a measurement that is difficult for PBTs because of their relatively low water solubilities. Measurements of PCBs freely dissolved pore water concentrations from Indiana Harbor sediment ranged from 100 to 1500 ng L-1 using a novel passive sampler technique (SPME PDMS-fiber). It was possible to determine ~ 80 congeners in the pore water. Isotherm experiments showed that less than 10 days were enough to achieve equilibrium between the PDMS-fiber and the sediment pore water concentration. A partitioning approach between PCBs and organic and black carbons yielded the best approach to calculate PCB pore water concentration in the sediment from bulk PCB concentrations. A release PCB concentration was calculated from the PCB pore water (measured and calculated) and the DOC values, and was used to estimate the release of PCBs from the sediment into the overlying water. Black carbon was also incorporated in the calculation of the mass transfer coefficient. *Keywords: PCBs, Sediments, SPMDs.*

MARTINEZ, A., <u>O'SULLIVAN, C.</u>, and HORNBUCKLE, K.C., Dept Civil & Environmental Engineering, University of Iowa, Iowa City, IA, 52242, USA. **Abundance of Black Carbon and Polychlorinated Biphenyl Congeners in Highly Impacted Sediment from Indiana Harbor and Ship Canal.**

The presence of carbonaceous geosorbents in sediments can result in strong sorption of polychlorinated biphenyls (PCBs) in sediments. Coal particles and residual of incomplete combustion such as soot and charcoal (termed as black carbon) are part of these geosorbents. Black carbon analysis is not trivial, and currently, there is not a standard analytical method. However, Chemothermal Oxidation at 375 °C (CTO-375) is the method more commonly used, and in a lesser extent, a chemical oxidation method (chemox). Highly impacted sediments from Indiana Harbor and Ship Canal (IHSC) were analyzing using both methods. Percentage of BC in the sediments ranged from 3.9 to 9.4% (n = 7), which are in the top extreme of other sediments around the world. Specific surface area (BET method) from the chemox method sediment ranged

from 1 to 5 m2 g-1, which is in concordance with published data for coal and charcoal. No significant difference were found between methods. After sediments were analyzed for BC, PCBs in the sediment were analyzed for 161 individual or coeluting congeners. Very low fractions of total PCBs after and before BC quantification were detected in the sediment (range 0.002 to 0.06, n = 7). This suggests that the amount of PCBs sorb into the BC is minimal in comparison to other sorbents present in the sediment. *Keywords: PCBs, Sediments, Carbon.*

MARTY, J.[1], ARTS, M.T.[2], IVES, J.T.[3], BOWEN, K.L.[4], JOHANNSSON, O.E.[4], KOOPS, M.A.[4], JOHNSON, T.B.[5], and POWER, M.[3], [1]St Lawrence River Institute, 2 St Lawrence Drive, Cornwall, ON; [2]CCIW, Environment Canada, Burlington, ON; [3]University of Waterloo, Waterloo, ON; [4]GLFAS, Fisheries and Oceans, Burlington, ON; [5]Ontario Ministry of Natural Resources, Glenora, ON. **Comparison of the Ecology of the Native *Mysis diluviana* and the Exotic *Hemimysis anomala* from Lake Ontario Based on Stable Isotopes and Fatty Acid Analyses.**

As a result of the 2006 invasion, two mysid species now inhabit the nearshore and the offshore waters of the Great Lakes, the native *Mysis diluviana* and the invasive *Hemimysis anomala*, Although the ecology of *M. diluviana* has been well described, the introduction of the invasive *Hemimysis* is raising new questions about how Great Lakes food webs are influenced by the new mysids. Depending on its ability to integrate into the nearshore food web and consume benthic production, *Hemimysis* could restore nearshore connectivity between pelagic and benthic food webs. If consumed by fishes, *Hemimysis* may become a valuable food resource and allow for increased coupling between nearshore and offshore food webs. The diet, trophic position, and nutritional value of both mysids species were determined here using carbon and nitrogen stable isotope values and fatty acid profiles. Significant differences in carbon pathways were observed between both species with *M. diluviana* relying on pelagic production and *Hemimysis* utilizing both benthic and pelagic food sources. Fatty acid profiles confirmed the importance of both species as a source of lipids available to higher trophic levels. *Keywords: Food chains, Stable isotopes, Invasive species.*

MASSON, C., P.O. Box 10341, Don Mills Station, North York, ON, M3C 0J9. **"To Restore and Maintain:" A Value Proposition for the 1987 GLWQA.**

What is the historical legacy of the 1987 Protocol to the Great Lakes Water Quality Agreement of 1978? The draft 2011 International Joint Commission indicators report proposes to assess 25-years of restoration and maintenance initiatives. The challenge is to identify and validate effective surrogates with respect to natural history, reference and desired states, scope, spatial and temporal scales, uncertainty, multiple stressors, forecasting, decision-making, mandates, plans, priorities, expectations, enforcement and timelines. This policy-based review scans IJC and agency reports, theory, research and management interventions to determine objectives, methods and deployment across large aquatic ecosystems. Using qualitative analyses, a modified suite of recommended core indicators were derived for which reliable binational 1987-2012 data are available, with emphasis on climate-relevance and carry-over potential to the renegotiated 2012 Agreement. For this to work variance must factor in. Assembling and

integrating indicators requires organizational acuity, key information and strategic alignment with valued ecosystem services. A value proposition for ecosystem integrity may bridge social-economic-ecological boundaries and increase operational efficiency. The key force driving organizational change is people and their knowledge. *Keywords: Assessments, Policy making, Value chain, Great Lakes Water Quality Agreement, Indicators, Knowledge management.*

MATHERS, A.[1], THREADER, R.[2], STANLEY, D.[2], and PRATT, T.C.[3], [1]RR 4, OMNR - Glenora Fisheries Station, Picton, ON, K0K 2T0; [2]PO Box 950, 2 Innovation Drive, Ontario Power Generation, Renfrew, ON, K7V 4H4; [3]1219 Queen St. E.,, Fisheries and Oceans Canada,, Sault Ste. Marie, ON, P6A 2E5. **American Eel in the Lake Ontario - Upper St. Lawrence River Ecosystem.**

American eel once supported an important fishery in the Lake Ontario and the upper St. Lawrence River and were an important component of this ecosystem. Eel abundance declined in the area during the late 1980s and the 1990s. In response, eel fisheries in Ontario were closed during 2004 and 2005. An action plan to restore eel abundance was initiated by Ontario Power Generation in 2006. As part of this plan, approximately 4 million eels have been stocked into the area between 2006 and 2010. Stocked eels appear to be surviving well, growing rapidly and distributing from the stockings sites, however it is not yet known if these stocked eels will contribute to the spawning stock. In a second component of the action plan, between 2008 and 2010, over 3,000 large eels have been transferred downstream of all barriers in the St. Lawrence. This objective of this pilot 'trap and transport' project is to reduce the mortality of eels in hydro generation turbines during their downstream migration. Preliminary results suggest that some of the transported fish do migrate out of the system successfully, however it seems unlikely that the numbers of eel transported can be increased significantly with the current approach to collecting them. Current status of eel, progress towards restoration and the challenges will be discussed. *Keywords: Conservation, Mitigation, Fish management, American eel.*

MATISOFF, G.[1], EDWARDS, W.J.[2], SCHLOESSER, D.W.[3], and SOSTER, F.M.[4], [1]Department of Earth, Environmental and Planetary Sciences, Case Western Reserve University, Cleveland, OH, 44106-7216; [2]Department of Biology, Niagara University, Lewiston, NY, 14109; [3]USGS Great Lakes Science Center, 1451 Green Rd, Ann Arbor, MI, 48105-2807; [4]Department of Geosciences, DePauw University, Greencastle, IN, 46135. **Chironomid Burrows Increase Sediment-Oxygen Demand in Lake Erie Sediments.**

Bottom sediments in central Lake Erie are populated by high densities (average = ~350 indiv/m2) of large burrowing chironomid larvae. These macrobenthos actively irrigate their burrows, which significantly increases oxygen exchange across the sediment-water interface by enhancing diffusive flux through the burrow wall. To quantify their effect on the sediment oxygen demand (SOD) we developed a 2-D model of the process using data on average burrow size, flow velocity through the burrow induced by the larvae, and larval oxygen consumption rate measured in our previously reported experiments. The model accounts for the diffusive transport of oxygen from both the water column and across the inside of the burrow into the sediments where it is consumed by a bacterial aerobic respiration reaction. Average oxygen concentrations

in the water column were assumed to be fixed at saturation and the initial concentrations in the sediment were set equal to 0 µM. The model was solved using the time-dependent finite element code COMSOL Multiphysics and run to steady-state. The flux of oxygen across the sediment-water interface at steady-state was calculated as a function of the burrow density. The results indicate that at the highest densities considered in the simulation (60 ind/m2), SOD is increased by about a factor of 3. *Keywords: Lake Erie, Sediment-oxygen demand, Oxygen.*

MCCARTHY, M.J.[1], GARDNER, W.S.[2], LEHMANN, M.F.[3], and BIRD, D.F.[4], [1]University of Guelph, Dept. of Integrative Biology, Guelph, ON; [2]University of Texas at Austin, Marine Science Institute, Austin; [3]University of Basel, Dept. of Environmental Sciences, Basel, Switzerland; [4]Université du Québec à Montréal, Dept. sciences biologiques, Montreal. **Water Column and Sediment-Water Interface Nitrogen Transformations in Missisquoi Bay, Lake Champlain: a Preliminary Nitrogen Budget.**

Sediment-water interface (SWI) and water column (WC) nitrogen (N) transformations were evaluated in Missisquoi Bay, Lake Champlain, using stable isotopes during the growing seasons in 2007-2009. Results suggested that nutrients generally did not limit primary production, but fine-scale N limitation was evident from heterocytes in late summer. Phytoplankton controlled nutrients from the top down but did not affect NH4+ uptake rates. However, high cyanobacteria proportion affected the balance between photoautotrophic and bacterial NH4+ uptake. WC NH4+ regeneration rates did not relate to phytoplankton, refuting the hypothesis that cyanobacteria inhibit regeneration. Sediments were a NO3- sink but also an NH4+ source to the WC. Anammox may account for 6 - 10% of total N2 production, but denitrification was the dominant N sink. Denitrification rates were related to ambient WC DIN concentrations but did not affect future concentrations. The data do not support the hypothesis that denitrification leads to conditions suitable for N fixing cyanobacteria. In contrast, the results indicate that conditions suitable for N fixing cyanobacteria caused lower denitrification. The lake was a net N sink in a preliminary N budget using WC and SWI N fluxes compared to estimated tributary N load, suggesting a 'missing' N source (not N fixation). *Keywords: Cyanophyta, N budget, N transformations.*

MCCOMBS, M.P., MULLIGAN, R., BOEGMAN, L., and BOUFFARD, D., 58 University Avenue, Kingston, ON, K7L 3N6, Canada. **Validation of a Hydrodynamic and Wave Model of Eastern Lake Ontario.**

In future, it may be feasible to construct an offshore wind farm for renewable energy in the area between Main Duck Island and Big Sandy Bay, in the Kingston Basin of eastern Lake Ontario. Prior to approval, there is a need to assess the wave, current and sediment dynamics through the complex bathymetry of the Kingston Basin. We apply the spectral surface wave model SWAN, coupled with the hydrodynamic model Delft3D to gain an understanding of the wave and flow conditions. The model will be validated using data from acoustic Doppler current profilers, thermistor chains, optical backscatter loggers and water level and wave gauges, collected in 2006, 2010-12. Future work will extend the model to determine the potential

environmental impacts of offshore wind farm construction in the region.
Keywords: Hydrodynamic model, Lake Ontario, Waves.

MCDONALD, K.[1] and <u>TONINGER, R.</u>[1], [1]Toronto Region Conservation Authority, 5 Shoreham Drive, Toronto, ON, M3N 1S4; [2]Toronto Region Conservation Authority, Toronto. **Wildlife Research and Management in Canada's Largest City? A Retrospective of Tommy Thompson Park.**

Tommy Thompson Park, also known as the Leslie Street Spit, is man-made peninsula extending 5 km in to Lake Ontario in the Toronto AOC. It is recognized as a Globally Significant Important Bird Area, and is one of the most significant colonial waterbird breeding sites on the Great Lakes. The site has supported 8 species of colonial waterbirds since the mid 1970's and currently includes the largest colonies of Double-crested Cormorant, Black-crowned Night-Heron, Ring-billed Gull, Herring Gull, Caspian Tern, Common Tern, and Great Egret in the AOC. Long term population trends at the site coupled with Great Lake Basin wide changes, provide convincing incite into reproductive success within the AOC. Through extensive planning and consultation, a strategic Natural Area Enhancement Plan for terrestrial and aquatic habitat enhancements has been developed and is currently being implemented. General habitat improvements, as well as species specific essential habitats targeting a range of life stages for fish, herpetiles, colonial waterbirds, waterfowl, shorebirds and mammals, have been created and enhanced. *Keywords: Lake Ontario, Colonial Waterbirds, Cormorants, Restoration, Urban areas.*

<u>MCGULLOCH, J.</u>, CHESNYUK, A., GUDIMOV, A., ARHONDITSIS, G.B., and DITTRICH, M., University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A4. **Dynamic Reactive-Transport Model of Phosphorus Diagenesis in Lake Simcoe Sediments: Uncertainty and Identifiably Study.**

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 study a dynamic diagenetic model was developed for Lake Simcoe to gain insight into the history of sedimentation within the lake, as well as to identify the portions of organic, inorganic and dissolved phosphorus in sediments. Sequential fractionation of lake sediments has been performed in order to validate and calibrate the model. Phosphorus is divided into four functional groups: inert phosphorus, organic phosphorus, inorganic phosphorus (sorbed to iron) and phosphorus dissolved in pore water. Using the flux of organic and inorganic matter as dynamic boundary conditions, the model results are in agreement with the measured flux of total phosphate to the system and the fractionation data of phosphorus binding forms. Phosphorus diagenesis has been studied under various conditions regarding future human and natural impact on Lake Simcoe.
Keywords: Sediments, Sequential fractionation, Model studies, Phosphorus, Lake Simcoe, Reactive-transport modelling.

MCKENNA, P.R.[1], RINCHARD, J.[2], HE, J.X.[3], and CZESNY, S.J.[4], [1]1816 South Oak Street, University of Illinois, Champaign, IL, 61820; [2]390 New Campus Drive, SUNY Brockport, Brockport, NY, 14420; [3]160 East Fletcher Street, Michigan DNR, Alpena, MI, 49707; [4]400 17th Street, Lake Michigan Biological Station, Zion, IL, 60099. **Exploring Spatial Variability in Lake Trout Diets throughout the Upper Laurentian Great Lakes - Stomach Content vs. Fatty Acid Signatures.**

Restoration of self-sustaining populations of lake trout Salvelinus namaycush in Lake Michigan and Lake Huron has been hindered by several factors including dietary related thiamine deficiency complex (TDC). With declining alewife population levels and expanding round goby, an in-depth record of lake trout feeding habits would allow for better understanding of their prey utilization on a basin-wide scale. Stomach contents analysis is a standard method in fisheries to describe a "snapshot" of fish diet; long term feeding patterns can only be determined through complimentary analysis of predators' tissue fatty acid signature (FAS). To determine spatial variability in lake trout diets, stomachs and muscle plugs were sampled from 631 lake trout collected throughout Lake Michigan, Lake Huron, and Lake Superior in spring of 2011. FAS were analyzed from muscle derived lipids. Analysis of similarity (ANOSIM) was used to determine spatial variability in prey consumed and in FAS. We found significant differences in diets of lake trout using both techniques. Diets differed spatially both within and between lakes. We will discuss the degree of corroboration between both techniques (stomach content and FAS analyses) and the implications of our results for management and sustainability of lake trout in the Upper Laurentian Great Lakes. *Keywords: Great Lakes basin, Fatty acids, Lake trout, Stomach content, Diets.*

MCKINLEY, G.A.[1], BENNINGTON, V.[1], and URBAN, N.R.[2], [1]University of Wisconsin - Madison, Center for Climatic Research, Madison, WI; [2]Michigan Technological University, Civil and Environmental Engineering, Houghton, MI. **Physical Drivers of Biogeochemical and Carbon Cycling in Lake Superior.**

The biogeochemistry and ecology of Lake Superior, the world's largest lake by surface area, has significant spatial heterogeneity that must be quantified if reasonable carbon budgets are to be developed from sparse observations. Three-dimensional coupled physical-biogeochemical modeling indicates that volumetric rates of respiration vary by two orders of magnitude across the lake, which leads to enormous spatial variability in the net metabolic balance; and this is likely a first order cause of the observed biogeochemical and ecological variability. We investigate the physical mechanisms driving this heterogeneity and discuss implications for the Lake's carbon budget. *Keywords: Respiration, Productivity, Biogeochemistry, Carbon cycle, Hydrodynamic model.*

MCLEOD, A.M., HAFFNER, G.D., and DROUILLARD, K.G., 401 Sunset Ave, Windsor, ON, N9B3P4. **Variability in PCB Concentration between Generalist and Specialist Species.**

The bioaccumulation process has been well studied and the affects of PCBs on aquatic systems is largely known. The mechanism of variation in PCB body burdens between individuals

of the same species, however, has been largely overlooked. This study analyzed PCB concentrations in three specialist forage fish species (*Pimephales notatus*, *Neogobius melanostomus*, *Labidesthes sicculus*) and two generalist forage fish species (*Notropis atherinoides*, *Notropis hudsonius*) from three locations in the Detroit River. Forage fish were used as a study system since higher feeding plasticity (for generalist species) and resource partitioning (for specialist species) are associated with species at low or intermediate trophic levels (Lowe-McConnell 1975; Gu *et al.* 1997). Initial results suggest that individual variation of high Kow chemicals is lower in specialist feeders than in generalist. It is predicted that high Kow persistent chemicals have the potential to be environmental tracers that will enhance our knowledge on energy flow in aquatic systems allowing an increased ability to evaluate the impacts of ecosystem disturbances (Pothoven *et al.* 2008). *Keywords: Indicators, PCBs, Fish diets.*

MCNAUGHT, A.S.[1], <u>BRENNICK, S.R.</u>[1], and ROSEMAN, E.F.[2], [1]Central Michigan University, 153 Brooks Hall, Mt. Pleasant, MI, 48858; [2]USGS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105-2807. **Dietary Preference of White Sucker (*Catostomus commersonii*) in St. Clair River Delta Wetlands.**

The Huron-Erie Corridor (HEC) experiences severe habitat degradation that negatively impacts native fish populations. As restoration efforts begin, it is important to understand which habitats are important for spawning and recruitment. The goal of this study is to compare the diet of larval fish (white sucker) in 3 wetlands in the St. Clair River Delta. These wetlands had varying degrees of connectedness to the main channel. Fish were collected using a plankton net and guts were examined under a microscope. Larval white suckers consumed higher numbers of total prey items, cladocerans and *Alona* spp. at site 2, and lower numbers of *Bosmina* spp. at site 1 than at other sites. The number of veligers consumed at site 1 was highest. Number of prey items varied with length. Large larvae consumed more *Alona* spp. and small larvae consumed more veligers. High consumption of veligers and lack of other prey items at site 1 may correlate to destruction by zebra mussels, which are common to the HEC. Site 2 is optimal for larval growth because it is characterized by low depth, low flow, high vegetation coverage, and close proximity to the main channel, allowing larval fish to flow into the habitat area. *Keywords: Fish, Coastal ecosystems, St. Clair River.*

<u>MEADOWS, G.A.</u>[1], COTEL, A.[1], and DESAI, N.E.[1], [1]University of Michigan - Dept. Atmospheric, Oceanic & Space Sciences, 2455 Hayward Ave., Ann Arbor, MI, 48109; [2]University of Michigan - Dept. Civil & Environmental Engineering, 2455 Hayward Ave., Ann Arbor, MI, 48109; [3]University of Michigan - Dept. Aerospace Engineering, 2455 Hayward Ave., Ann Arbor, MI, 48109. **Motion Compensated Buoy, Laser Wind Sensor Measurements of the Turbulent Marine Boundary Layer Over Lake Michigan.**

Beginning in September 2011, a new environmental monitoring buoy was deployed by Grand Valley State University (GVSU) in eastern Lake Michigan. The 6m length, 5200 kg, Wind Sentential Buoy by AXYS Technologies serves as a motion compensated host and power/data transmission platform for the Vindicator, three-beam, vertical Laser Wind Sensor

(LWS). The Vindicator provides Doppler sensed, three-dimensional, wind components at six elevations above the water surface (up to 150 m) at data rates up to 1 Hz. The combination of the Wind Sentential Buoy and Vindicator LWS provide a unique, in-situ and remote sensing package, the first such over-water deployment in the Great Lakes. LWS sensed, three-component, wind velocity observations are investigated as a function of height above the water surface. One second measurements of the instantaneous velocity in three directions, East, North and vertical respectively are provided for six, vertical, 40 meter, range bins which are centered at 58, 63, 78, 93, 113 and 123 meters above the water. From these measurements, the velocity profile, turbulent intensity and turbulent kinetic energy quantities are computed as a function of time and elevation through two major Great Lakes fall storm events. Results are compared to classic marine boundary layer theory. *Keywords: Remote sensing, Atmosphere-lake interaction, Buoys.*

METCALFE, B.W. and JOHNSON, T.B., Ontario Ministry of Natural Resources, Aquatic Research and Development Section, Glenora Fisheries Station, R.R.#4, 41 Hatchery Lane, Picton, ON, K0K 2T0. **Assessing Fish Health in Lake Ontario Using Biochemical and Nutritional Metrics.**

Fisheries biologists commonly use weight-based condition metrics as a basic indicator of fish health. Coupled with other morphological, biochemical, and nutritional metrics, a more complete description of fish health can be generated and used to infer the state and quality of a fish's resources. In this study we used a number of fish health metrics to compare fish sampled at several locations of differing physical and biological properties in Lake Ontario. Our results will compare the different metrics, as well as our interpretation of fish health relative to perceived environmental differences. Characterizing fish response among sites may reveal the relative influence of different mechanisms on fish and ecological health of Lake Ontario. *Keywords: Bioindicators, Fish, Lake Ontario.*

MICHALAK, A.M.[1], SCAVIA, D.[2], STEINER, A.[2], MOORE, M.[2], LAPORTE, E.[3], ANDERSON, E.[4], BELETSKY, D.[4], BOSCH, N.[5], BRIDGEMAN, T.B.[6], CHO, K.[2], DALOGLU, I.[2], DEPINTO, J.V.[7], EVANS, M.A.[2], FAHNENSTIEL, G.[8], HO, J.[9], JOHENGEN, T.[8], MCWILLIAMS, M.[2], POSSELT, D.[2], RICHARDS, P.[10], RUBERG, S.A.[8], SCHWAB, D.J.[8], and WRIGHT, D.[2], [1]Carnegie Institution for Science, Stanford, CA; [2]University of Michigan, Ann Arbor, MI; [3]Michigan SeaGrant, Ann Arbor, MI; [4]Cooperative Institute for Limnology and Ecosystems Research, Ann Arbor, MI; [5]Grace College, Winona Lake, IN; [6]University of Toledo, Toledo, OH; [7]LimnoTech, Ann Arbor, MI; [8]NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI; [9]Stanford University, Stanford, CA; [10]Heidelberg University, Tiffin, OH. **The 2011 Algal Bloom in Lake Erie: A Conceptual Model of an Extreme Event.**

The summer of 2011 saw the occurrence of the largest algal bloom in Lake Erie in recent memory. This presentation will explore the discrete events and longer-term trends that contributed to its occurrence, and examines whether these factors represent a unique set of conditions, or a scenario consistent with future trends that are expected within the context of the feedbacks associated with regional climate impacts, land use change, and agricultural practices

within the Great Lakes basin. Elements of the conceptual model include (i) a forensic analysis of the meteorological events that led up to the bloom, (ii) their impact on lake circulation, (iii) multi-year trends in land use, crop rotation, fertilizer application timing and amounts, and different tillage practices, and (iv) an analysis of surface runoff and nutrient loading caused by these factors. *Keywords: Algae, Climate change, Lake Erie, Land use, Nutrients.*

MIDDAUGH, C.R., RYAN, D.J., LEET, K.E., HÖÖK, T.O., and SEPÚLVEDA, M.S., Purdue University, Department of Forestry and Natural Resources, 195 Marsteller St., West Lafayette, IN, 47907. **Effects of Lampricides on Target and Non-Target Species: from Metabolite Changes to Ecological Consequences.**

Although the lampricide 3-trifluoromethyl-4-nitrophenol (TFM) has been used for over 60 years to control sea lamprey (*Petromyzon marinus*) in the Great Lakes, the mode of toxic action of TFM is not completely understood and impacts (including sub-lethal effects) of TFM on non-target species have not been fully evaluated. We explored these knowledge gaps by quantifying complete metabolite signatures (metabolomics) and non-lethal impacts (growth) of fishes exposed to different TFM concentrations. We exposed juveniles of three species of fish [sea lamprey, lake sturgeon (*Acipenser fulvescens*) and rainbow trout (*Oncorhynchus mykiss*)], to various concentrations of TFM (0.6-7.5 mg/L) over a twelve-hour period. Following exposure, livers from a subset of individuals were immediately preserved for metabolomic analysis using liquid chromatography-mass spectrometry. Growth (up to a month) was monitored for the remaining rainbow trout and lake sturgeon. We found no differences in growth among treated and control fish, indicating a limited effect on individuals within our size range. However, preliminary metabolomic analyses indicate significant differences in metabolite expression patterns among fish exposed to different TFM concentrations. Current work is comparing metabolite expression across treatments and species. *Keywords: Invasive species, Sea Lamprey, Tributaries, TFM, Metabolomics.*

MIDWOOD, J.D. and CHOW-FRASER, P., McMaster University, Department of Biology, 1280 Main St. W., Hamilton, ON, L8S4K1. **Movement of Northern Pike (*Esox lucius*) among Coastal Marshes of Eastern Georgian Bay, Lake Huron.**

Coastal wetlands provide critical spawning and foraging habitat for fishes. In the predominantly small (<2 ha) coastal wetlands of eastern Georgian Bay, Lake Huron, sustained low water levels have altered fish habitat. In order to manage these wetlands and maintain fish community diversity, it is essential to understand how fishes utilize small, locally situated wetlands. In the summer of 2011, we implanted radio tags in 12 northern pike (*Esox lucius*) to track their movements among coastal wetlands. Majority of the pike moved beyond our study area. Pike that frequented wetland areas tended to be young (2-5 years) and small (<600 mm). On average, these smaller pike moved among wetlands that were 1.4 km apart, although some moved as far as 3.9 km. Our results suggest that large mobile predators use multiple wetlands over relatively large areas during the active season, potentially linking these discrete marshes. Results from this study will aid in our understanding of fish metacommunity dynamics, and

provide a rationale for delineating wetland complexes at a scale that is appropriate for protecting critical fish habitat in the Great Lakes coast. *Keywords: Wetlands, Spatial analysis, Fish.*

MILES, J.J., DILLON, P.J., EIMERS, M.C., and NORTH, R.L., Trent University, 1600 West Bank drive, Peterborough, ON, K9J 7B8. **The Impact of Land use on the Forms of Phosphorus in Headwater Sub-Catchments the Beaver River Watershed, Lake Simcoe, Ontario.**

Land use affects nutrient export from catchments, and agriculture is an important source of phosphorus (P) to many surface waters. The seasonal relationships between the different forms of P and land use in the Lake Simcoe catchment of Ontario have not yet been established. The purpose of this study was to examine the effect of land use on the P forms in the Beaver River watershed, a major inflow to Lake Simcoe. Total phosphorus (TP), total dissolved phosphorus (TDP) and soluble reactive phosphorus (SRP) concentrations were measured at 9 sites on headwater streams that are influenced by different land uses, including agricultural, forested and wetlands. The results indicated a significant positive relationships between both SRP and TDP with the percentage of non-intensive agriculture (R^2=0.73; R^2=0.74, respectively) and intensive plus non-intensive agriculture (R^2=0.46; R^2=0.73, respectively). Our results suggest that non-intensive agricultural activities (non-row crops) have a greater impact on SRP concentrations than does intensive agriculture (row crops), while TDP is affected equally by both types of agriculture. *Keywords: Tributaries, Phosphorus, Lake Simcoe.*

MILLER, A., CHAPUT, T., WILLS, A., and LEE, D.R., Environmental Technologies Branch, Chalk River Laboratories, Atomic Energy of Canada Ltd., Chalk River. **Chalk River Laboratories has Little Effect on Concentrations of Cesium-137, Strontium-90 and Mercury in Game Fish.**

The quality of game-fish in the Ottawa River above and below the Chalk River Laboratories of Atomic Energy of Canada Ltd. was examined in 2007. A total of 123 fish were collected in about equal numbers at each of four locations, two upriver (Mackey and Rolphton) and two downriver (Pointe au Baptême and Cotnam Island). Previously, small but elevated levels of ^{90}Sr and ^{137}Cs were detected in the river water below the Laboratories. However, the analysis of fish caught in 2007 did not reveal statistically elevated concentrations of ^{137}Cs in flesh and ^{90}Sr in bone downstream of CRL as compared to upstream locations, even when compared with upstream Mackey fish, which are isolated from the Laboratories by the 40-m high Rapides des Joachims hydroelectric dam. Mercury concentrations were comparable to concentrations in fish in uncontaminated lakes of Ontario and Quebec. However, the concentration of mercury in fish collected both above the hydroelectric dam at Mackey (45 km upstream) and at Cotnam Island (45 km downstream) was lower as compared with fish collected nearer the Laboratories. *Keywords: Mercury, Isotope studies, Fish.*

MILLER, C.J.[1], ANDERSEN, E.S.[1], CREECH, C.T.[3], BASKARAN, M.[2], SELEGEAN, J.P.[3], and HUI, J.[1], [1]Department of Civil and Environmental Engineering, Wayne State University, Detroit, MI, 48202; [2]Department of Geology, Wayne State University, Detroit, MI, 48202; [3]US Army Corps of Engineers, 6309 W Jefferson Ave, Detroit, MI, 48226. **Anthropogenic Impacts on Sediment Production in Great Lakes Watersheds.**

Over the past several centuries, anthropogenic influences in the Great Lakes watershed have altered the rates of sediment production and delivery. The present study examines historical accumulation of sediments in reservoirs of the Great Lakes watershed to determine the relationship between the anthropogenic influences and rates of sediment accumulation. The study data is also used to estimate remaining reservoir storage capacity. Twelve reservoirs with watersheds of various land-use distributions have been evaluated in this research. This paper describes the research process and results for one of these reservoirs, Lake Rockwell in Kent, Ohio. Field methods include vibracore sampling and acoustic doppler current profiler mapping of the reservoir bottom. Numerical modeling employs the Soil and Water Assessment Tool (SWAT). Sediment cores have been analyzed using radionuclide dating techniques. GIS techniques have been used to reveal changes in sediment storage over time using both the bathymetric mapping of present day conditions and digitized historical pre-dam construction maps. Historical and demographic studies have been completed to provide insight on anthropogenic changes in the contributing watershed during the pre-dam to present-day period. *Keywords: Great Lakes basin, Sediment load, Watersheds.*

MILLER, D.H.[1], TIETGE, J.E.[2], MCMASTER, M.E.[3], MUNKITTRICK, K.R.[4], XIA, X.[5], and ANKLEY, G.T.[2], [1]U.S. EPA, Mid-Continent Ecology Division, Grosse Ile, MI, 48134, US; [2]U.S. EPA, Mid-Continent Ecology Division, Duluth, MN, 55804, US; [3]Environment Canada, Ecosystem Health Assessment, Burlington, ON, L7R 4A6, Canada; [4]Department of Biology, University of New Brunswick, Saint John, NB, E2L 4L5, Canada; [5]Computer Sciences Corporation, Grosse Ile, MI, 48138, US. **Application of Biochemical Markers for Population Level Assessment of a White Sucker (*Catostomus commersoni*) Population Exposed to Bleached Kraft Pulp Mill Effluent.**

A need in ecological risk assessment is an approach that can be used to link chemically-induced alterations in molecular and biochemical endpoints to adverse outcomes in whole organisms and populations. A predictive population model was developed to translate changes in fecundity measures of a population of white sucker (*Catostomus commersoni*) collected at Jackfish Bay, Lake Superior to alterations in population growth. Individual-level responses of fish exposed to pulp mill effluent were used to demonstrate the model's capability to project alterations in population status. Monitoring data from the Jackfish Bay site includes biochemical endpoints, such as steroid measurements relevant to an adverse outcome pathway (AOP) for estrogen receptor (ER) activation. In combination with population modeling, the AOP framework can be used as an organizing principle by which mechanistic data (e.g. circulating steroid concentrations) can be effectively translated into endpoints meaningful to ecological risk (e.g. population status). Extrapolation of the population modeling construct demonstrated at the Jackfish Bay site can be made to other white sucker populations at sites that are less data rich.

This abstract does not necessarily reflect U.S. EPA Policy. *Keywords: Populations, Model studies, Risk assessment.*

MILLIGAN, M.S.[1], RICHARDS, D.[1], CONRAD, A.[1], CRIMMINS, B.S.[2], XIAOYAN, X.[2], HOLSEN, T.M.[3], HOPKE, P.K.[4], and PAGANO, J.J.[5], [1]Department of Chemistry and Biochemistry, SUNY Fredonia, Fredonia, NY, 14048; [2]Center for Air Resources Engineering and Science, Clarkson University, Potsdam, NY, 13699; [3]Department of Civil and Environmental Engineering, Clarkson University, Potsdam, NY, 13699; [4]Department of Chemical and Biomolecular Engineering, Clarkson University, Potsdam, NY, 13699; [5]Environmental Research Center, SUNY Oswego, Oswego, NY, 13126. **Identification of Emerging Contaminants in Great Lakes fish using GCxGC-TOF Mass Spectrometry.**

As part of the Great Lakes Fish Monitoring and Surveillance Program (GLFMSP), sponsored by the US-EPA, we have been employing GCxGC-TOF mass spectrometry to aid in the identification of emerging contaminants in Great Lakes fish tissue. Five gram composites of Lake Trout whole fish tissue from each of the Great Lakes were extracted using Accelerated Solvent Extraction (ASE), followed by GPC and silica gel column cleanup. Final extracts were analyzed by GCxGC using a 30 m SGE HT8 primary column and a 1.6 m BPX50 secondary column, coupled with a time of flight mass spectrometer. Mass spectra generated by a deconvolution algorithm were compared to NIST mass spectral libraries for potential hits, which were then assessed on a peak-by-peak basis. Numerous brominated, fluorinated, chlorinated, and non-halogenated potential emerging contaminants have been tentatively identified using this approach. Some of these compounds have been found on the Howard-Muir list of potential persistent and bioaccumulative in-use chemicals, and others may be the result of degradation of brominated fire retardants. Final confirmation of these potential contaminants will be confirmed using available standards. *Keywords: Environmental contaminants, Fish, Toxic substances.*

MINELGA, V.[1], DOBBIE, T.[1], and KOH, S.[2], [1]Point Pelee National Park, 407 Monarch Lane, RR#1, Leamington, ON, N8H 3V4, Canada; [2]University of Alberta, 11455 Saskatchewan Dr, Edmonton. **Measuring Changes in Forest Tree Health and Vegetation Communities on Middle Island in Response to the Management of Hyperabundant Double-Crested Cormorant Populations.**

Tree health monitoring was established on Middle Island in 2004 to evaluate the impact of nesting double-crested cormorants on the vegetation communities of the island. Twelve north-south bearing transects were established for a total of 52 stations. Monitoring was conducted on an annual basis since 2004. A plotless point quarter method was used at each station to obtain stem frequency and density data along with measures of physical characteristics, height and diameter. Herbaceous and groundcover monitoring, using a 1m x 1m quadrant at the centre of each plot, was also initiated in 2004 and has since been completed from 2007 to 2011. This data is used to quantify tree and pole damage in relation to cormorant nest densities. An analysis was undertaken on data collected in 2004 to 2006 by Koh et al. and found correlations between high numbers of nesting double-crested cormorants and lower crown densities, higher foliage transparency and higher branch damage. Since 2008, active management has been initiated on

the island in an effort to reduce the effects of double-crested cormorant nest numbers on the island's plant communities. Analysis of the data collected for 2007-2011 has been undertaken to determine the response of the island's vegetation communities to the decreasing numbers of nesting double-crested cormorants. *Keywords: Vegetation, Conservation, Lake Erie.*

MINGELBIER, M.[1], LECOMTE, F.[1], BRODEUR, P.[1], DUMONT, P.[1], VACHON, N.[1], and MORIN, J.[2], [1]880, Ch. Ste Foy - 2e étage, Quebec, QC, G1S 4X4, Canada; [2]1550 av. d'Estimauville, Quebec, QC, G1J 0C3, Canada. **How Human Alterations and Natural Variations Explain Opposite Responses in Yellow Perch Stocks along the St. Lawrence River?**

Even if the St. Lawrence River (SLR) seems to be an open system, yellow perch stocks exhibit opposite temporal responses in three successive fluvial lakes. Despite stringent management actions, perch stock recently collapsed in lake Saint-Pierre (LSP), while they increased in Lake Saint-François (LSF) and Lake Saint-Louis (LSL). Although the apparent SLR connectivity, landscape genetics revealed the existence of distinct stocks reflecting the presence of natural and human barriers to gene flow in the river (i.e. dams, water masses, distance). Since those lakes are exposed to contrasting human alterations and natural variations, we compared the responses of LSF, LSL and LSP stocks to fishing pressure, water level regulation, land use, urbanization, shore degradation and commercial navigation. Furthermore, time series available for yellow perch were analysed within the 1960-2010 period to measure the effect of habitat availability for various life history stages; the patterns detected were compared with the pressures listed above. This analysis highlights various pressures combinations leading to contrasting responses in yellow perch stocks. As past efforts to restore the LSP stock were focusing mostly at reducing fishing pressure, we believe that further actions should now consider habitat restoration, including water quality. *Keywords: St. Lawrence River, Yellow perch, Fisheries.*

MODLEY, D.M., 54 West Shore Rd., Grand Isle, VT, 05458. **Asian Clam *(Corbicula fluminea)* Rapid Response and Ongoing Management in Lake George, NY.**

Asian clams *(Corbicula fluminea)* were first discovered in Lake George, NY in August 2010. Local, state, and federal partners quickly formed the Lake George Asian Clam Rapid Response Task Force to address the new infestation. The Task Force worked together to review treatment options and supported surveys to delineate the population. The Task Force also coordinated a pilot project to test the effectiveness of a benthic barrier mat treatment in fall 2010. The small size of the known infestation site in southern Lake George and the early detection of this species led to the spring 2011 benthic barrier mat treatment, for which the Task Force worked to raise money and secure all necessary permits. During the summer of 2011 a lake-wide survey was conducted and an additional three sites with Asian clam infestations were confirmed. Benthic barrier matting and suction harvesting techniques were used at two other sites to control the populations. Preliminary results and cost of the control technologies and fund raising efforts will be shared. *Keywords: Asian clam, Invasive species, Management, Education.*

MOHAMED, M.[1] and STAMMLER, K.L.[2], [1]125 Resources Road, Toronto, ON, M9W 1V7, Canada; [2]University of Waterloo, Waterloo, ON, N2L 3G1. **Loadings and Concentrations of Nutrients, Suspended Solids, and E. coli in Agricultural Watersheds of Southwestern Ontario and their Relationship to Land Use.**

Agricultural land use affects directly the small streams flowing through agriculturally dominated catchments and indirectly waters that receive these stream inputs, including larger rivers and the Great Lakes. Southwestern Ontario is a region of intense crop and livestock production, where agricultural inputs are a major source of nutrients, bacteria, and suspended sediments to streams. In this work, we examined the concentrations and loadings of total phosphorus (TP), nitrite + nitrate (NO2+NO3), suspended solids (SS), and Escherichia coli (E. coli) of 15 small streams draining agriculturally-dominated regions in Southwestern Ontario. Seasonal patterns suggest that the majority of the annual loads of TP, NO2+NO3, and SS were delivered in winter, while E.coli loads peaked during the autumn. A comparison of stream loadings to work done approximately 30 years ago (PLUARG) shows similar seasonal trends, but suggests that loadings of some substances found in our work may be appreciably higher than those found by PLUARG. The relationship between census-level land use and water quality suggest that cattle and poultry density in the study watersheds were positively related to TP and E.coli concentrations. Future studies will benefit from finer scale land use data and a quantification of current loadings at more PLUARG reference. *Keywords: Watersheds, Water quality, Nutrients.*

MOODY, P.M. and BROWN, C.M., Civil and Environmental Engineering, 12B Marston Hall, University of Massachusetts, Amherst, MA, 01002. **Evaluation of Lake Superior Outflow Regulation Plans using Robustness and Climate Informed Risk.**

The uncertainty associated with climate change requires alternate approaches to evaluate water resources systems. Methods based on the historic record do not account for potential climate changes while alternative approaches, like robust decision making, sacrifice formal characterization of risk used in economic analysis. This paper describes a hybrid approach and its application to the regulation of outflows from Lake Superior. A climate response function relating Net Basin Supply to stakeholder defined hazard levels is used to assess regulation plan performance. The initial evaluation determines plan robustness without consideration of climate variable probability distributions. This determines the climate conditions that result in unacceptable hazard levels and which plans perform adequately over the widest climate range. Plans then are evaluated using climate informed probabilities associated with the historic climate, paleo reconstructed climate, and General Circulation Model output. The source of climate information influences climate variable probability distributions, which alters the expected value of the hazards for each regulation plan. This analysis is used to inform decisions concerning regulation plan selection under climate uncertainty. *Keywords: Climate change, Risk assessment, Decision making.*

MOORE, D.J., Canada Centre for Inland Waters, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **Long-term Population Studies of Waterbirds on the Canadian Great Lakes, 1976-2011.**

Dr. Weseloh's career has focused on the monitoring, research, and conservation of colonial waterbirds on the Great Lakes. Since the 1980s, he has been co-lead of the Bi-national Great Lakes Decadal Colonial Waterbird Census, which tracks changes in the abundance and distribution of 9+ breeding species. Over the past 4 decades, some species colonized the region (Am. White Pelican, Great Black-backed Gull), some increased in abundance (Double-crested Cormorant, 136-fold; Great Egret, 14-fold; Ring-billed Gull, +39%; Caspian Tern, +34%; Black-crowned Night-Heron, +18%) and others declined (Common Tern, -41%; Herring Gull, -24%; Great Blue Heron, -7%). Research has focused on understanding the factors driving these trends, covering a variety of waterbird life history components including: foraging ecology; mark-recapture/demography; breeding effort and success; post-breeding dispersal, roosting and migratory behavior; monitoring sources of mortality. Selected results from these studies will be presented in more detail. Dr. Weseloh's body of work, and the impact of the many collaborative relationships he forged throughout his career, have shaped our understanding of waterbird ecology on the Great Lakes, and will continue to serve as a model for monitoring, policy development and conservation of these species nationally. *Keywords: Avian ecology, Species diversity, Great Lakes basin.*

MORRISON, B.J. and STEWART, T.J., Ontario Ministry of Natural Resources, Lake Ontario Management Unit, Picton, ON, K0K 2T0. **A Conceptual Model of Lake Ontario Nearshore and Offshore Trophic Flows.**

A food web context linking changes in Great Lakes water quality, lower trophic levels, invasives, and fisheries can provide mechanistic understanding useful to development of management policy. The Lake Ontario Technical Committee and partners are conducting a multi-trophic level sampling program in 2013, but a robust and flexible modeling framework to integrate these data and support hypotheses evaluation and policy development is lacking. In this paper, we provide a simplified conceptual model linking nearshore and offshore trophic processes that can be used to inform sampling designs and mass-balance modeling frameworks. We discuss the challenges in parameterizing the model, approaches to achieving mass-balance, dealing with uncertainty, and potential applications. *Keywords: Lake Ontario, Ecosystem modeling, Carbon.*

MULVANEY, K.K.[1], PROKOPY, L.S.[1], FOLEY, C.J.[2], and HÖÖK, T.O.[1], [1]Purdue University, Department of Forestry and Natural Resources, West Lafayette, IN, 47907; [2]Illinois-Indiana Sea Grant College Program, 195 Marsteller St., West Lafayette, IN, 47907. **Information Needs and the Organizational Network of Great Lakes Fisheries Management.**

In order to better understand climate change information needs for fisheries management in the Great Lakes, we conducted a survey and network analysis of Great Lakes fisheries decision-makers as well as focus groups with fisheries researchers for each of the Great Lakes.

We found that although climate change has only been minimally integrated into Great Lakes fisheries thus far, both decision makers and researchers are interested in the implications of climate change on fisheries, especially in terms of long-term threats. Researchers and decision-makers identified particular research and information needs and concerns for incorporating climate change into management as well as their preferred methods for receiving information. Additionally, more than 100 research, management, stakeholder and public-interest organizations were identified in the network analysis. While this indicates that there are many opportunities for information to be shared, information could also be lost in such a complex organizational network. Our research aims to provide researchers with a clearer vision of research needs for the incorporation of climate change into Great Lakes fisheries and also to ensure that decision makers receive valuable information through their preferred methods and available network channels. *Keywords: Climate change, Lake management, Fish management.*

MUNAWAR, M.[1], MUNAWAR, I.F.[2], FITZPATRICK, M.[1], and NIBLOCK, H.[1], [1]Fisheries & Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6; [2]Plankton Canada, Burlington, ON, L7L 2L8. **A Structural and Functional Assessment of the Microbial - Planktonic Food Web of Lake Ontario.**

Lake Ontario continues to suffer from a variety of anthropogenic stressors including eutrophication, toxic chemicals, phosphorus abatement, invasion of exotics, stocking of salmonids and the control of sea lampreys. A lakewide survey was organized during 2008 at 12 stations along 3 transects. Several microbial and planktonic food web parameters were sampled including bacteria, heterotrophic nanoflagellates, ciliates, pico-, nano- and net- phytoplankton. In addition, size fractionated primary productivity and bacterial growth rates were estimated. The taxonomic analysis of phytoplankton indicated that rare and less common species (each individually contributing 5% or less of the total biomass) were responsible for the high biodiversity observed and collectively accounted for a large proportion of the biomass. The 2008 food web structure was compared with the previous study conducted during 2003. During the summer of 2008, the food web was dominated by autotrophs compared the dominance of heterotrophs in 2003. This presentation will offer an integrated view of the current structure, function and health of the microbial - planktonic food web of Lake Ontario.
Keywords: Ecosystem health, Autotrophy, Photosynthesis, Heterotrophy, Biodiversity.

MUNAWAR, M.[1], NIBLOCK, H.[1], FITZPATRICK, M.[1], KLING, H.J.[2], and LORIMER, J.[1], [1]Fisheries and Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6; [2]Algal Taxonomy & Ecology Inc., 31 Laval Dr., Winnipeg, MB, R3T 2X8; [3]DFO, Burlington. **Comparing in Situ Fluorometry and Standard Microscopy: Is Pigment Based Algal Classification Comparable to Taxonomic Analysis?**

Comprehensive taxonomic assessments of phytoplankton have traditionally been obtained by standard techniques using various types of microscopes (e.g. inverted, epi-fluorescent, SEM, etc.). Although such taxonomic evaluations are time consuming, potentially expensive, and require qualified taxonomists, such analyses do guarantee detailed community structure and species data. In our investigation an in situ fluorometer with the capability of

detecting major algal classes based on accessory pigments (FluoroProbe by bbe Moldaenke) was deployed. Study sites were located across a broad spectrum of habitats in the Great Lakes including Bay of Quinte and Hamilton Harbour. We compare pigment based algal classes generated by the Fluoroprobe with the taxonomic groups and species composition resulting from standard Utermöhl inverted microscopy. The results indicate that fluorometric data was generally not compatible with the taxonomic results. Although we have conducted seasonally intensive sampling in diverse environments, we believe that more assessments are needed. Fluorometric data should always be validated against standard microscopic techniques. *Keywords: Measuring instruments, Phytoplankton, Bay of Quinte.*

MUNAWAR, M., <u>FITZPATRICK, M.</u>, NIBLOCK, H., and BOWEN, K.L., Fisheries & Oceans Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **A Spatial Assessment of the Planktonic Food Web of the Bay of Quinte, Lake Ontario, 2010.**

Fisheries & Oceans Canada organized the first spatial surveys of the lower trophic levels of the Bay of Quinte, Lake Ontario in June and August of 2010. The study design allowed us to track the changes in trophic state in the upper, middle and lower bay. The upper bay, for example, was hyper eutrophic during the August survey, with total phosphorus concentrations of 40 μg l^{-1}, chlorophyll *a* levels of 30 μg l^{-1} and primary productivity reaching 160 mg C m^{-3} h^{-1}. Phytoplankton biomass of 2 g m^{-3} was somewhat lower than expected under such conditions and was dominated by the filamentous diatom *Aulacosira granulata*. Conversely, zooplankton biomass of 0.8 g m^{-3} was relatively high and dominated by *Bosmina*. These observations suggest that the largely herbivorous zooplankton community had grazed down the smaller (< 20 μm) edible phytoplankton leaving behind a large proportion of inedible filamentous algae. This paper will explore the linkages between phytoplankton and zooplankton communities throughout the Bay of Quinte with a particular emphasis on feeding ecology. *Keywords: Algae, Feeding behaviour, Eutrophication, Zooplankton.*

<u>MURRY, B.A.</u>[1], STOLLER, J.B.[2], MADEL, G.[1], FULLARD, C.[1], HAAS, M.[1], GALAROWICZ, T.[1], WOOLNOUGH, D.A.[1], BOASE, J.C.[3], ANIA, A.[3], CHIOTTI, J.[3], BAKER, J.[4], LEONARDI, J.[4], UZARSKI, D.G.[1], and HAYES, D.[2], [1]Institute for Great Lakes Research, Central Michigan University Biological Station, Biology Department, Central Michigan University, Mt. Pleasant, MI, 48859; [2]Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI, 48824-1222; [3]U.S. Fish and Wildlife Service, Alpena Fish and Wildlife Conservation Office, Waterford, MI, 48327; [4]Michigan Department of Natural Resources, Fisheries, SLHMU, Lapeer, MI, 48446. **Effects of Restored Fish Passage on Food Web Properties: an Evaluation of New Rock Ramp Structures within the Saginaw River, MI Drainage.**

Fish passage projects are growing more common and represent a fundamentally important conservation / restoration strategy aimed at increasing ecosystem connectivity and available spawning habitat for fishes. There are, however, several potentially negative and often overlooked consequences of restored fish passage, including increased spread of invasive species and contaminants, changes in community composition, and ultimately alteration of food web

properties. There are many ways to investigate such potential adverse effects, but an assemblage size-spectra approach has the advantage of integrating across multiple potential food web changes to investigate impacts on emergent food web properties, including the capacity of the system to support fish and the ecological efficiency of the system. We test the hypotheses that (1) free-flowing reference rivers and rivers with restored fish passage will have greater capacity and higher efficiency than similar sized dammed rivers and (2) from a community ecology perspective that differences in diversity and functional group dominance will also impact a rivers food web capacity and ecological efficiency. Present data suggests that species richness and functional group dominance have a stronger influence on food web properties than ecosystem connectivity. *Keywords: Saginaw Bay, Fish passage, Size-spectra.*

MUSIC, B., FRIGON, A., and SLIVITZKY, M., Ouranos-Consortium on regional climatology and adaptation to climate change, 550, Sherbrooke W, Montreal, QC, Canada, H3A 1B9, Montreal, QC, H3A 1B9, Canada. **Future Great Lakes/St-Lawrence Hydrological Conditions as Projected by an Ensemble of RCM Simulations.**

Several recent studies suggest that the hydrological models, which typically use air temperature as a proxy for potential evapotranspiration across all time scales and climate regimes, project an exaggerated evapotranspiration increase in future climate due to global warming. As a consequence, significant runoff reduction in the Great Lakes/St-Lawrence Basin is projected, resulting in decreased net basin supply (NBS) and a drop in Great Lakes water levels. In this study, we analyze an ensemble of Regional Climate Model (RCM) simulations to assess future changes of main hydrological variables over the Great Lakes/St-Lawrence region. These results are then applied to derive the range of possible changes in the Great Lakes' NBS. Given the fact that surface energy budget constraints in traditional hydrological model simulations are not necessarily enforced, the hydrological impact assessment obtained from direct hydrological outputs of RCMs (that are based on the concept of energy and water budget conservation), should lead to more reliable projections of NBS change. In addition, throughout a RCM simulation, exchanges of water, energy and momentum fluxes take place across the soil-vegetation-atmosphere interface at each time step, thus allowing the effects of important feedback processes to be included. *Keywords: Regional Climate Model, Great Lakes basin, Climate change.*

NARAYAN, A. and PONNAMBALAM, K., 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada. **Model Based Extreme Value Analysis and its Application in Great Lakes.**

Extreme value analysis is complicated by a lack of long historic data. While paleohydrological studies can be useful they are not easily available and their calibration is not universally accepted. In this paper, we use stochastic differential equation (SDE) based models to study Lake Erie especially with regard to its extreme values, for example, extreme lake outflows and levels, and dry periods. Stochastic differential equations (SDEs) can be used to simulate conceptual catchments. In many cases, even a simple, and often used inflow distributions (for example, normal distribution) whose flows are used as inputs to the SDE model provide interesting distributions for extreme values. We will provide a brief introduction to

stochastic differential equations and then explain application with Lake Erie data.
Keywords: Model studies, Probability distributions, Water level fluctuations, Risks.

NEFF, B.D., PITCHER, T.E., PERES-NETO, P.R., HEATH, D.D., and WILSON, C.C., University of Western Ontario, Department of Biology, London, ON, N6A 5B7. **Conservation and the Architecture of Fitness of Atlantic salmon: Reintroduction into Lake Ontario.**

Lake Ontario Atlantic salmon were once an important top predator of the native fish community but were extirpated from the lake in 1896. Over the past two decades, efforts have gone into revitalizing the Great Lakes habitat and Canada is now poised to successfully reintroduce Atlantic salmon. The objective of our partnership with the Ontario government and industry is to provide a comprehensive scientific evaluation of three stocks of Atlantic salmon that have been approved for reintroduction. Using a quantitative genetics approach coupled with introductions into multiple stream environments we will provide a detailed analysis of fitness in the wild from egg to adult, the pinnacle of conservation and restoration research. Controlled semi-natural stream experiments involving non-native salmonids will be used to assess the competitive ability of Atlantic salmon. Our research will (1) identify the best reintroduction streams and microhabitat features associated with high performance of Atlantic salmon, (2) determine whether non-native salmonids will have to be managed within targeted streams, and (3) identify the best stock and families based on returning adults for reintroduction. The work will allow us to make recommendations about conservation programs that will direct policy on management and utilization of natural resources.

NEFF, M.R.[1], BHAVSAR, S.P.[2], and CHIN, J.X.Y.[3], [1]Department of EEB, University of Toronto, 25 Willcocks Street, Toronto, ON, M9P 3V6; [2]Ontario Ministry of the Environment, Environmental Monitoring and Reporting Branch, 125 Resources Rd, Toronto, ON, M5S 3E8; [3]Department of Biology, University of Toronto at Mississauga, 3359 Mississauga Road, Mississauga, ON, L5L 1C6. **Spatial and Temporal Trends of Total Lipid Content in Great Lakes Fish.**

Analysis of total lipid content of fishes may be useful in both understanding lipophilic contaminant trends as well assessment of fish population health. Previous studies on some Great Lakes fish have indicated overall declining trends in PCB concentrations, as well as declining trends in fish condition, a measurement which assesses the ratio of fish length to body weight. In this study, we found total lipid content to be in decline for eight species within the Canadian Great Lakes over a 35-year period (1970s-2008). There were no clear patterns relating to gender or sampling location within a lake. We hypothesize that influence of invasive species and climate change may be responsible for some trends in some lakes; however, these declines may be the result of multiple environmental factors. This study provides important context for a number of ecological and anthropogenic issues, including fish population health, lipophilic environmental contaminants, and nutritional benefits to fish consumers. *Keywords: Temporal trends, Lipid content, Fisheries.*

NEWMAN, M.[1], DEADMAN, P.[1], and MORTSCH, L.[2], [1]Department of Geography and Environmental Management, University of Waterloo, Waterloo, ON; [2]Adaptation and Impacts Research Section, Environment Canada, Waterloo, ON. **Examining the Response of Wetland Vegetation Community Composition to Fluctuating Water Levels Through Various Modelling Approaches.**

The vulnerability of Great Lakes coastal wetlands to fluctuating water levels is well documented. Understanding the non-linear relationships that exist between patterns of wetland vegetation and changing water levels is becoming increasingly important, noting projected water level changes due to climate change. Three different modelling approaches were developed and compared to determine their performance in replicating the response of wetland community vegetation to changing water levels at the Long Point wetland complex, Lake Erie, ON. They include: a feed forward artificial neural network trained using randomly selected sample sites from the larger dataset; a rule-based decision model that uses a series of if-then statements related to pre-existing vegetation, water depth and wetland vegetation tolerance ranges; and a multinominal logistic regression model. Data collected within the Long Point complex from 2007-2010 via a series of transects are utilized. Input variables include: water levels, water depth, previous, existing and adjacent vegetation, as well as a digital elevation model. Model output is the determination of generalized wetland classes, which are compared to known historical wetland vegetation coverages. Challenges associated with utilizing data to inform wetland vegetation modelling are discuss *Keywords: Model testing, Coastal wetlands, Water level fluctuations.*

NEWSTED, J.L., Cardno Entrix, 4295 Okemos Road, Suite 101, Okemos, MI, 48864, US. **Application of the Tissue Residue Approach (TRA) to Assess Potential Risks of Perfluorinated Compounds to Aquatic Organisms.**

Perfluoroalkyl acids (PFAs) are synthetic fluorinated organic compounds that can be released to the environment during manufacturing processes, from commercial products and applications. While PFAs have received increased attention in monitoring programs, the assessment of the risks PFAs pose to aquatic organisms is still being investigated. The tissue residue approach (TRA) provides a framework for analyzing aquatic toxicity in terms of mode of action and tissue residue concentrations and was applied to several perfluorooctane sulfonate (PFOS) and several other PFAs for which toxicity data were available. Using acute and chronic toxicity data from invertebrate and fish studies, and assuming that steady state conditions had been reached at the termination of each study, PFOS TRA values were determined for freshwater organisms. Based on this analysis, calculated whole body TRA values for PFOS ranged from 0.01 to 7.0 mmol/kg. To better understand the uncertainties inherent in this approach, additional analyses were conducted that used kinetic models and/or measured tissue data. Analyses were also determined for PFOA. The results of these assessments were compared to PFC concentrations in fish tissues collected from North America. In general, current concentrations of PFCs do not pose a significant risk to aquatic organisms. *Keywords: Risk assessment, Perfluorooctane sulfonate, Toxic substances.*

NGHIEM, S.V.[1] and LESHKEVICH, G.[2], [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA, 91109; [2]NOAA/Great Lakes Environmental Research Laboratory, 4840 South State Road, Ann Arbor, MI, 48108. **Toward an Operational Satellite Synthetic Aperture Radar (SAR) Ice Type Classification Algorithm for the Great Lakes.**

The high resolution of satellite synthetic aperture radar (SAR) measurements with its all-weather, day/night sensing capabilities make it well suited to map and monitor Great Lakes ice cover. Using our library of calibrated polarimetric SAR ice backscatter signatures, an algorithm was developed to classify and map major Great Lakes ice types using RADARSAT-1 SAR data. Although initial algorithm validation 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. NASA AIRSAR C-band polarimetric data collected in conjunction with in situ measurements imply that multi-polarization backscatter data could be used to map ice types and open water without this ambiguity. Radarsat-2 polarimetric data was then used to create an ice/water mask for both small and large incidence angles encountered in the data. This presentation describes the use of these masks with ENVISAT ASAR AP (dual co-polarized) data and the subsequent classification of ice types in the imagery by incident angle using our library of signatures. Our results indicate that different combinations of polarizations should be used in different ranges of incidence angle for ice and water identification. *Keywords: Remote sensing, Ice, Satellite technology.*

NORTH, R.L.[1], KIM, T.Y.[2], SMITH, R.E.H.[2], and DILLON, P.J.[1], [1]Department of Chemistry, Trent University, 1600 West Bank Drive, Peterborough, ON, K9J 7B8; [2]Department of Biology, University of Waterloo, Waterloo, ON, N2L 3G1. **How Productive is Lake Simcoe?**

Our current understanding of lake metabolism is based on measurements made during the open-water season, and few studies have addressed metabolism under ice. In Lake Simcoe, first-ever measurements of epilimnetic planktonic community metabolism revealed that the lake was net autotrophic 57% of the times measured. Lake-wide rates of areal gross production (AGP) and areal respiration (AR) derived from oxygen and carbon methods were measured from October 2010 to July 2011, inclusive. The AGP and AR were low, with mean values of 20.3+4.1 and 11.9+2.6 mmolO/m^{2}d, respectively. AGP:AR varied seasonally, with a median ratio of 2.5. Net autotrophy was measured at the beginning of the open-water season and continued through the summer stratified season and into the fall. In December, there was a switch to net heterotrophy, which was sustained under the ice until March. Net autotrophy then occurred, associated with algal blooms that had up to 3x more biomass than measured during the summer months, and the highest measured in vitro net community production rates. The high concentrations of under-ice algae were dominated by a small centric diatom (Stephanodiscus). This work contributes to a better understanding of the relative importance of winter limnology in the year-round production of temperate lakes. *Keywords: Lake Simcoe, Metabolism, Phytoplankton.*

NURNBERG, G.K.[1], MOLOT, L.A.[2], and LOH, P.S.[2], [1]Freshwater Research, 3421 Hwy 117, Baysville, ON, P0B 1AO; [2]Faculty of Environmental Studies, York University, 4700 Keele Street, Toronto, ON, M3J 1P3. **Evidence of Internal Phosphorus Load in Lake Simcoe.**

Hypoxia and cyanobacterial blooms were a problem in Lake Simcoe during the 1980s and have re-occurred in recent years to a lesser degree despite extensive nutrient load reduction from the catchment basin. This re-occurrence could indicate an internal phosphorus (P) source. Internal P load as redox-dependent release from bottom sediments is hard to determine in a large, relatively shallow and partly unstratified lake such as Lake Simcoe. Of the lake's three major basins, only Kempenfelt Bay stratifies long enough to develop hypoxia in the stagnant summer hypolimnion. Consequently, signs of internal P loading are investigated in this basin first. Results and insight can then be applied to the more obscure indications of redox-related P loading in the shallower basins. The following indications of sediment P release are available from historic data (MOE/LSRCA). 1. Hypolimnetic hypoxia occurs although the hypoxic factor (number of days an area equal to the bay's surface area is overlain by water of ≤ 2 mg/L dissolved oxygen) has decreased substantially from 15.8 d/yr (1980-1994) to 4.3 d/yr (1995-2011); 2. Redox dependent metals, Fe and Mn, increase with depth; 3. Euphotic P and chlorophyll increase and water clarity decreases during fall turnover, possibly related to cyanobacterial blooms. Mass balances are being investigated. *Keywords: Sediments, Lake Simcoe, Phosphorus.*

O'BRIEN, T.P., FARHA, S., HONDORP, D., and NEWMAN, K., 1451 Green Rd., Ann Arbor, MI, 48105. **Research Capabilities and Program Overview of USGS Large Vessels in Lakes Michigan and Huron.**

Lakes Huron and Michigan are the 4th and 5th largest lakes in the world by surface area with a majority of their aquatic habitat occurring offshore (>10 km) over deep water (30-250 m). As such, synoptic research surveys of these systems require large vessels (>60ft) capable of deploying fishing gear in deep water, and operating for extended periods (up to 30 days), often in distant and remote locations. The long duration and great distances traveled by vessels during research surveys requires a fleet of research ships that are self-sufficient with respect to scientific operations (sampling, processing and storing scientific samples), vessel operation/performance, and crew accommodations. Safe and efficient operation and maintenance of such large sampling platforms requires correspondingly large budgets and infrastructure to accomplish science missions. Despite large operating costs, these vessels and the unique science they provide are relied upon by multi-jurisdictional and bi-national partner agencies managing fisheries and aquatic ecosystems across the Great Lakes. In this presentation we describe the research capabilities, vessel configurations, operational model, and current research missions of large USGS vessels operating on Lakes Huron and Michigan. *Keywords: Fish populations, Lake Michigan, Lake Huron.*

O'DONNELL, D.M., STRAIT, C.M., EFFLER, S.W., and PERKINS, M., PO Box 506, Syracuse, NY, 13214. **Lake Champlain: Optical Characterization, Historic Comparisons, and Tests of Closure.**

In situ measurements of inherent and apparent optical properties were made August 17-19, 2011 in Lake Champlain to advance the characterization of the underwater and emergent light fields of the lake and to support related IOP-based model development and testing. Measurements were made using a combined profiling package of ac-s and BB9 meters (WETLabs®). Remote sensing reflectance and diffuse attenuation coefficient was measured using a HyperPro II (Satlantic®). Spectral and vertical patterns of absorption, scattering and backscattering are reported. Spatial patterns of optical characteristics are presented and relate drivers are considered. Comparisons to an earlier (1990) optics survey conducted by the Upstate Freshwater Institute are presented. Both analytical and semi-analytical optics models are evaluated for closure. *Keywords: Underwater optics, Lake Champlain, Remote sensing.*

O'GORMAN, R.[1] and MADENJIAN, C.P.[2], [1]USGS Lake Ontario Biological Station, 17 Lake Street, Oswego, NY, 13126; [2]USGS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105. **Research Vessels of the Great Lakes Science Center: A Recent History.**

The fleet of large research vessels operated on the Great Lakes by the U.S. Geological Survey's Great Lakes Science Center has undergone many changes since 1970. Vessel numbers and size have increased; old vessels have been retired and new ones built; vessels have been re-located to different lakes; vessel maintenance and crew management has switched from decentralized to centralized and back again; and, most importantly, safety equipment and training has vastly improved. The history of these changes, their affect on research, and the lessons learned during the evolution of the Science Center's fleet will be discussed. *Keywords: Planning, Vessel program history, Great Lakes basin.*

OLIVER, S.K., BRANSTRATOR, D.K., and HRABIK, T.R., University of Minnesota Duluth, Department of Biology, Duluth, MN, 55812. **Nutrient Regeneration by *Mysis Diluviana* and the Copepod Community in the Deep Chlorophyll Layer of Lake Superior.**

Despite a phosphorus limited system and recent declines in total phosphorus, phytoplankton in Lake Superior's deep chlorophyll layer (DCL) maintain lower C:P ratios than their epilimnetic counterparts. This suggests higher phosphorus availability at these depths (25-50m). We hypothesized that the copepod community, along with migrating zooplankton like *Mysis diluviana*, provide a concentration of biomass and subsequent nutrient regeneration that may elevate nutrient availability beneath the thermocline in Lake Superior. *Mysis* and the zooplankton community collected from the western arm of Lake Superior were incubated, and excretion of soluble reactive phosphorus (August 2010 and 2011) and ammonium (August 2011) were measured. There was significant overlap between the DCL and peak nighttime distribution of both *Mysis* and the dominant copepod *Limnocalanus macrurus* in both years. Here, we present daily nutrient contributions, calculated as the mass-specific excretion rate multiplied by biomass

and time spent in the DCL, and investigate the role of zooplankton in providing essential nutrients to primary producers. *Keywords: Nutrients, Zooplankton, Migrations.*

OMARA, M., HOLSEN, T.M., XIA, X., CRIMMINS, B.S., and HOPKE, P.K., Center for Air Resources Engineering and Science, Clarkson University, Box 5708, Potsdam, NY, 13699. **An Improved Sampling Methodology for the Measurement of Dissolved Hydrophobic Organic Contaminants using PoraPak Rxn RP Resin and Accelerated Solvent Extraction.**

Accurate determination of dissolved hydrophobic organic contaminants (HOCs) is critical in the assessment of their transport and fate in aquatic ecosystems. This presentation will discuss an improved method that employs an innovative sampling design incorporating the use of PoraPak Rxn RP (PPR) resin (Waters Corporation, Milford, MA) and accelerated solvent extractor (ASE) columns. Large volume water samples were collected from Lake Superior aboard the R/V Lake Guardian, filtered, and simultaneously pushed through a sampling manifold, designed to hold five ASE columns (33 mL capacity) in parallel, each prepacked with 9 g of precleaned PPR resin. Backup ASE columns were connected in series to each of the five columns to permit determination of potential breakthrough of target contaminants. This set-up obviates the need for storage of water samples in large tanks prior to filtration and solid-phase extraction, thus eliminating potential background contamination. The advantages of using customized ASE columns for both sampling and extraction will be discussed. The retention efficacy of target HOCs (polychlorinated biphenyls and polybrominated diphenyl ethers) on PPR resin will be presented. Analytical recovery data, analyses of blanks, and the potency of PPR resin versus classical adsorbents such as XAD-2 will also be discussed.
Keywords: PoraPak Rxn RP Resin, Sampling methodology for dissolved HOCs, Pollutants.

OVEISY, A.[1], BOEGMAN, L.[1], and YERUBANDI, R.R.[2], [1]Environmental Fluid Dynamics Laboratory, Department of Civil Engineering,Queen's University, Kingston, ON, K7L 3N6, Canada; [2]Water Science and Technology Directorate, NWRI-Environment Canada, Burlington, ON, L7R 4A6, Canada. **Three-Dimensional Hydrodynamics and Nutrient Transport in the Bay of Quinte.**

The Bay of Quinte suffers from eutrophication resulting from excessive nutrient loads and it was identified as a Great Lakes Area of Concern in 1986. Eutrophication likely results from nutrients being trapped due to limited mixing and water exchange between the bay and Lake Ontario, mainly because of the long Z-shape of the Bay of Quinte. In this study, the effects of metrological forcing, river inflow, the exchange flow with Lake Ontario and hydrodynamic conditions, such as mixing and horizontal transport were investigated using a 3D hydrodynamic model. The model was validated against physical observations in the bay and shows a favourable agreement. The complex current patterns in the bay were studied using release of netural buoyant particles, and the residence time and dilution of the tributary inflow to the bay were determined using release of passive tracers and calculation of water retention times. The horizontal rates of dispersion associated with each river was also estimated. The results emphasize spatially varied hydrodynamic conditions, which result in low horizontal transport in inner parts of the bay, while efficient mixing can be seen near the connection with Lake Ontario. This hydrodynamic

modeling is the base for future watershed management and complete water quality modeling. *Keywords: Water quality, Hydrodynamic model, Bay of Quinte.*

OZERSKY, T.O.[1], EVANS, D.O.[1], and GINN, B.K.[2], [1]Ontario Ministry of Natural Resources, 2140 East Bank Drive, Peterborough, ON, K9J 7B8; [2]Lake Simcoe Conservation Authority, 120 Bayview Parkway, Newmarket, ON, L3Y 4X1. **Effects of Dreissenid Mussels on Nutrient Dynamics in Lake Simcoe, Ontario.**

Nutrient control is a key management priority for Lake Simcoe, but little is known about the effects of invasive dreissenid mussels on nutrient dynamics in the lake. Because of their high biomass in Lake Simcoe, dreissenids can have large effects on nutrient cycling and storage. Quantifying these effects is essential to understanding the lake's nutrient regime. We measured rates of N and P excretion and deposition by zebra and quagga mussels collected at 4, 10, and 18 m in spring, summer and fall, as well as the amounts of nutrients stored in mussel tissues and shells. The effects of dreissenids on nutrient dynamics and stoichiometry differed with depth, season, and species. Our results show that dreissenids have greatly increased the rates of nutrient remineralization and deposition, and that dreissenid tissue and shells constitute important nutrient sinks. These results agree with earlier findings that dreissenids have re-engineered benthic production dynamics in Lake Simcoe in a manner consistent with the nearshore shunt hypothesis. We show that dreissenid impacts on nutrient dynamics help to explain past changes to the lake's ecosystem, and that ongoing restructuring of dreissenid populations could lead to future changes to the nutrient status of the lake. *Keywords: Benthos, Nutrients, Benthic-pelagic coupling, Dreissena.*

PAGNUCCO, K. and RICCIARDI, A., Redpath Museum, McGill University, Montreal, QC, H3A 2K6. **In the Driver's Seat? Disentangling the Influence of Abiotic Factors and Round Gobies (Neogobius melanostomus) on the Composition of Macroinvertebrate Communities in the St. Lawrence River.**

Invasive species often arrive simultaneously with environmental disturbances, confounding cause and effect interpretations of apparent impacts. Without experimentation, it is often unclear whether an invasive species is a driver of ecological change, or whether its proliferation is merely coincident with other drivers. Here, we combine predator exclusion experiments and field surveys to analyze the relative importance of abiotic factors and an invasive benthivorous fish, the Eurasian round goby (*Neogobius melanostomus*), in the alteration of macroinvertebrate assemblages and subsequent benthic algal production in the St. Lawrence River. We use an information theoretic approach (Structural Equation Modeling) to evaluate interaction pathways between round goby density and abiotic factors. Although both density and abiotic factors had significant effects on algal production, the effect size of turbidity was double that of goby density, indicating the importance of studying the impacts of invasive species across abiotic gradients. Predator exclusion experiments revealed that algal concentrations were two times greater in the presence of gobies, while field surveys suggested a negative correlation between goby density and algal production. Possible explanations for this apparent paradox will be discussed. *Keywords: Round goby, Macroinvertebrates, St. Lawrence River.*

PALMER, M.E.[1], WINTER, J.G.[1], and SOMERS, K.M.[2], [1]Ministry of the Environment, 125 Resources Road, Toronto, ON, M9P 3V6; [2]Dorset Environmental Science Centre, Ministry of the Environment, 1026 Bellwood Acres Road, P.O. Box 39, Dorset, ON, P0A 1E0. **Temporal Coherence of Great Lakes Water Quality.**

The Ontario Ministry of the Environment monitors water quality (chemistry and phytoplankton) at 17 municipal water treatment plant intakes in the Great Lakes watershed, including intakes in Lakes Ontario, Erie, Huron and Superior, their connecting channels, and the St. Lawrence River. Untreated water samples have been collected weekly since 1976-1985. Samples are analyzed for total and dissolved nutrients, chloride, silica, conductivity, pH, carbon, chlorophyll and phytoplankton biomass and species composition. Sampling of municipal water intakes provides a cost-efficient method to monitor year-round water quality at multiple sites. The data have been used for measuring the response of water quality to nutrient reduction programs, zebra and quagga mussel invasion and climate change. We will use these long-term data to measure the temporal coherence of water quality among sites, which will help us to understand the relative importance of local vs. broad scale environmental drivers in determining the water quality of the Great Lakes. Preliminary results suggest annual trends in water quality are synchronous among intakes. Seasonal trends are sometimes synchronous but only for select water quality parameters. Synchronous trends will be analyzed in relation to factors such as climate, hydrology and land use to explain similarities. *Keywords: Water quality, Temporal coherence, Monitoring.*

PANKHURST, H.[1] and GRABAS, G.P.[2], [1]Central Lake Ontario Conservation, 100 Whiting Ave, Oshawa, ON, L1H 3T3; [2]Canadian Wildlife Service, Environment Canada, Toronto. **Durham Region Coastal Wetland Monitoring Project: Status and Trends.**

Durham Region supports a distinct concentration of coastal wetlands on the north shore of Lake Ontario. Human-induced stressors including encroaching urban development, water level regulation, habitat degradation, and invasive species introductions are taking their toll on these ecosystems. The Durham Region Coastal Wetland Monitoring Project (DRCWMP) evolved to address the need for conservation and monitoring of these important ecosystems. The DRCWMP, a multi-agency, multi-year initiative, has been monitoring the physical attributes and biological communities of 18 coastal wetlands since 2002. The biotic communities under study include macroinvertebrate, fish, bird, amphibian, submerged aquatic vegetation and other vegetation communities both within and surrounding the wetlands. Water quality, sediment quality and water levels are some of physical features being monitored. Following ten years of field work, the results demonstrate that Durham Region coastal wetlands are generally in a degraded condition. However, encouraging trends show the improvement of water quality and submerged aquatic vegetation at some wetlands where restoration work has been completed. Continued monitoring of these wetlands will be important to assess the success of restoration activities and to provide feedback on adaptive management techniques. *Keywords: Wetlands, Monitoring, Coastal wetlands.*

PARENT, A.C.[1], BOURDAGES, L.[2], GRENIER, P.[2], CHAUMONT, D.[2], and ANCTIL, F.[1], [1]Laval University, Civil engineering departement, 1065 rue de la Médecine, Québec, QC, G1V 0A6; [2]Ouranos, 550 Sherbrooke Ouest, Tour Ouest, 19e étage, Montréal, QC, H3A 1B9. **Climate Analogues as Guides for a Water Conservation Adaptation Study to Climate Change.**

The project concerns the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement. Climate change will modify the annual volume of available water and its temporal distribution, potentially increasing the vulnerability to water of specific regions or industrial sectors. The objective of this project is to identify adaptation measures related to the expected climate changes in support to the proposed national policy of water conservation and efficient use for the portion of the Province of Quebec territory affected by the Agreement. Our approach relies on climate analogues to first determine the management methods that are appropriate to the anticipated climatic conditions prevailing in the St. Lawrence River basin. The climate analogues method allows the identification of areas where the recent climate corresponds to the future climate projected at another location, here in the St. Lawrence River basin. Climatically analogous locations are identified from the distributions of three indicators selected for their representativeness of the water demand issue: the aridity index, the annual cumulative precipitation, and the growing degree-day. Adaptation measures are next selected from the best practices identified in the literature focusing on the analogue locations that lie in the Agreement territory. *Keywords: Great Lakes basin, Climate change.*

PARKER, S.R.[1], TRUSCOTT, J.[2], MURPHY, S.D.[1], and HARPUR, C.[2], [1]University of Waterloo, 200 University Avenue, Waterloo, ON, N2L 3G1; [2]Fathom Five National Marine Park, 248 Big Tub Rd., Tobermory, ON, N0H 2R0. **Managing for Resilience in a Freshwater Protected Area: Fathom Five National Marine Park, Lake Huron.**

Protected areas are considered to be the cornerstone of biodiversity conservation strategies and as valued sources for human well-being and ecosystem services. Yet they are not inviolable to the growing and unprecedented impacts facing social-ecological systems worldwide. As disturbances such as invasive species and climate change transform many of the Great Lake ecosystems to new and novel states, the consequences of these changes for protected areas are significant and not fully understood. In a context of uncertainty and change, we will explore the practice of managing for resilience in a freshwater protected area, Fathom Five National Marine Park, Lake Huron. Our resilience-based approach focuses on elements that build the capacity of a protected area to cope with disturbance while maintaining its defining structures, functions, and feedbacks. The incorporation of resilience thinking within each of the management planning stages of assess, plan, and manage will be discussed. As well our experience with spatially planning for resilience by utilizing the decision support tool Marxan with Zones will be demonstrated. While our work is still preliminary, it highlighted the complexity of the problem facing Fathom Five and reframed conservation solutions through a resilience lens. *Keywords: Protected Areas, Decision making.*

PASCOE, T., <u>MCDANIEL, T.V.</u>, and WATSON, S.B., Environment Canada, Science and Technology Branch, Burlington, ON, L7R 4A6. **The CABIN Program; Monitoring the Benthic Macro-Invertebrate Community as a Bio-Indicator for Lake of the Woods.**

The Canadian Biomonitoring Network (CABIN) provides an integrated national approach for managing, assessing and distributing information on the biological condition and biodiversity of aquatic ecosystems in Canada. Assessment of the benthic macro-invertebrate community of Lake of the Woods (LOW) was conducted to compliment a physical and chemical water quality monitoring program by providing an effect-based indicator of biological response. Sediment composition, chemistry, water quality and benthic macro-invertebrate structure were sampled at 31 off-shore stations within major basins of LOW over a three year field program. Offshore benthic habitats varied within the lake, with thermal stratification in deep northern basins resulting in low concentrations of dissolved oxygen. Sediment concentrations of nutrients and some metal species (Ni, Cu, Cr, Ni, Mn) exceeded provincial sediment quality guidelines at the majority of benthic stations. Preliminary analysis of off-shore benthic communities noted a reduction in diversity in deep northern basins where dissolved oxygen was low and concentrations of metals and nutrients in the sediments were elevated. The goal of this program is to develop a baseline CABIN reference model for Lake of the Woods to be utilized for tracking temporal trends and assessment of condition in the future. *Keywords: Sediment quality, Macroinvertebrates, Bioindicators.*

<u>PATERSON, G.</u>[1], RUSH, S.A.[1], DROUILLARD, K.G.[1], JOHNSON, T.B.[2], ARTS, M.T.[3], LANTRY, B.F.[4], and FISK, A.T.[1], [1]Great Lakes Institute for Environmental Studies, University of Windsor, Windsor, ON, N9B 3P4; [2]Glenora Fisheries Station, R.R. #4, 41 Hatchery Lane, Picton, ON, K0K 2T0; [3]Environment Canada, National Water Research Institute, Burlington, ON, L7R 4A6; [4]USGS Lake Ontario Biological Station, Oswego, NY, 13126. **Fatty Acids as Indicators of Resource Quality and Habitat Partitioning in Lake Ontario Forage Fish Species.**

Alewife, rainbow smelt and slimy scuplin represent the primary forage species in Lake Ontario that have supported salmonid top predators in the lake since the late 1960's. In this study, we measured fatty acid profiles in Lake Ontario alewife, rainbow smelt, slimy sculpin, and round goby in order to understand changes in prey quality that may be associated with the introduction and establishment of round goby in the Lake Ontario food web. Alewife were characterized by high proportions of myristic, linolenic and α-linoleic fatty acids reflecting their primarily pelagic life history. In contrast, rainbow smelt and slimy sculpin were characterized by ω3:ω6 fatty acid ratios associated with their deeper pelagic and profundal foraging ecologies. For round goby, fatty acid profiles for this species were described by high proportions of arachidonic acid and ω3:ω6 fatty acid ratio indicative of their nearshore littoral habitat preference. These results also indicate that salmonid diets high in round goby have substantially different nutrient profiles as indicated by fatty acid content. Such a diet may be also be relatively high in unsaturated fatty acid content which which may have potential consequences for the health and survival of cold water top predators in Lake Ontario. *Keywords: Trophic level, Prey fish, Food chains, Habitats.*

PATERSON, M.[1], SCHIFF, S.L.[2], WATSON, S.B.[3], SCHINDLER, D.W.[4], and <u>MOLOT, L.A.</u>[5], [1]Frshwater Institute, 501 University Crescent, Winnpieg, MB, R3T 2N6; [2]Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, ON, N2L 3G1; [3]National Water Research Institute, Environment Canada, Burlington, ON, L7R 4A6; [4]Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9; [5]Faculty of Environmental Studies, York University, Toronto, ON, M3J 1P3. **Can the Lessons of Lake 227 be applied to the Management of Other Eutrophic Systems?**

For over 40 years, Lake 227 in the Experimental Lakes Area has been artificially fertilized with phosphorus and nitrogen and then phosphorus alone. There is an unparalleled data set describing, for example, changes in species composition and biogeochemistry, much of which has been published. There are clearly commonalities between Lake 227 and other eutrophic systems. Nevertheless, a question has been raised: is Lake 227 too unique to be useful in designing management programs? Do we understand enough about eutrophication in general and Lake 227 specifically to apply the lessons of Lake 227 to the management of other systems? We will provide a synopsis of the past development of these blooms and present preliminary work from a recent multiagency strategic project designed to address some of the major knowledge gaps about nutrient processing and sequestration and how these may significantly qualify the risk of severe blooms. *Keywords: Nutrients, Management, Eutrophication, Lake 227, Cyanophyta.*

<u>PEKARIK, C.</u>[1], WESELOH, D.V.C.[2], MOORE, D.J.[3], and DE SOLLA, S.R.[4], [1]Canadian Wildlife Service, Environment Canada, 351 St. Joseph Blvd., Office 15073., Gatineau, QC, K1A 0H3; [2]Canadian Wildlife Service, Environment Canada, 4905 Dufferin St., Toronto, ON, M3H 5T4; [3]Canadian Wildlife Service, Environment Canada, Canada Centre for Inland Waters, Box 5050, Burlington, ON, L7R 4A6; [4]Canadian Wildlife Service, Environment Canada, Canada Centre for Inland Waters, Box 5050, Burlington, ON, L7R 4A6. **Legacy Contaminants in Great Lakes Herring Gulls, 1987-2010.**

In this paper we report on spatial and temporal trends in legacy contaminants in eggs of Herring Gulls from 15 sites on the Great Lakes and connecting channels, 1987-2010. We collected fresh gull eggs, during late April and early May, from 2-3 breeding colonies in each Great Lake and from single sites in the St. Lawrence, Niagara and Detroit rivers. Analyses were performed at the National Wildlife Research Centre in Ottawa. PCBs and TCDD have declined by approximately 78% and 85%, respectively, but levels of these two contaminants have been fairly constant since 2004 Levels of DDE and mirex have declined by approximately 87% and 73%, respectively despite a period of increase from 1987 through 1993-94, but they have declined steadily since that time. The final three legacy compounds under consideration, dieldrin, HE and HCB, declined by approximately 91%, 88% and 64%, respectively. HE and dieldrin have declined fairly steadily since 1987; HCB has shown some fluctuations, especially during 1987-97. All three compounds have fluctuated to some extent since 2005. *Keywords: Great Lakes basin, Avian ecology, Herring Gulls, Organochlorine compounds.*

PENNUTO, C.M.[1], BURLAKOVA, L.E.[1], KARATAYEV, A.Y.[1], PEREZ-FUENTETAJA, A.[1], KRAMER, J.W.[2], MATISOFF, G.[3], BADE, D.L.[4], MAYER, C.[5], and BRIDGEMAN, T.B.[5], [1]Great Lakes Center, Buffalo State College, Buffalo, NY; [2]Heidelberg University, National Center for Water Quality Research, Tiffin, OH; [3]Case Western Reserve University, Cleveland, OH; [4]Kent State University, Kent, OH; [5]University of Toledo, Lake Erie Center, Toledo, OH. **Benthos and Water Column Correlations in Nearshore Lake Erie.**

The effects of dreissenid mussels on water column nutrient conditions remain a significant management question in Lake Erie. We measured 14 water column constituents, algal biomass, and turbidity at eight locations along the Lake Erie nearshore in conjunction with the benthic community. Central and western basin nutrients declined with offshore depth more than eastern basin nutrients. There was a strong west to east decline in TP levels with a marked drop in TP levels from Ashtabula eastward. Two sites in the Central basin (off Fairport Harbor, OH and Erie, PA) and the Western Basin sites (off Monroe, MI and Turtle Creek, OH) showed marked nearshore to offshore changes in multiple water column parameters, having only 4 of 14 (28.5%) measured constituents remain unchanged. The remaining sites exhibited marked nearshore to offshore changes in over 70% of the measured parameters. Dreissenid mussel density declined from west to east, but mussel biomass increased, indicating mussels in the eastern basin were larger than those in the western basin. Although correlative, patterns suggest Dreissenid mussels may be food limited in the eastern basin. *Keywords: Nutrients, Dreissena, Lake Erie.*

PEPPLER, M.C. and PETERS, C.A., 8505 Research Way, Middleton, WI, 53562, US. **USGS Lake Management Plan Support: Web Mapper for Project and Site Metadata.**

Through our activities within each of the Great Lakes Lake Management Plans (LaMPs), the USGS is uniquely positioned to assist with designing and implementing a GIS based web mapping application (or LaMP mapper) that will integrate a variety of data (for example water quantity and quality measurement locations, fish population, and bathymetry). The LaMP mapper will allow for program managers and researchers with little GIS capabilities to upload and view the locations and extent of past and current data collection efforts and provide a basis for coordinating future activities within the basin. Currently available data, more recent datasets, as well as data that are already available in the form of national datasets will be used to populate the LaMP mapper. The LaMP mapper will serve as a tool through which administrators, scientists, and the public can gain access to program summary data without GIS expertise to help share information about data and increase collaboration. The LaMP mapper is ready for data inputs from any group that would like to contribute. Linkages are being explored with other data portals and mapping projects. *Keywords: Data storage and retrieval, Great Lakes basin, Decision making.*

PEREZ-FUENTETAJA, A. and ANKRAH, B.A., Biology Department and Great Lakes Center, Buffalo State College, 1300 Elmwood Ave., Buffalo, NY, 14052. **Feeding Ecology of the Round Goby in Lake Erie and in an Invaded Stream.**

In this study we compared the feeding ecology of the round goby (*Neogobius melanostomus*) in Lake Erie and in a tributary stream to the Niagara River. Gobies in the lake had access to dreissenid mussels, which they started incorporating into their diet at 40 mm total length, and they attained a larger size than the stream gobies during development. Gobies in the stream fed on a variety of macroinvertebrates, and they also experienced a diet shift after 40 mm total length, when they started feeding on caddisfly larvae. Stable isotopes analyses of 13C indicated that the carbon sources in the food webs of gobies in the lake and in the stream were different. Phytoplankton was the major carbon source for gobies from the lake, while carbon from detritus fueled the food web of gobies from the stream. Gobies in the lake had a higher trophic position (3.91) that gobies in the stream (2.88). Also, in the lake, gobies of different sizes had different 15N signatures, while size did not affect the isotopic signatures of gobies in the stream. These differences result from gobies in the lake switching from a diet of soft benthos to molluskivory during development, while gobies in the stream eat an increasing amount of caddisfly larvae, which are not isotopically different from other preferred benthic foods, such as chironomids. *Keywords: Round goby, Invasive species, Fish diets.*

PERNICA, P.[1], WELLS, M.G.[1], and SPRULES, W.G.[2], [1]Department of Physical and Environmental Sciences, University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1c 1A4; [2]Department of Ecology and Evolutionary Biology, University of Toronto Mississauga, 3359 Mississauga Rd, Mississauga, ON, L5L 1C6. **Is There a Relationship Between Variance in Horizontal Plankton Distribution and Internal Waves in the Epilimnion of Lake Opeongo, Canada?**

Previous observations have found a strong correlation between the patchiness of zooplankton in the epilimnion and wind speed in Lake Opeongo (Blukacz et al. 2009), with a maximum patchiness occurring for intermediate wind speeds between 3-6 ms-1. Using field data from July and August 2009 and 2010 we report observations of the presence of internal waves in the weakly stratified epilimnion during periods of intermediate wind in Lake Opeongo, Ontario. While the epilimnion is often assumed to be homogenously turbulent, numerous studies have shown that the epilimnion often displays intermittent mixing and weak temperature gradients. Statistical analysis of zooplankton distribution from July 2009 show that the small scale spatial variability of small zooplankton (268-450 um) is greatest when the stratification has intermediate gradient Richardson Numbers, $Rig \sim 0.5$. The variance of isotherm displacement is also a maximum for $Rig \sim 0.5$ which occurs during intermediate wind speeds. We will discuss the occurrence of these internal waves, their relationship with values of Rig and the effect of these waves on the distribution of zooplankton in the epilimnion. Our main observation is that increased variance of isotherm displacement at moderate Rig values is linked to the increased variation of zooplankton patchiness. *Keywords: Plankton, Stratification, Internal waves.*

PERRI, K.A. and BOYER, G.L., SUNY: ESF, 1 Forestry Drive, Syracuse, NY, 13210. **Cyanobacterial Prescence, Water Quality, and Toxicity in Sodus Bay, New York.**

Sodus Bay attracts large numbers of boaters every summer due to its relatively large size and location on Lake Ontario's southern shore. In 2010, Sodus Bay experienced a large outbreak of toxic *Microcystis*. The growing presence of these blue-green algae (cyanobacteria) has concerned citizens around the Bay because of their potential toxicity and impact on summer tourism. Pigment (chlorophyll and phycocyanin), toxin (microcystin and anatoxin-a), and nutrient (phosphorus and nitrogen) analyses were done on weekly samples collected from June-October, 2011. The Bay experienced several cyanobacterial blooms in 2011. The neurotoxin anatoxin-a was produced at low levels throughout the season, while hepatotoxic microcystin levels peaked in the fall, reaching levels of >20 μg per L. A significant fraction of the toxin was found in the dissolved phase. Total nitrogen throughout the season averaged (1.13 mg N per L) and did not significantly change during bloom events. Total dissolved phosphorus during the fall bloom event (4.4-11.3 μg P per L) dropped from the bay-wide summer average (13.8 μg P per L). These results suggest phosphorus may play an important role in controlling the formation of cyanobacterial blooms in Sodus Bay. *Keywords: Harmful algal blooms.*

PETERS, C.A. and SULLIVAN, D.J., USGS, Wisconsin Water Science Center, 8505 Research Way, Middleton, WI, 53562. **Use of Technology to support Tributary and Embayment Monitoring for the Great Lakes Restoration Initiative (GLRI).**

Monitoring in tributaries, embayments (river-mouths), and near-shore, in support of the Great Lakes Restoration Initiative (GLRI), include a significant focus on new technologies. To provide potential for less expensive long-term water-quality monitoring to estimate real-time loads; regression models are developed to relate continuous sensor measurements to discrete water-quality constituent measurements at thirty tributaries. The sites are continuously monitored for pH, SC, temp, DO, and turbidity. The sites are equipped with automated samplers to collect samples on a fixed-interval and on an event-driven basis. Samples are analyzed for nutrients, suspended sediment, and chloride; at a subset of sites automated sampling for pathogens, fecal indicator bacteria, optical properties, and wastewater-associated compounds is done. Near-shore and embayment (river-mouth) sites are monitored for water-quality and ecological components to explore the character and dynamics of hydrologic mixing zones. An automated underwater vehicle (AUV) was used to conduct 3-dimensional water-quality and bathymetric surveys of embayments and the near-shore. Colorimetric dissolved organic matter (cDOM) sensors were tested for potential use as surrogates for more expensive analyses (mercury, pathogens, wastewater compounds). *Keywords: Tributaries, Technology, Monitoring, Embayments, Water quality.*

PETRICH, N.T.[1], SPAK, S.N.[2], CARMICHAEL, G.R.[3], HU, C.[1], MARTINEZ, A.[1], RODENBURG, Z.[1], and HORNBUCKLE, K.C.[1], [1]Dept Civil and Environmental Engineering, University of Iowa, Iowa City, IA, 52242; [2]Public Policy Center, University of Iowa, Iowa City, IA, 52242; [3]Dept Chemical and Biochemical Engineering, University of Iowa, Iowa City, IA, 52242. **Quantifying Meteorological Artifacts in Passive Air Sampling: Implications for Urban and Regional POPs Monitoring in the Great Lakes Region.**

Polyurethane foam (PUF) passive air samplers are widely deployed to sample semi-volatile pollutants, but estimating concentrations from passive sampling requires constant empirical mass transfer rates, which add unquantified uncertainties to concentrations and the spatial and temporal information they contain. Here we present an approach for modeling hourly flow rates, mass transfer coefficients, and concentrations from hourly meteorology using first principles chemistry, physics, and fluid dynamics. This method is applied to polychlorinated biphenyls for 2008, using meteorological observations and those simulated by the Weather Research and Forecasting (WRF) model. We quantify effects of meteorology on the spatial and seasonal variability in congener-specific sampling rates and their uncertainty, isolating influences of the Great Lakes on advection, diffusion, volatility, and PUF saturation on a 12 km grid across the region and at urban scale over Chicago. We highlight practical implications for sampling network design, including site density, monitor representativeness, co-location with weather observations, and sampling period, with case studies at the Integrated Atmospheric Deposition Network and the University of Iowa network in metropolitan Chicago.
Keywords: Mathematical models, PCBs, Airsheds.

PETTITT-WADE, H., MCLEAN, K., HEATH, D., and FISK, A.T., Great Lakes Institute for Environmental Research, University of Windsor, 401 Sunset Avenue, Windsor, ON, N9B 3P4. **Investigating the Link Between Diet, Ecological Niche And Environmental Fitness in Aquatic Invasive Species.**

In a novel environment, species with a wide ecological niche are thought to be better competitors, and diet plasticity has been shown to be an important attribute of successful aquatic invasive species. We aimed to investigate the influence of ecological niche and diet in determining the success rate of aquatic invasive species (AIS) in the Great Lakes. We define the success of AIS according to the scale and speed of post-established spread. Successful and less successful species were compared: round/tubenose goby *Neogobius melanostomus*/*Proterorhinus semilunaris* and spiny/fishhook waterflea *Bythotrephes longimanus*/*Cercopagis pengoi*. Zebra mussels *Dreissena polymorpha* provided baseline stable isotope values. Stable isotopes $\delta^{15}N$ and $\delta^{13}C$ (IRMS), mercury (DMA-80 analyzer) and gut contents were used as tracers of ecological niche width. We hypothesised that more successful AIS have a broader diet and ecological niche width. It is suggested that this could in part be due to a link between environmental plasticity, diet and ecological niche. In collaboration with several other projects as part of CAISN II, this study provided an integrated approach to understanding AIS post-established spread and invasion risk in the Great Lakes.
Keywords: Niches, Environmental fitness, Invasive species, Goby, Diets, Water flea.

PHENICIE, D.K.[1], LARSON, W.M.[2], DEPINTO, J.V.[2], and WEIGAND, P.[3], [1]Council of Great Lakes Industries, 3600 Green Court, Suite 710, Ann Arbor, MI, 48105; [2]LimnoTech Inc., 501 Avis Drive, Ann Arbor, MI, 48108; [3]NCASI, PO Box 13318, Research Triangle Park, NC, 27709. **Water Footprint Pilots at Four Great Lakes Industrial Facilities.**

Concerns regarding water scarcity around the world have driven researchers and public policy makers to develop water use accounting or "water footprinting" tools. Previous work has focused on high consumptive use cases such as food or beverage production and used mostly in water scarce regions where supplies are limited and/or in response to concerns regarding citizen access to water. As use of these tools has increased, manufacturers have felt a need to gain understanding of how they apply to water use situations in the Great Lakes Region where supplies are more plentiful, water uses are mostly non-consumptive, and withdrawal volumes high. The Council of Great Lakes Industries has conducted a study, sponsored by the Great Lakes Protection Fund, that examined 19 water use accounting methodologies, focused on metrics used by these models, and applied the metrics to four large manufacturing facilities within the Great Lakes Region. The study results show how application of "water footprinting" metrics characterize water uses in industries, provide conclusions regarding water use accounting tools themselves, demonstrate which metrics are of most significance in a Great Lakes context, and suggest how the methodologies can be made more applicable for heavy industry and Great Lakes water use assessments. *Keywords: Assessments, Water footprint, Environmental policy, Water use metrics, Watersheds, Industrial water supply.*

PHILLIPS, J.C. and MCKINLEY, G.A., University of Wisconsin-Madison, Madison, WI, 53706. **Learning from the Global Oceans: The Ecological Impact of CO$_2$ Acidification of Lake Superior and Lake Michigan.**

The pH of the surface ocean is predicted to drop 0.3-0.4 units by 2100 under steady fossil fuel consumption. Model projections of Lakes Superior and Michigan suggest a similar decline in pH by 2100 as the surface ocean. In response to projections for marine ecosystems, the NOAA Ocean Acidification Steering Committee released the *NOAA Ocean and Great Lakes Acidification Research Plan* in April 2010. Initiatives for the Great Lakes have not been implemented, leaving them under-studied with respect to carbon acidification. This project assesses expected changes in carbonate chemistry and the likely ecological impacts in Lakes Superior and Michigan in order to encourage high-quality monitoring coupled with biological research. We use biogeochemical models to make projections based upon atmospheric pCO$_2$ scenarios. Using such models, we have studied past events of acid rain to better understand each lake's sensitivity to pH changes under various biochemical conditions. Lastly, we have interviewed and surveyed leading Great Lakes' scientists on likely impacts, particularly on calcifying organisms and early life stages, making this an interdisciplinary first look at Great Lake acidification. *Keywords: Carbon, Lake Michigan, Lake Superior.*

PICHEL, W.G.[1], LESHKEVICH, G.[2], LI, X.[3], MONALDO, F.[4], and JACKSON, C.[5], [1]NOAA/NESDIS/Center for Satellite Applications and Research, 5200 Auth Road, Camp Springs, MD, 20746; [2]NOAA/Great Lakes Environmental Research Laboratory, 4840 South State Road, Ann Arbor, MI, 48108; [3]IMSG at NOAA/NESDIS, 5200 Auth Road, Camp Springs, MD, 20746; [4]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD, 20723; [5]Global Ocean Associates, 6220 Jean Louise Way, Alexandria, VA, 22310. **NOAA SAR-Derived High-Resolution Winds for the Great Lakes.**

The Center for Satellite Applications and Research (STAR) within the National Environmental Satellite, Data, and Information Service (NESDIS) of the National Oceanic and Atmospheric Administration (NOAA), has been providing experimental wind-speed products derived from synthetic aperture radar (SAR) imagery since 1999. These products are now undergoing a transition to operations in preparation for the launch of operational SAR satellites in the next few years. Currently, experimental wind products are available from NOAA using data from the European Space Agency (ESA) ENVISAT satellite in a number of U.S. coastal areas, including occasional coverage of the Great Lakes. Great Lakes wind products show wind pattern variations at 500 meter resolution with an accuracy in the range of 1.5-2.5 m/s. The advantages of SAR sensors over other wind measuring instruments and remote sensors are surface wind measurement at very high spatial resolution, measurement capability under all types of weather except very heavy rain, and measurement close to the coast and in straits and bays. An overview of the wind-generation system along with samples of Great Lakes wind products and validation statistics are presented. *Keywords: Remote sensing, Synthetic aperture radar (SAR), Satellite technology, Winds, Spatial analysis.*

PITCHER, T.E. and BLACK, C., Biological Sciences, University of Windsor, 401 Sunset Ave, Windsor, ON, N9B 3P4. **Effects of Hybridization on the Reintroduction of Atlantic Salmon to Lake Ontario.**

Atlantic salmon (*Salmo salar*) has historically been one of the most important salmonids in Lake Ontario for its role in commercial and sport fisheries and as a top predator. Although Atlantic salmon played a key role in Lake Ontario they were extirpated, partly owing to habitat loss due to human activities. Over the last two decades efforts have gone into revitalizing the lake's habitat and studies suggest that the Lake Ontario basin is now in appropriate condition for Atlantic salmon reintroduction. Three strains (LaHave, Sebago, and Lac St-Jean) of Atlantic salmon have been approved for reintroduction into Lake Ontario. However, little is known about the viability of hybrids from crosses created between strains. Hybrids can exhibit hybrid vigour or hybrid breakdown resulting from the effects of new genes being introduced into a population. We collected gametes from eight females and eight males (4 of each sex from each strain) and performed a full-factorial breeding design producing 64 families consisting of non-hybrid and hybrid offspring. Survival metrics were measured to assess whether hybrid vigour or breakdown occurs. Preliminary data show that there was no difference in early survivorship in hybrids as compared to non-hybrids, providing no support for the hybrid breakdown or vigour hypotheses. *Keywords: Lake Ontario, Hybridization, Salmon, Genetic quality, Remediation, Atlantic salmon.*

PLANAS, D. and PAQUET, S., GRIL-Dep. Sc. Biologiques. UQAM, C.P. 8888 Suc Centre Ville, Montreal, QC, H3C 3P8. **Extreme Storm Events and Harmful Algae Blooms Occurrences, in a Lake with Low External Nutrient Loads.**

Potentially harmful cyanobacteria (CYAH) biomass is usually low in the epilimnion of stratified lakes with low dissolved phosphorus (0,5 - 10 µg DP/L). Although, algal deep peaks (> 100 µg Chl/l) occur in these lakes. CYAH blooms events seem to increase since the last decade. It's established that storm events frequency and severity has rise probably due to climate change: extreme rainfall and high gust wind speed may explain the frequency of blooms. Consequently, turbulent vertical instability entrains phosphorus (PHOS) from deep waters to epilimnion and simultaneously may carry along deep peak CYAH. This let surface water PHOS enrichment and burst CYAH biomass over the lake surface. Our aim is to evaluate the relationship between the occurrence, the frequency and the magnitude of the storm events and the CYAH blooms appearances, considering PHOS injections too. The study was done in a small Eastern Townships lake, (L. Bromont: 48 Ha; max depth 7,2 m) stratified from April - June to end September - end October. Photic zone extend from 7 m in early summer < 3 m at the end of summer. Extreme events around the region: storms ($\geq$ 21 days, mean=13 days); extreme rainfall (>20 mm, normal=1,3 mm); wind speed (100 - 120 km/h) *Keywords: Harmful algal blooms, Climate change, Cyanophyta.*

POSTE, A.E.[1], OZERSKY, T.O.[2], and DILLON, P.J.[1], [1]Trent University, Peterborough, ON; [2]Ontario Ministry of Natural Resources, Peterborough, ON. **Dreissenid Mussels and Round Gobies: A Pathway for the Trophic Transfer of Microcystin in the Bay of Quinte (Lake Ontario).**

Accumulation and trophic transfer of microcystin has been observed in aquatic food webs worldwide, however, many gaps remain in understanding the trophodynamics of this cyanotoxin. We sought to explore the role played by invasive filter-feeding dreissenid mussels in the food web transfer of microcystin. In parts of the Laurentian Great Lakes, dreissenids dominate the diet of the round goby, an invasive and abundant benthivorous fish. Dreissenids are also an indirect source of food to many benthic invertebrates that feed on their biodeposits, which may represent an important benthic pathway for the transfer of microcystin to invertebrates and benthivorous sportfish. We collected water and food web samples (round gobies, dreissenid mussels and their biodeposits) on five occasions in the summer and early fall of 2011. Microcystin was determined using anti-ADDA enzyme linked immunosorbent assay (ELISA) and was detectable in nearly all water and biotic samples. Microcystin concentrations ranged from 0.1-2.5 µg/L in water and 52.0-442.8, 96.4-1815.7 and 3.6-67.0 µg/g dry weight in dreissenid mussels, mussel biodeposits and round gobies respectively. These results suggest that round gobies, dreissenid mussels and round gobies represent an important pathway for the aquatic food web transfer of microcystin. *Keywords: Cyanophyta, Microcystin, Bay of Quinte, Dreissena.*

POTTER, B.L.[1], LENTERS, J.D.[1], HINKEL, K.M.[2], and SHENG, Y.[3], [1]School of Natural Resources, University of Nebraska-Lincoln, Lincoln, NE, 68583; [2]Department of Geography, University of Cincinnati, Cincinnati, OH, 45221; [3]Department of Geography, University of California-Los Angeles, Los Angeles, CA, 90095. **Sensitivity of Arctic Thaw Lakes to Climate Change: An Energy Balance Case Study of Emaiksoun Lake (Barrow, Alaska).**

Thermokarst lakes (or "thaw" lakes) are a prominent feature of the landscape on the Arctic Coastal Plain of northern Alaska. They provide an abundant freshwater resource that supports terrestrial and aquatic ecosystems, subsistence hunting and fishing, and local water supplies. Thaw lakes also interact strongly with the regional hydroclimate and help shape the landscape through thermokarst processes. Although it is well known that the Arctic is particularly vulnerable to changes in climate, the impacts of these changes on the energy and water balance of Arctic thaw lakes are poorly understood. In this study, we develop a mixed-layer energy balance model of Emaiksoun Lake (in Barrow, Alaska) using detailed observations of the summertime energy balance during a 3-year period (2008-2010). The model is then used to test the sensitivity of summer mean water temperature, evaporation, and autumn freeze-up date to imposed changes in regional climate. These changes include variations in spring ice-off date, as well as summer mean air temperature, solar radiation, wind speed, and relative humidity. Implications for anticipated future climate change are also discussed. *Keywords: Atmosphere-lake interaction, Climate change, Arctic.*

POZDNYAKOV, D.[1], SHUCHMAN, R.A.[2], LESHKEVICH, G.[3], SAYERS, M.J.[2], JOHENGEN, T.[4], and BROOKS, C.N.[2], [1]7, 14th Line, office 49;, Business Centre "Preobrazhensky" Vasilievsky Island, St. Petersburg, RUSSIA, 199034, Russia; [2]MTRI, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [3]NOAA GLERL, 4840 S. State St, Ann Arbor, MI, 48108; [4]4840 S. State Rd, Ann Arbor, MI 48108, cCooperative Institute for Limnology and Ecosystems Research (CILER) University of Michigan, Ann Arbor, MI, 48108. **Generation of an Operational Algorithm to Retrieve Chlorophyll, Dissolved Organic Carbon, and Suspended Minerals from Satellite Data of the Great lakes.**

A set of algorithms have been developed for the five Great Lake that utilizes SeaWifs, MODIS, or MERIS satellite data to estimate Chlorophyll (chl), dissolved organic carbon (doc), and suspended minerals (sm), the three primary Color Producing Agents (CPAs). The algorithms utilize a specific hydro-optical (HO) model for each lake. The HO models provide absorption functions for all three CPA components as well as backscatter relationships for the chl, and sm and were generated using near surface optical data collected with in situ water chemistry measurements. These in situ optical data are housed in a geospatial data base and will be made available via a web portal to support other Great lakes investigations. These new algorithms provided more accurate chl values then those obtained using the standard OC3 NASA MODIS retrieval when compared to the EPA and other in situ cruise observations, as well as providing the additional information on doc and sm. The suite of atmospheric correction algorithms for MODIS was also evaluated. In general the standard NASA algorithm does an adequate correction all of the time. *Keywords: Phytoplankton, Suspended Minerals, Remote sensing, Water Color, Dissolved organic matter.*

PRITCHARD, C.L., Ontario Streams, 50 Bloomington Rd W, Aurora, ON, L4G 0L8, Canada. **In-stream Atlantic salmon Eyed-Egg Incubation Techniques.**

With the help of current restoration efforts, reintroduction of Atlantic salmon to watersheds like the Humber is now possible. With efforts underway in the Credit River, Duffins Creek and Cobourg Brook, many lessons have been learned when it comes to raising and stocking hatchery fish. Unfortunately there are limitations in the number of eggs a hatchery can handle, thus restricting stocking scope. The practice of incubating Atlantic salmon eyed-eggs directly in headwater creeks, whereby viable fingerlings are produced, could be a tool in reintroduction efforts if a successful method can be proven. Through an innovative partnership between Ontario Streams, MNR and landowners, plus strong involvement of volunteers, various eyed-egg incubation methods have been tested within the Humber watershed. In 2011, promising results with a new method, Incubation Tubes, were observed. Survivourship of eggs to the fry stage of up to 67.4% was noted, with results at remaining sites ranging from 7.4% to 57.1%. Electrofishing surveys at each site were also completed and these results were compared to 2 sites where fry had been raised at a volunteer hatchery and stocked out as swim-up fry. The linear regression analysis of YOY captured against number of fry stocked indicated that the tubes produced significantly more YOY per swim-up fry stocked. *Keywords: Salmon, Fish management, Lake Ontario.*

PURIC-MLADENOVIC, D.[1] and GEE, K.[2], [1]Information Management & Spatial Analysis Unit, Southern Science & Information Section, OMNR, 4th Floor, South Tower, 300 Water St, Peterborough, ON, Peterborough, Canada; [2]Ontario Ministry of Natural Resources, Midhurst District, 2284 Nursery Road, Midhurst, ON, L0L 1X0, Canada. **A Vision for Terrestrial Vegetation Inventory and Monitoring for the Lake Simcoe Watershed.**

It is expected that land development and climate change pressures will put additional stress on already altered natural heritage and terrestrial vegetation in the Lake Simcoe (LS) watershed. As a result, there has been a growing need to preserve and improve the existing state, and ensure steady flow of ecological goods and services through integrated landscape planning, conservation and adaptive management actions. The strength and success of these activities depend, among others, on the amount, health and quality of terrestrial vegetation, and timely detection of any changes in any of these. Consistent vegetation inventory and monitoring information is necessary to establish a baseline condition, support monitoring and reporting across different scales, and satisfy the existing and future data needs. An inventory pilot project demonstrated, in the field and analytically, that the collected data can be used to meet diverse requirements of the LS Protection Plan as well as other vegetation management applications. The pilot enabled deriving and testing a set of monitoring criteria that are readily obtainable from field information and incorporating them in the LS Monitoring Strategy. This plot based inventory also enabled the vision and planning for a strategic terrestrial monitoring design across the watershed. *Keywords: Climate change, Monitoring, Standards, Vegetation, Inventory, Lake Simcoe.*

QUAZI, S., CHESNYUK, A., and DITTRICH, M., University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A4. **Geochemistry of Iron and Phosphorous In Lake Superior Sediments: Comparison of Two East Basin Sites.**

Phosphorous (P) along with Nitrogen initially limits phytoplankton production in lakes. Similarly, studies show that low iron (Fe) availability in freshwater environment may limit the phytoplankton productivity. Therefore, it is imperative to study the geochemical interaction of Fe and P in a freshwater oligotrophic lake like Superior. In this study we evaluated the partioning of Fe and P in sediment cores from two sites (EM: 230m water depth and ED: 310m water depth) in the East Basin using sequential extraction. Pore water was analyzed for O_2, pH, Fe, Mn, Ca, Si, and P. PHREEQC was used to predict the geochemical phases of Fe and P in the complex natural system. Subsequently the Fe-P chemistry in the two sites was compared. Results indicate that pore water contained more Fe and P in the EM site compared to the ED site. Similar was in the case of Fe and P extracted with sequential technique. Sequential extraction suggested the presence of an iron rich layer at a depth of 8-10 cm below the sediment-water interface for the ED site which was confirmed with the PHREEQC model. In contrast, the EM site had an iron rich layer below 12 cm. Interestingly for both the sites Vivianite [$Fe_3(PO_4)_2.8H_2O$] was observed only at the deeper depths. *Keywords: Lake Superior, Iron, Sediments, Phosphorus.*

QUINN, C.J., NORTH, R.L., and DILLON, P.J., 1600 West Bank Drive, Peterborough, ON, K9J 7B8. **Bacterial Production and Biomass in Lake Simcoe.**

In the past, Lake Simcoe experienced eutrophication, which affected the oxygen (O_2) availability to coldwater fisheries that support a \$200 million/year tourism industry. Bacteria serve an important function in aquatic environments by helping in nutrient regeneration, carbon metabolism and secondary production. This is the first study to measure bacterial production, biomass and abundance in Lake Simcoe on a year-round basis. We measured the spatial and temporal variation in the microbial community from June 2010 to July 2011 to examine its contribution to the seasonal development of hypoxia in Lake Simcoe. Using a dual-isotope method (3H-TdR and 14C-leu), the average seasonal bacterial production was 0.130+/-0.173 µgC/L/h and 0.268+/-0.304 µgC/L/h respectively. The highest production was observed in the spring and summer. The average seasonal bacterial abundance was 14.93+/-15.60 cells x10^8/L with an average biomass of 1.10+/-1.25 ugC/L. The seasonality of bacterial activity (production, abundance and biomass) in relation to environmental factors (temperature and O_2) and water quality parameters (phosphorus, DOC and chlorophyll a) were examined. Bacterial production was most strongly correlated with surface temperature and DOC. Overall, bacterial production is extremely low in Simcoe relative to other temperate large lakes. *Keywords: Biogeochemistry, Water quality, Food chains.*

RAGNARSSON-STABO, H., SANDSTRÖM, A., AXENROT, T., and BERGSTRAND, E., Stångholmsvägen 2, Drottningholm, SE-17893, Sweden. **Are Trends and Dynamics in Recruitment of Pelagic Fish Species in L. Vänern and Vättern Driven by Climate Variability?**

We analyse trends and dynamics in time-series of recruitment in smelt and vendace in Swedish L. Vänern and L. Vättern with particular emphasis on the importance of climate variability. The time-series were derived from annual hydroacoustic surveys supplemented with mid-water trawling. Both species dominate the pelagic zone in the majority of large and deep lakes in N. Europe and are of importance for the dynamics of ecosystems and as prey for commercial fish species. The variation between years with successful recruitment and years with low recruitment was considerable in both species and especially for vendace. There were no temporal synchronies between the two lakes. Ultra-oligotrophic L. Vättern was characterised by strong cyclic pulses in vendace recruitment while recruitment dynamics in meso/oligotrophic L. Vänern were more influenced by climate factors. We discuss the importance of climate forcing for the population dynamics of these important fishes as well as potential cascading effects on other trophic levels. *Keywords: Acoustics, Climates, Recruitment.*

RAMIN, M. and ARHONDITSIS, G.B., University of Toronto, Department of Physical & Environmental Sciences, Toronto, ON, M1C1A4, Canada. **The Effects of Recycling Rates on Lake Ecosystem Dynamics.**

An emerging hypothesis in limnology is that the prolonged stratification of lakes due to climate warming may increase the dependence of planktonic food webs on internal nutrient regeneration mechanisms (i.e., bacterial mineralization, zooplankton excretion). Our current conceptualization of aquatic communities, however, suggests that while the strength of the recycling feedback loop is indeed related to climate forcing, other biotic factors (e.g., zooplankton community composition) along with the system productivity may also be equally important. What do the contemporary operational models predict about the role of recycling rates in different trophic environments? How tight is the relationship between mineralization rates and lake warming? How realistically do modellers describe the mechanisms by which nutrients in non-living organic matter are recycled into inorganic forms? Our study addresses these questions using a complex biogeochemical model that simulates multiple elemental cycles, multiple functional phytoplankton and zooplankton groups. We provide evidence that warmer climatic conditions and longer stratification periods will increase the dependence of lakes on nutrient regeneration rates. The lake productivity response, however, is non-linear and non-monotonic and is modulated by the type of nutrient limitation. *Keywords: Stoichiometry, Ecosystem forecasting, Mineralization rates, Ecosystem modeling, Nutrients, Climate change.*

RANEY, S.M.[1] and EIMERS, M.C.[2], [1]Environmental & Life Sciences, Trent University, 1600 West Bank Drive, Peterborough, ON, K9J 7B8; [2]Department of Geography, Trent University, 1600 West Bank Drive, Peterborough, ON, K9J 7B8. **The Influence of Land Use Change on Stream Water Phosphorus Levels across Southern Ontario.**

Total phosphorus (TP) concentrations have declined over the past three decades in many Ontario lakes and streams. In Lake Ontario, declines in TP were most evident in the early 1980s, and have been attributed to reductions in TP levels in wastewater. Over the same time period chloride (Cl) levels have risen in many surface waters in Ontario. Increases in Cl have been primarily attributed to increased road salt applications related to urbanization. The coincidence of rising Cl with declining TP suggests that changes in land use, namely conversion of agricultural land to urban and increases in road density may have contributed to TP declines. To determine the influence of land use change on TP trends, long-term (> 8 yrs) Provincial Water Quality Monitoring Network data were examined from streams across southern Ontario, spanning the region from Orillia to Lake Ontario and from Kitchener to Belleville. Of 118 stations, 61 showed significant ($p < 0.1$) declines in TP and significant increases in Cl. Of these sites, approximately 1/3 had no upstream wastewater treatment plant, and thus coincident declines in TP and increases in Cl may be a result of suburbanization, or conversion of agricultural land to impervious surfaces. Thirty eight streams showed no change in TP, but had significant increases in Cl indicating increased traffic. *Keywords: Phosphorus, Water quality, Urbanization.*

RAOOF, B., SUMATH, E., and DITTRICH, M., University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A4. **The Effects of Nutrient and Light Availability on Phototrophic Organisms from Lake Superior.**

Although primary productivity in the water column represents major source of organic carbon in Lake Superior, few studies have attempted to measure and quantify carbon production. In the present study phototrophic organisms from sediment water interface from stations, IR (234m deep) and ED (310m deep) were isolated and studied. Using PCR-DGGE technique it was found that these organisms were composed of prokaryotes, and eukaryotes but no archae. The isolates were grown at different light intensities and nutrient levels to study their response. The phototrophic organisms found at the IR station preferred both high concentration of nutrients and high light intensity of 70 μE. Those found at the ED station preferred both low nutrients and lower light intensities of 18.3 μE. There was no growth of micro organisms under extreme low light conditions. These results indicate that different species of phototrophic organisms prefer different concentrations of nutrients because of their location in the water column. *Keywords: Photosynthesis, Phytoplankton, Lake Superior.*

RAZAVI, N.R.[1], QU, M.[1], ZHONG, Y.[2], REN, W.[2], WANG, Y.[1], and CAMPBELL, L.M.[3], [1]Department of Biology, Queen's University, Kingston, ON; [2]School of Life Sciences, Fudan University, Shanghai, China; [3]Environmental Science, Saint Mary's University, Halifax, NS. **Using Stable Isotopes to Quantify Mercury Exposure in Subtropical Reservoir Fish.**

Large reservoirs are used for fisheries worldwide, but are predisposed to high methylmercury (MeHg) production if water level fluctuations are frequent. China is the world's largest emitter of atmospheric mercury (Hg), and relies increasingly on reservoirs that undergo water level changes as a result of their use for flood control and/or hydropower, for fish production. Chinese reservoirs are understudied, especially given their potential exposure to the sources of Hg listed above. We characterized the food web of a large reservoir in Eastern China using stable isotopes of carbon (δ^{13}C) and nitrogen (δ^{15}N) to assess habitat use and trophic position, respectively, in stocked and wild fish. Data showed that 1) overall, fish have very low Hg concentrations, especially in stocked species (e.g. *Aristichthys nobilis*). Wild fish generally have double the Hg concentrations of stocked fish, and two carnivorous wild species were above the Chinese consumption guideline of 0.3 mg/kg wet weight (e.g. *Siniperca chuatsi*); 2) overall fish Hg concentrations were significantly related to trophic position (i.e. δ^{15}N) but not to organic matter pathway (i.e. δ^{13}C); 3) biomagnification of Hg, derived using the log10[Hg]-δ^{15}N slope, was about 0.1. *Keywords: Reservoirs, Stable isotopes, Mercury.*

RAZAVI, S.[1], ASADZADEH, M.[1], TOLSON, B.[1], FAY, D.M.[2], MOIN, S.[3], and BRUXER, J.K.[4], [1]Department of Civil and Environmental Engineering, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1; [2]Great Lakes - St. Lawrence Regulation Office, Environment Canada, 111 Water St., 2nd Floor, Cornwall, ON; [3]International Joint Commission, 234 Laurier Ave W. 22nd Floor, Ottawa, ON; [4]Environment Canada, 867 Lakeshore Rd., Burlington, ON. **Evaluation of New Control Structures in the Great Lakes for Better Managing Water Levels in Future.**

Managing the water levels across the Great Lakes - St. Lawrence system is critically important to a variety of stakeholders including the shipping industries and shoreline property owners. The possible future substantial increase in the frequency and persistence of extreme water levels throughout the system may justify building new control structures and further excavations along the rivers. This presentation partially summarizes a study accomplished under the International Upper Great Lakes Study (International Joint Commission) to provide an exploratory conceptual analysis of how and to what extent future extreme water levels can be mitigated by new control structures and excavations in the system. This study investigates the potential benefits and the associated costs of two new (hypothetical) control structures to regulate the outflows of the Lakes Michigan-Huron and Erie as well as excavations along the St. Clair and Niagara Rivers. A multi-scenario, multi-reservoir, bi-objective optimization formulation was proposed and solved to develop regulation plans (i.e., parametric rule curves) for the system enabled with the new control structures. Results demonstrated that the system-wide regulation with the new control structures could substantially reduce the risk and magnitude of extreme lake levels but at large costs. *Keywords: Computer models, Optimization, Lake management, Regulation plan, Climate change.*

REAVIE, E.D.[1] and JUGGINS, S.[2], [1]Natural Resources Research Institute, University of Minnesota Duluth, Ely, MN, 55731; [2]School of Geography, Politics and Sociology, Newcastle University, Newcastle upon Tyne, NE1 7RU, United Kingdom. **Calibrating Diatom-based Indicators for the Great Lakes: How Many Samples are Enough?**

Diatom-based transfer functions have become popular indicators of aquatic condition. Two large, diatom-based training sets from the Great Lakes were investigated to determine optimal sample sizes for inference models: (1) coastlines, (2) pelagic phytoplankton. Weighted average models to infer phosphorus were developed. Training set sample sizes ranging from 10 to the maximum were created through random selection, and performance of each model was evaluated. For each iteration, diatom-inferred nutrient data were related to stressor data (e.g., adjacent agricultural activity) to characterize model ability to track human activities. At least 40-80 samples were needed to capture environmental conditions to such a degree that non-analogue situations should be rare, and so should provide an unambiguous result if the diatom model was applied to any sample assemblage. One should exercise caution when dealing with smaller training sets unless there is certainty that the selected samples reflect the regional variability in diatom assemblages and environmental conditions. We also advise that our minimum required sample size may not necessarily extend to other regions and environmental variables. We encourage training set users to employ a similar evaluation to determine whether they have effectively sampled their region of interest. *Keywords: Indicators, Sample size, Diatoms, Monitoring.*

REDDER, T.M., DEPINTO, J.V., and MCCULLOCH, R.D., 501 Avis Drive, Ann Arbor, MI, 48108. **Development of Integrated Tools for Assessing Current and Future Sedimentation in Great Lakes River Mouth Systems.**

Sediment management is a significant challenge in many Great Lakes harbors, where frequent dredging maintenance of navigational systems is often required. Toledo Harbor, which provides navigational access from Lake Erie through the lower 10 miles of the Maumee River, provides a good example of these challenges. The navigation channel in Toledo Harbor is subject to significant rates of sedimentation resulting from the combined effects of suspended sediment loading from the Maumee River and wind-wave resuspension and redistribution of bed sediments in Maumee Bay. A significant need for this and similar river mouth systems is the development of quantitative tools to assess current and future projected watershed sediment loadings and resulting sedimentation patterns. One of the measures of progress included in the GLRI Action Plan is a 2.5% reduction in sediment deposition in Toledo Harbor by 2014. Evaluating potential reductions in sedimentation rates for such a complex system requires the integration of all pertinent sediment data into predictive modeling tools. Such an integrated assessment is currently being conducted on behalf of the USACE for Toledo Harbor, with the expectation that it can serve as a template for addressing similar sediment issues in other Great Lakes river mouth systems. *Keywords: Sediment transport, Watersheds, Sediment load.*

REDDER, T.M., <u>FLYNN, A.M.</u>, DEPINTO, J.V., and SELVENDIRAN, P., 501 Avis Drive, Ann Arbor, MI, 48108. **Representing Ephemeral Gully Erosion in SWAT: Implications for Modeling Agricultural Management Practices in the Maumee River Watershed.**

The Soil & Water Assessment Tool (SWAT) model has gained widespread use in the Great Lakes for simulating the delivery of water, sediment, and nutrients from agriculturally-dominated landscapes. Several current SWAT applications are currently under development for the Maumee River basin and are being designed to project current and future watershed conditions and their impact on pollutant loadings to the Western Lake Erie Basin. One disadvantage of the existing version of SWAT is that it lacks an option to explicitly simulate the process of ephemeral gully (EG) erosion. Previous studies in the Maumee have suggested that EG erosion is likely more important than sheet and rill erosion in removing sediment and nutrients from agricultural fields in certain regions within the basin. This has important implications for developing realistic projections of sediment and nutrient reductions that are likely to occur as a result of watershed management practices. To address this limitation, the SWAT source code was enhanced to include the "tillage-induced ephemeral gully erosion model" (TIEGEM) model that was originally developed for use with the AnnAGNPS model. The incorporation of this EG erosion model is expected to provide a more flexible and accurate tool for evaluating watershed management alternatives in the Maumee basin. *Keywords: Watersheds, Nutrients, Model studies.*

<u>REDPATH, T.D.</u>, City of Ottawa, 655 Shefford Road - 2nd Floor, Ottawa, ON, K1J 8G8. **The City of Ottawa's Water Quality Monitoring Initiatives for the Ottawa River.**

As the largest municipality located along the Ottawa River, the City of Ottawa has an impact on the river's water quality. The main sources of material discharged to the Ottawa River include: stormwater runoff, combined sewer overflows during wet weather events, and treated effluent from the Robert O. Pickard Environmental Centre (Pickard Centre). In 2010, City council adopted the Ottawa River Action Plan (ORAP), whose key objectives are: i) to maintain a healthy aquatic ecosystem, with a focus on addressing challenges presented by existing development and infrastructure; and ii) to optimize recreational use and economic development of the Ottawa River, with a focus on reducing beach closures. This presentation will summarize the key monitoring initiatives that are being carried out by the City's Water Environment Protection Program in support of the ORAP, including: baseline water quality monitoring, beach monitoring for bacteria, environmental effects monitoring of the Pickard Centre, wet weather monitoring in streams, and water quality modelling of the Ottawa River. An overview of the sites that are part of the City's monitoring programs, some preliminary trends in terms of water quality data, and the use of the water quality model in decision making will be discussed. *Keywords: Water quality, Monitoring, Urban watersheds.*

REID, K.[1], JIAO, Y.[2], TSIPLOVA, K.[1], NUDDS, T.[1], and DESSON, E.[3], [1]Department of Integrative Biology, University of Guelph, Guelph, ON; [2]Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA; [3]Anishinabek/Ontario Fisheries Resource Centre, North Bay, ON. **Stock Assessment and Management in Data-poor Commercial Fisheries: Lake Nipigon Lake Whitefish.**

Time series of CUE data, catch at age, growth-, and mortality-related information for Lake Nipigon lake whitefish stocks are absent or incomplete. We developed and implemented of a series of alternative hierarchical and uniform Bayesian surplus production models suitable for this data-poor fishery. These models were used to estimate biological reference points, i.e., FMSY and BMSY and their uncertainty. We estimated the historic and current fishery status of the Lake Nipigon lake whitefish and showed that both the reference point estimates and stock status were highly uncertain. The results are highly sensitive to the priors and the catch and CUE time series used for parameter estimation. DIC was used to rank the models. According to the best model, the probability of overfishing in 2010, i.e., $P(F_{2010} > F_{MSY})$, was very low at 0.005, while the probability that the population was overfished in 2010, i.e., $P(B_{2010} < B_{MSY})$ is 0.544 due to high uncertainty about both B_{2010} and B_{MSY}. The estimated catch at $F_{MSY} = 624,000kg$ is well above 2010 harvest levels of 154,000kg. We discuss implications for harvest policy and several options to reduce stock status uncertainty to more acceptable levels. *Keywords: Risk assessment, Assessments, Fish populations.*

REID, M.K., WOZENCRAFT, J.M., DUNKIN, L.M., SYLVESTER, C.S., and MACON, C.L., 7225 Stennis Airport Rd, Ste 100, Kiln, MS, 39556, USA. **U.S. Army Corps of Engineers Airborne Coastal Mapping in the Great Lakes.**

The Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) is a collaboration of the US Army Corps of Engineers (USACE), US Naval Oceanographic Office, and the National Oceanic and Atmospheric Administration. The JALBTCX executes the USACE National Coastal Mapping Program (NCMP) by providing high-resolution bathymetric and topographic light detection and ranging (lidar) elevation data, as well as hyperspectral and true-color aerial imagery along a 1-mile swath of the coastal U.S. on a recurring basis. Using its survey capabilities, airborne survey data are used to develop a suite of Geographic Information Systems (GIS) mapping products, including seamless bathymetric/topographic digital elevation models (DEMs), shoreline vectors, land cover classification, seafloor reflectance, and image mosaics. The JALBTCX collected its first airborne coastal mapping data in the Great Lakes in 1994 with more recent surveys occurring 2006 -present. Alongside these survey efforts is the continued development of information products, focusing on quantification of coastal change, extraction of parameters to better understand coastal infrastructure and vulnerability, and development of data fusion techniques for environmental and physical characterization (e.g. seafloor, land cover, and water column characteristics).

RICHARDS, R.P.[1], BAKER, D.B.[1], DEPINTO, J.V.[2], VERHAMME, E.M.[2], and BRIDGEMAN, T.B.[3], [1]National Center for Water Quality Research Heidelberg College 310 E. Market Street, Heidelberg University, 310 E. Market Street, Tiffin, OH, 44883; [2]LimnoTech,

501 Avis Drive #1, Ann Arbor, MI, 48108; [3]Dept. Environmental Sciences, Lake Erie Center, 6200 Bayshore Road, Oregon, OH, 43618. **Maumee River Hydrology and Nutrient Loading in Relation to a Major Cyanobacteria Bloom in the Western Basin of Lake Erie, 2011.**

During the late summer of 2011, the Western Basin of Lake Erie experienced by far the largest documented cyanobacteria bloom at least since the mid 1980s; this bloom eventually extended well into the Central Basin as well. We hypothesize that an important cause of this bloom was the recent history of discharge and nutrient loading that preceded the bloom. The previous fall (2010) was a time of low flow in the Maumee, with little nutrient delivery to the Western Basin. Good weather allowed early harvest of crops and fertilization of fields. Several storm runoff events in February delivered substantial quantities of water, sediment, and nutrients to the Western Basin. A short window of dry weather led to more fertilizer application in March. Immediately thereafter, stormy weather returned, with a sequence of three major storm events. By the end of May, more phosphorus had been delivered to Lake Erie from the Maumee than is delivered in most entire years. The summer that followed was free of major runoff, allowing the nutrient-rich water mass to remain in the Western Basin until temperature conditions favored the development of the bloom. This sequence of events represents a plausible scenario for the typical condition in a future Lake Erie climate. *Keywords: Cyanophyta, Tributary loading, Nutrients, Lake Erie.*

RICHARDSON, V. and DOVE, A., Environment Canada, Water Quality Monitoring and Surveillance, Burlington, ON. **Keeping up with the Times - Year-Round Nutrient Loading Measurements in Canadian Lake Erie Tributaries.**

In order to update estimates of nutrient loads from tributaries to the Great Lakes, Environment Canada has initiated a new monitoring program in selected Lake Erie tributaries. Year-round monitoring of nutrient concentrations (including SRP) is being conducted in approximately 9 tributaries, with plans to instrument some of these locations with automated samplers. This program is one component of a new initiative aimed at better understanding the environmental impacts of tributaries to the Lake Erie nearshore and to develop targets that will be reduce the impacts of nuisance algae in those areas. *Keywords: Loading, Water quality, Lake Erie.*

RICHARDSON, W.B., LARSON, J.H., VALLAZZA, J.M., VELDBOOM, J.A., BARTSCH, L.A., and NELSON, J.C., US Geological Survey Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Rd, La Crosse, WI, 54603, United States. **Variation in Fatty Acid Content of Seston from Tributaries, Rivermouths and Nearshore Lake Michigan.**

Variation in land-use often controls quality and quantity of material transported by rivers to lakes. This transported material likely plays an important role in supporting productivity of near-shore zones of Lake Michigan. Fatty acid (FA) content of transported material indicates potential food quality for consumers and support of lake foodwebs. We explored the variation in seston FA quality and quantity by sampling river, river mouths, and nearshore zones of 11 Lake Michigan tributaries in September, 2010. Seston (1 - 35 µm dia.) FAs were in greatest

concentration by volume ($\mu g \cdot L^{-1}$) in rivers, but greatest per mass ($\mu g \cdot mg^{-1}$) in Lake Michigan, suggesting river water carried large quantities of low-quality particles, while relatively sparse lake seston was rich in FAs. Seston total FA content ($\mu g \cdot L^{-1}$) was inversely correlated with percent watershed forest and positively correlated with percent agricultural landuse. Seston ($\mu g \cdot L^{-1}$) omega-3 FAs in rivermouths was strongly correlated with percent agricultural landuse. Agricultural landuse appears to contribute large amounts of low quality seston to rivermouths. Lake seston contained lipid-rich, but sparse, particles. Rivermouth food webs likely benefit from a mixing of these two sources of seston. *Keywords: Estuaries, River mouth, Lake Michigan, Food chains.*

RICKETTS, R.D., University of Minnesota Duluth, Large Lakes Observatory, Duluth, MN, 55812. **The R/V Blue Heron: the University of Minnesota's Laboratory on the Great Lakes.**

The University of Minnesota's research vessel, the Blue Heron, is operated by the Large Lakes Observatory out of Duluth, Minnesota. The 87' former fishing trawler has been converted into a limnological research vessel and outfitted with state of the art scientific gear. The Blue Heron has berthing for 11 crew and scientists and operates 24 hours per day with potentially several weeks between port calls. The vessel is part of the University National Oceanographic Laboratory System (UNOLS) and as a member is held to extremely rigorous safety and scientific standards. The ship has a full suite of sediment sampling gear (grab sampler, multi-corer, gravity corer and piston corers), acoustic gear for lake-floor mapping (multibeam, sidescan/CHIRP, Geopulse and air-guns), equipment for water-column characterization (underway sampling system, CTD/Carousel, fluoroprobe, in-situ nitrate analyzer, towed Triaxus system) and biological sampling gear (plankton nets and 60' mid-water trawling gear). The ship's two laboratories allow for underway analyses while the large working deck allows for recovery, servicing and redeploying of meteorological buoys and sub-surface scientific moorings. The vessel can accommodate biologists, chemists, geologists and physicists and is available for charter by research scientists on any of the Great Lakes. *Keywords: Bottom sampling, Acoustics, Buoys.*

RIDAL, J.J.[1], NORRIS, K.[2], HODSON, P.V.[2], CAMPBELL, L.M.[3], LEAN, D.R.S.[4], and TWISS, M.R.[5], [1]St. Lawrence River Institute of Environmental Sciences, 2 St. Lawrence Drive, Cornwall, ON, K6H 4Z1; [2]Department of Biology, Queen's University, Kingston, ON; [3]Environmental Science. Saint Mary's University, Halifax, NS; [4]Lean Environmental, Apseley, ON; [5]Department of Biology, Clarkson University, Potsdam, NY. **Fish Mercury Contamination in Lake St. Francis, St. Lawrence River (Ontario and Quebec) Canada: Trends, Patterns and the Source Conundrum.**

Concentrations of mercury (Hg) in sports fish in Lake St. Francis, a fluvial lake within the St. Lawrence River system downstream of Massena, N.Y. and Cornwall, ON, remain elevated compared with upstream fish despite cessation of most local industrial sources. Total (THg) and methyl mercury (MeHg) concentrations were determined for porewater, sediments, amphipods and small yellow perch from 27 sites in Lake St. Francis. Hg concentrations in

amphipods and perch were not related to any sediment parameter suggesting that'legacy' contamination of sediments does not drive mercury contamination of fish. Greatest fish mercury concentrations were found near north shore tributaries. To characterize tributary inputs, chromophoric dissolved organic matter (CDOM), specific conductivity, THg and MeHg water concentrations measured at tributary mouths. Hg concentrations were 2-20 times greater than is typical of the St. Lawrence River (ca 500 pg L^{-1} THg and 50 pg L^{-1} MeHg) and were significantly correlated to CDOM concentrations. Highest water THg and MeHg concentrations were found in the south shore tributaries in contract to fish concentrations which were lowest along the south shore and higher on the north shore, suggesting differences in mercury bioavailability between north and shore tributary inflows. *Keywords: Sediments, Bioaccumulation, Mercury.*

RIDGWAY, M.S. and MIDDEL, T.A., Harkness Laboratory of Fisheries Research, Aquatic Research Section, Ontario Ministry of Natural Resources, Trent University, Peterborough, ON, K9J 7B8. **Distribution of Double-Crested Cormorants Before, During and After a Regime Shift in the Coastal Food Web of Lake Huron.**

Regime shifts in marine food webs produce dramatic changes in distribution and populations of colonial waterbirds. No example of this phenomenon has been detected to date in large freshwater lakes in part because of the spatial stability of secondary production in lakes. Regime shifts have been exclusively associated therefore with marine ecosystems. Here we describe a shift in the distribution of double-crested cormorants detected on the water in the coastal zone of Lake Huron before, during and after a regime shift in 2003. Annual multiple aerial surveys over a 5 year period were used to model habitat occupancy as a function of region and depth. The regime shift on Lake Huron resulted in cormorants foraging in shallower waters across the entire coast and a sharp reduction in the importance of the North Channel during the regime shift. After the regime shift cormorants foraged closer to shore generally with a return of the North Channel in relative importance. The overall change in distribution stems from the loss of alewife and the adoption of new food resources and foraging locations. This study demonstrates the importance of research on waterbird ecology at relevant scales in the Laurentian Great Lakes - the scales at which Chip Weseloh conducted his research and monitoring over his career. *Keywords: Cormorants, Distribution patterns, Monitoring.*

RIEDEL, M.S.[1], STONE, A.G.[1], and SELEGEAN, J.P.[2], [1]W.F. Baird and Associates, 2981 Yarmouth Greenway Dr, Madison, WI, 53711; [2]U.S. Army Corps of Engineers, 477 Michigan Avenue, Detroit, MI, 48226. **Impacts of Beaver Dam Management Scenarios on Stability and Connectivity of a Lake Superior Tributary for Fish Migration.**

The Knife River, a tributary to Lake Superior near Two Harbors, MN, supports a vibrant brook trout, brown trout, and naturalized steelhead fishery. However this is fragmented by numerous beaver dams spread throughout the river and its branches. While the beaver dams can create a step-pool profile in the river that isolates fishes, the attenuation of flows traps sediments, can reduce stream power and bank erosion, and creates critical wetland habitat. We modeled the hydraulic impacts of the current density of beaver dams on the Knife River, along with two

potential management scenarios examining pre-settlement beaver densities and no beaver dams, to determine the influences of beaver populations on riverine conditions. Under typical daily flows, the beaver dams create a step-pool system in the water levels and increase water surface levels upstream of the dam. Under a large summer storm event, water level impacts were observed both upstream and downstream of the dams. Under the high density simulation for current conditions, the beaver dams resulted in a cascading failure and subsequent flood wave downstream. These results illustrate the impact that beaver dam management can have on stability and connectivity of cold-water riverine habitat for migratory fishes in Great Lakes tributaries. *Keywords: Model studies, Tributaries, Fisheries.*

RINCHARD, J.[1], YEO, L.[1], and CZESNY, S.J.[2], [1]The College at Brockport - State University of New York, 350 New Campus Drive, Brockport, NY, 14420, US; [2]Illinois Natural History Survey - University of Illinois, 400 17th Street, Zion, IL, 60099, US. **Tissue Specific Fatty Acid Response to Dietary Shift in Lake Trout *Salvelinus namaycush*.**

Fatty acid signature (FAS) analysis is a useful tool in food web studies because it can provide insights into the long term feeding habits of predators based on the degree of similarity between their FAS and that of their prey. Lake Michigan lake trout *Salvelinus namaycush* has been feeding predominantly on alewives but recently round gobies became alternative prey as their population expands. To validate field observations and to illustrate the degree of variability in FAS one can expect in a freshwater system we evaluated fatty acid transfer from prey to predator. Lake trout juveniles were fed for a year a diet comprised of exclusively alewife or round goby. Then, to simulate a diet shift, treatments were switched and experiment continued for another 6 months. We compared FAS in lake trout tissues (whole body, liver, muscle, adipose fat, brain, and eye) after a year, and throughout the diet shift to illustrate the physiological response to the changes in dietary FAs. These results will provide insights into how fatty acid signatures can provide time-integrated and energy based depictions of food web structure and when compared with field data can serve as a template for qualitative and quantitative diet studies. *Keywords: Fish, Bioindicators.*

RISENG, C.M.[1], MASON, L.[1], RUTHERFORD, E.S.[2], and WANG, L.[3], [1]University of Michigan, School of Natural Resources and Environment, 440 Church St, Ann Arbor, MI, 48109-10041; [2]NOAA Great Lakes Environmental Research Laboratory, 4840 S. State Rd, Ann Arbor, MI, 48108-9719; [3]International Joint Commission, Great Lakes Regional Office, 100 Ouellette Avanue, 8th Floor, Windsor, ON, N9A 6T3. **The Great Lakes Aquatic Habitat Framework (GLAHF).**

The Great Lakes Aquatic Habitat Framework (GLAHF) is an aquatic habitat database and spatial framework in the development stage that focuses on the coastal and nearshore systems of the U.S. and Canada. It expands upon the Great Lakes GIS project (NOAA/GLERL) by creating a finer spatial grid extending from watersheds to the open waters of the Great Lakes. The habitat framework will facilitate the integration of key habitat components for hierarchical aquatic habitat classification and will enable prediction of land use impacts and climate change impacts on Great Lakes coastal habitats. GLAHF is based on a nested spatial framework covering open

water (1.8 km2 cell) and coastal (30m2cell) zones and a relational georeferenced habitat database. GLAHF incorporates existing and modeled aquatic habitat data such as topobathymetry, substrate, and distance from nearest river. We present key habitat variables that have been developed including high resolution circulation and fetch patterns that incorporate velocity and direction, seasonal vertical water temperature distribution, spring surface water temperatures, and estimates of chlorophyll a. We will use these variables to identify spatio-temporal variation in productive zones and demonstrate the utility of GLAHF for managers, researchers, and resource agencies. *Keywords: Great Lakes basin, Habitats, GIS.*

RITZENTHALER, A.A.[1], ALAMEDDINE, I.[1], CAMPBELL, K.B.[2], and GRONEWOLD, A.D.[2], [1]University of Michigan School of Natural Resources and Environment, 440 Church Street, Ann Arbor, MI, 48109; [2]NOAA Great Lakes Environmental Research Laboratory, 4840 South State Road, Ann Arbor, MI, 48108. **Developing Bacterial Watershed Fate and Transport Models in "Data-Limited" Tributaries.**

Many tributaries impacting recreational water quality of the Great Lakes are not monitored at a spatial or temporal scale suitable to support robust calibration of pollutant fate and transport models or model-based forecasting. In order to help close this gap in regional water quality research, we explore benefits of regionalizing parameters from a simple fate and transport model calibrated to data from Jumping Run Creek (a small coastal tributary in eastern North Carolina) to Great Lakes tributaries. Jumping Run Creek, unlike most tributaries monitored for bacterial water quality, has a relatively long (roughly 5 years) uninterrupted record of bacterial concentration and flow measurements which serve as a potential basis for appropriately quantifying uncertainty in conventional pollutant fate and transport models. We assess model parameter values within a Bayesian statistical framework, an approach which explicitly acknowledges both parameter uncertainty and correlation, propagating both into uncertainty in model-based loading simulations and forecasts. We then demonstrate how these parameter values can be used as "prior" information when applied to Great Lakes tributaries in order to better identify locations of concern and forecast events which lead to poor water quality and subsequently threaten human health. *Keywords: Model studies, Bacterial fate and transport, Tributaries.*

ROBINSON, C.J., Ontario Federation of Anglers and Hunters, 4601 Guthrie Drive, Peterborough, ON, K9J 8L5. **Benefits and Challenges of Partnerships in Native Species Restoration Programs - Ontario's Lake Ontario Atlantic salmon Example.**

As social and legal impetus for native species restoration grows and stresses agency resources, private-public partnerships with a potential diversity of governments, stakeholders, and corporations may increasingly be considered as solutions. Since 2005, the Ontario Federation of Anglers and Hunters has been a lead partner in a large example of such a partnership - the Lake Ontario Atlantic Salmon Restoration Program. In that time the Lake Ontario Atlantic Salmon Restoration Program has grown to over 40 organizations, including three levels of government (federal, provincial, municipal), stakeholder groups, corporate sponsors, foundations, landowners, schools and individuals. The program has experienced both

the benefits and challenges an ever-evolving broad range of partners can bring. The benefits have been synergies between organizations, and innovations in fundraising, communications and project delivery. Challenges in program coordination have required patience and accommodation to achieve the long-term success that benefits all partners. A key lesson learned is the need to understand the unique perspectives of all partners, in particular corporate sponsors, which will maximize the opportunities for benefits and prepare for the challenges of future partnerships in native species restoration and conservation efforts. *Keywords: Conservation, Partnerships, Non-governmental organizations.*

ROBINSON, J.[1], NEFF, M.R.[1], and BHAVSAR, S.P.[2], [1]Department of EEB, University of Toronto, 25 Willcocks Street, Toronto, ON, M5S 3B2; [2]Ontario Ministry of the Environment, Environmental Monitoring and Reporting Branch, 125 Resources Rd., Toronto, ON, M9P 3V6. **Long-Term Assessment of Mercury in Sport Fish from the St. Lawrence River, Canada.**

The St. Lawrence River system in the Cornwall, ON region is currently listed as an Area of Concern (AOC) due to high contaminant levels, including mercury (Hg). Trends in sport fish Hg concentrations can indicate changes in the environmental levels of mercury and the effectiveness management strategies. The aim of this study was to examine long-term temporal trends in Northern Pike, Smallmouth Bass, Walleye and Yellow Perch Hg concentrations from the St. Lawrence River AOC compared to surrounding areas in the river. It was found that Hg concentrations in Yellow Perch declined significantly in all sampled blocks, including the AOC, while Hg levels in other species did not show significant declining trends. Differences in Hg concentrations amongst river blocks varied depending on the study species. In general, AOC Hg concentrations were significantly higher compared to the other sampling areas. The data suggests that recovery is still ongoing in this AOC and that appropriate care should still be applied when consuming fish from this section of the St. Lawrence River. *Keywords: Assessments, St. Lawrence River, Mercury.*

ROCHE, J.M. and LEE, D.R., Environmental Technologies Branch, Chalk River Laboratories, Atomic Energy of Canada Limited, Chalk River. **Discharge of a Groundwater Plume to a Major River.**

To address the gap between the hydrogeology of groundwater-contaminant plumes and the ecology of receiving water bodies, we determined the groundwater flux of Sr-90 to an embayment of the Ottawa River at Atomic Energy of Canada Limited's Chalk River Laboratories. The flow path of the plume was understood from plume monitoring activities. However, the specific discharge zone had not been mapped. The complicated hydrogeological setting (K ranges over several orders of magnitude) required identification of the discharge area using riverbed radiation detectors, analysis of shoreline phreatophytes and sampling water under the ice sheet. Once the discharge zone was outlined, we measured vertical gradient, K_h and pore-water chemical and isotopic parameters using mini-piezometers. Direct measurements of seepage flux in the littoral area revealed rates of groundwater discharge up to 33 L/m^2 per day. Sediment pore waters contained gross beta values (a surrogate for Sr-90) as high as 590 Bq/L. The gross

beta measurements in tree swallow nestlings were at least 100 times background, indicating the value of this parameter as a tracer at this site. Our preliminary conclusion is that the source of excess beta in the swallows was Sr-90 borne by groundwater into the invertebrate community, but this requires confirmation. *Keywords: Tracers, Groundwater, Hydrogeology.*

ROCKWELL, D.C.[1], CAMPBELL, K.B.[1], SCHWAB, D.J.[2], MANN, G.E.[3], WAGENMAKER, R.[3], JOSHI, S.J.[4], LANG, G.A.[2], and GRONEWOLD, A.D.[2], [1]CILER University of Michigan,, 440 Church Street, Ann Arbor, MI, 48109; [2]NOAA/GLERL, 4840 South State Street, Ann Arbor, MI, 48108; [3]NOAA/NWS Detroit Pontiac Forecast Office, 9200 White Lake Rd., Whitelake, MI, 48386; [4]Michigan StateMichigan Sea Grant Outreach Coordinator, 4840 South State Street, Ann Arbor, MI, 48108. **Beach Water Quality Management Decision Support Systems for Forecasting Probability of Exceeding *E. coli* Levels.**

NOAA's Center of Excellence Great Lakes and Human Health is developing and NWS is testing forecast decision support systems (DSS) at five beaches. Forecast DSS have been evaluated at 24 beaches. Daily 120 hour forecasts of the probability of exceeding State regulatory criteria are an important step in managing recreational water quality to optimize beach recreational use and protect human health. USEPA's Virtual Beach is used to develop the Forecast DSS. Independent variables are available from the National Digital Forecast Database and the Great Lakes Coastal Forecast System. Examples are cumulative rainfall, wind direction and speed, lake currents, surface water and air temperature, cloud cover, dew point, bacterial watershed concentrations in discharge and run off, and time of sampling. Forecast DSS provide better estimates of public health risk than use of the previous day's E. coli method. This is especially true in predicting conditions for swimming with an average of 3 fewer errors per beach. Examples of 2012 forecast DSS will be presented. Comparison of current beach management tools with the Forecast DSS will be discussed. There were over 225 beaches monitored 2 or more times per week in 2010. Forecast DSS suggest Great Lake beach management tools in 2010 prevented swimming more than 600 days, an error rate > 15%. *Keywords: Beach Water Quality, Management, E. coli, Decision making, Human health, Forecasting.*

RODGERS, D.W., Aberfoyle AquaScience, 4 Maple Leaf Lane, RR3, Guelph, ON, N1H 6H9. **The Ottawa River Project and the Development of Bioenergetics Based Modelling of Pollutant Accumulation in Aquatic Biota.**

The Ottawa River Project was a joint collaborative project between the University of Ottawa and the National Research Council of Canada from 1972 - 77. Its objective was to use a series of linked compartmental models to describe the movement and transfer of pollutants, especially mercury, methylmercury and persistent organic contaminants through the physical and biological components of a three mile section of the Ottawa River. Among the most significant products of the project was the development of a bioenergetics-based model of pollutant accumulation by fish (Norstrom et al. 1976), which coupled pollutant biokinectics to fish bioenergetics. Specifically the uptake of pollutant from both food and water was directly related to metabolic rate, while pollutant clearance was expressed as a function of body weight.

Subsequent studies have confirmed the validity of these models, which have been applied to a wide variety of contaminants including metals, organic compounds and radionuclides. Conversely, contaminant accumulation may also provide insight into the Great Lakes fish ecology and community dynamics. *Keywords: Methylmercury, Bioaccumulation, Bioenergetics.*

ROSBOROUGH, D.R., DURANT, G.M., and SAGER, J.C., Ontario Ministry of Natural Resources, Fish Culture Section, 300 Water St, Peterborough, ON, K9J 8M5, Canada. **Ontario Ministry of Natural Resources - Fish Culture in Support of the Lake Ontario Atlantic Salmon Restoration Program.**

In 2006, the Ontario Ministry of Natural Resources (OMNR), building on earlier experimental work, began Phase 1 of the Lake Ontario Atlantic salmon Restoration Program, in partnership with the Ontario Federation of Anglers and Hunters. The stocking component required the acquisition and development of three captive brood stocks from LaHave R. (NS), Sebago L. (ME) and Lac Saint-Jean (QC). Progeny from these brood stocks are stocked into selected tributaries of Lake Ontario at three life stages: feeding fry, fall fingerlings and spring yearlings. At age three, a PIT tag is surgically implanted in each brood fish and a tissue sample is taken for DNA analysis. At spawning, PIT tags are read to document the parents of each family. Eggs from specific families are assigned to experimental groups (representing the life stage stocked) which enables us to track the offspring of each mated pair in the wild, using genetic tools. As well as being a critical foundation for assessment, PIT tagging increases knowledge about the biology of different strains of Atlantic salmon in a hatchery environment. This program expansion required the redevelopment of facilities at OMNR's Normandale and Harwood Fish Culture Stations, including state-of-the-art systems. Challenges exist and lessons have been learned in the large-scale rearing of Atlantics. *Keywords: Fish hatcheries, Atlantic salmon, Lake Ontario, Restoration, Ontario Ministry of Natural Resources.*

ROSMAN, L.[1], SECORD, A.[2], TARBELL, B.[3], and BROOKS, S.[4], [1]NOAA/ORR/ARD, 290 Broadway, 20th Fl, New York, NY, 10007; [2]U.S. Fish and Wildlife Service, 3817 Luker Road, Cortland, NY, 13045; [3]St. Regis Mohawk Tribe, Environment, 412 State Route 37, Akwesanse, NY, 13655; [4]New York State Department of Environmental Conservation, 625 Broadway, Albany, NY, 12233. **The St. Lawrence Natural Resource Damage Assessment Process and Potential Restoration Opportunities for the St. Lawrence River Ecosystem.**

The St. Lawrence ecosystem supports a diversity of habitats, fish, and wildlife, but contaminants and other anthropogenic factors have degraded its environmental quality. Industrial facilities in Massena, New York released hazardous substances such as PCBs, PAHs and metals into the St. Lawrence River system. Federal, state and tribal governments acting as stewards for natural resources worked cooperatively with the potentially responsible parties to conduct a natural resource damage assessment to evaluate environmental harm under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The goal of the assessment is to identify what constitutes appropriate restoration to compensate the public for injury to ecological, recreational, and cultural services. Upon resolution of this matter the Trustees intention is to improve the environment of the St. Lawrence River watershed by

implementing sustainable restoration projects closely connected to resources impacted by the environmental contamination. *Keywords: PCBs, Natural resource damages, St. Lawrence River, Restoration, Sediments.*

ROWAN, D.J., Atomic Energy of Canada Ltd., Chalk River Laboratories, Chalk River, ON, K0J 1J0, Canada. **A Dynamic Approach to Modelling Stable Carbon and Nitrogen Isotopes in Aquatic Foodwebs.**

Stable carbon and nitrogen isotopes are commonly used to quantify trophic linkages and relationships in aquatic foodwebs. However, seasonal variation observed in lower trophic levels and in many systems limits the broad applicability of stable isotope techniques. Dynamic approaches that can handle the complexity of seasonal variation in stable isotope signatures would increase the generality of the technique and would lessen the need to force these dynamic data into steady state solutions. In this paper, I present stable isotope data from the Ottawa River and a dynamic solution to seasonal variation in stable carbon and nitrogen isotope signatures. The Ottawa River receives hypolimnetic water from upstream reservoirs, and zooplankton exhibit extreme variation in both stable carbon and nitrogen isotopes. Through a mass balance approach that incorporates field derived estimates of carbon and nitrogen turnover, I describe the seasonal pattern in the pelagic, zooplankton-smelt-walleye food web of the Ottawa River. This mass balance approach is readily applicable to any system and provides a dynamic solution to stable carbon and nitrogen isotope variability at lower trophic levels and its transfer to higher trophic levels. *Keywords: Stable isotopes, Food chains, Mathematical models.*

ROWE, M.D., PAUER, J.J., DEPETRO, P.A., and KREIS, R.G., US EPA Large Lakes Research Station, 9311 Groh Rd., Grosse Ile, MI, 48138. **Modeling the Sensitivity of Primary Production in Lake Michigan to Nutrient Loads with and without Dreissenid Mussels.**

Dreissenid (quagga) mussels became established in large numbers in Lake Michigan beginning around 2004. Since then, significant changes have been observed in Lake Michigan open-water chlorophyll and nutrient concentrations, and in primary production. We updated the LM3-Eutro model to investigate the response of chlorophyll concentrations and primary production in Lake Michigan to nutrient loading scenarios with and without representation of dreissenid mussel filter feeding. LM3-Eutro is a high resolution (5-km horizontal, 19 sigma-layers) nutrient, phytoplankton, zooplankton, and detritus model. We made several improvements to the model: 1) updated daily N and P loads for 1994-2008, 2) an interactive sediment compartment for nutrients, 3) updated photosynthesis-irradiance curves, and 4) representation of dreissenid mussel filter-feeding effects. Mussel biomass and temperature-dependent filtration rate were specified, based on literature values. The model was calibrated and verified over the period 1994-2008 using available data. Model runs illustrate the sensitivity of chlorophyll and primary production to changes in nutrient loads with and without dreissenid mussels. This abstract does not necessarily represent the official position of US EPA. *Keywords: Model studies, Nutrients, Dreissena.*

ROWE, M.T. and ZANATTA, D.T., Central Michigan University, Institute for Great Lakes Research, Mount Pleasant, MI, 48859. **Genetic Structure of the Fatmucket Mussel (*Lampsilis siliquoidea*) in the St. Clair River Delta and Tributaries: Effects of the *Dreissena* Invasion?**

The St. Clair River Delta is a refuge habitat for native unionid mussels and has retained unionid populations while they have largely disappeared from open waters of Lake St. Clair. Nine variable microsatellite markers were used to assess the genetic population structure of the Fatmucket Mussel (*Lampsilis siliquoidea*) across 18 sites (n=342 individuals) within the delta and several of its tributaries. We were particularly interested to determine how *Dreissena*-induced unionid declines may have impacted genetic structure. Results indicate that Fatmuckets within the various bays of the St. Clair Delta and tributaries show limited genetic differentiation by geographic distance but still represent a single population with ongoing gene flow, little differentiation among sampling sites, relatively high allelic richness at all sites, and no evidence of a recent genetic bottleneck. The Fatmucket is the most common species found in the delta and it can be assumed that the genetic health of this species represents a best-case scenario for mussel populations there. No evidence of a serious loss of genetic health in this species offers some hope that less common and imperiled species found in the St. Clair Delta may have also retained their genetic health in the face of significant demographic declines. *Keywords: Bottlenecks, Dreissena, Molecular ecology, Unionids, Lake St. Clair.*

ROZON, R.M. and SHORT, S.M., University of Toronto Mississauga - Ecology and Evolutionary Biology, 3359 Mississauga Rd. N., Mississauga, ON, L5L 1C6. **Diversity and Dynamics of Algal Viruses in the Bay of Quinte.**

The Bay of Quinte is a Lake Ontario area of concern that experiences seasonal reoccurrences of harmful algal blooms (HABs). Little is known about freshwater algal viruses, but since algal viruses play a role in marine HAB ecology, and are abundant in freshwaters it can be speculated that viruses are important in the ecology of freshwater HABs. To initiate algal virus research in the Bay of Quinte, three stations were sampled bimonthly throughout 2011. By targeting algal virus DNA polymerase and major capsid protein genes, PCR amplification confirmed the presence of diverse phycodnaviruses (viruses of eukaryotic algae) in all samples. Similarly, by targeting a gene encoding tail sheath proteins of the *Microcystis aeruginosa* cyanophage Ma-LMM01, PCR provided evidence for *Microcystis* phages in the Bay. Sequences derived from these amplified gene fragments will be analyzed phylogenetically to identify the specific types of viruses present in the Bay. Quantitative molecular techniques will be used to examine virus population dynamics and correlate changes in abundance to changes in various environmental parameters. This research highlights a significant knowledge gap in understanding the ecology of the Bay of Quinte, which like all water bodies, is greatly influenced by the status of its primary producers. *Keywords: Bay of Quinte, Algal viruses, Phytoplankton, Phycodnaviruses, Harmful algal blooms, Quantitative PCR.*

RUCINSKI, D.K.[1], DEPINTO, J.V.[1], SCAVIA, D.[2], BELETSKY, D.[3], and SCHWAB, D.J.[4], [1]LimnoTech, 501 Avis Dr., Ann Arbor, MI, 48108; [2]Graham Environmental Sustainability Institute, 625 E. Liberty, Ann Arbor, MI, 48104; [3]CILER - School of Natural Resources and the Environment, 4840 S. State Rd, Ann Arbor, MI, 48108; [4]Great Lakes Environmental Research Laboratory, 4840 S. State Rd, Ann Arbor, MI, 48108. **A Modeling Analysis of Loading Scenarios and Hypoxia in Lake Erie.**

Hypoxia (dissolved oxygen < 2mg·L-1) in the central basin of Lake Erie continues to pose a potential hazard to ecosystem health, despite reductions in phosphorus loading. A suite of ecosystem models, varying in complexity, have been developed to investigate the response of the system of nutrient loads and multiple environmental stressors. This suite is utilized in a modeling analysis, demonstrating the simulated dissolved oxygen response under several loading and management scenarios. *Keywords: Eutrophication, Lake Erie, Oxygen.*

RUDSTAM, L.G., WATKINS, J.M., HOLECK, K.T., and SULLIVAN, P., Department of Natural Resources, Cornell University, Bridgeport, NY, 13030. **High Frequency Acoustics Reveal Patchiness Structure in Zooplankton Distribution in Lake Ontario.**

During July 2008, we surveyed Lake Ontario with three different frequencies of hydroacoustics, 70, 120 and 430 kHz both day and night. Useable data was obtained from 6 to 60 m depth with the 430 and 120 kHz units. During the day, most scattering was at 430 kHz indicating scattering from zooplankton. During the night, mysids migrate into the water column and backscattering increases, especially below the thermocline, and scattering at 120 kHz increases. Scattering at 430 kHz was correlated with zooplankton biomass obtained with net tows. Both net tows and acoustics reveal high zooplankton biomass in deeper water. This biomass peak is sometimes associated with the deep chlorophyll layer and sometimes below this layer. Uncertainty in absolute abundance estimates was primarily associated with uncertainty in the equation scaling acoustics to biomass. Relative water column abundance estimates along a N-S transect varies 28 fold among 500 m sections of the survey. With the observed variation, 11 point samples are needed to measure zooplankton abundance with a coefficient of variation of 30%(SE/mean) which is about twice the current sampling rate. This highlights the importance of developing surveying tools for assessing zooplankton abundance in large lakes. *Keywords: Hydroacoustics, Lake Ontario, Zooplankton.*

RUGE, Z.[1], LOHMANN, R.[1], ADELMAN, D.[1], HELM, P.[2], and MUIR, D.[3], [1]URI Graduate School of Oceanography, South Ferry Road, Narragansett, Ri, 02882; [2]Ontario Ministry of the Environment, 125 Resources Road, West Wing, Toronto, ON, M9P 3V6; [3]Environment Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **Spatial, Temporal Trends and Air-Water Exchange of PAHs across Lake Superior.**

Passive polyethylene samplers were deployed from April - October 2011 in lower atmosphere and surface water of Lake Superior to (i) enhance the measurements of the spatial variability of atmospheric concentrations of persistent bioaccumulative toxics (PBTs) around the Lake; (ii) assess whether the lakes are volatilizing or absorbing gas-phase PBTs to derive fluxes

and loading to the lakes; and (iii) detect emerging contaminants of concern. Initially, we focused on polycyclic aromatic hydrocarbons. A total of ~65 samplers were deployed along the U.S. and Canadian shore and in-lake in paired air-water deployments. Water concentrations were dominated by fluoranthene, phenanthrene, methylphenanthrenes and pyrene at > 10 pg/L. Samplers deployed at Sault Ste Marie were roughly 10x higher than those from the more open Lake Superior at Marquette. Lowest concentrations were determined at Eagle Harbor. The reproducibility of polyethylene samplers deployed in triplicates was excellent, at mostly < 10% relative standard deviation, but higher for PAHs at lower concentrations. By using the same sampling matrix (in our case polyethylene, PE) in air and water, activity gradients across the air-water interface were derived. Air-water exchange ratios were mixed, but indicated mostly deposition of PAHs across Lake Superior. *Keywords: Environmental contaminants, Atmosphere-lake interaction, Lake Superior.*

RUSH, S.A.[1], PATERSON, G.[1], JOHNSON, T.B.[2], LANTRY, B.F.[3], and FISK, A.T.[1], [1]Great Lakes Institute for Environmental Studies, University of Windsor, Windsor, ON, N9B 3P4; [2]Ontario Ministry of Natural Resources, Glenora Fisheries Station, Picton, ON, K0K 2T0; [3]USGS Lake Ontario Biological Station, Oswego, NY, 13126. **Stable Isotopes Reveal Short-Term Retention of Hatchery-Derived Diet in Lake Ontario Lake Trout.**

Conservation efforts to sustain and rebuild populations of lake trout (Salvelinus namaycush)must account for diet and energy requirements. For hatchery-reared lake trout, stable isotopes of carbon, nitrogen and sulfur may be useful in evaluating dietary contributions from the hatchery versus lentic sources, revealing growth-related changes in isotopic composition after release. Material collected from Lake Ontario in 2010, including hatchery-reared and recaptured lake trout, 5 major prey species (mysis, rainbow smelt, round goby and slimy sculpin), and hatchery-based diet samples were analyzed for carbon, nitrogen and sulphur stable isotopes. Results indicated that the 3 stable isotopes proved useful in differentiating among prey sources with prey-specific relationships reflecting temperature, diet and habitat. In general, for lake trout, $\delta^{13}C$ and $\delta^{34}S$ values decreased while $\delta^{15}N$ values increased after release. Transitions from hatchery diet to lake-derived prey were evident in all 3 isotope values, with integration of non-hatchery derived sources occur between 1 and 3 months post-release. These results provide further evidence that stable isotopes are a useful tool for examining the integration of released lake trout into Great Lakes ecosystems. *Keywords: Lake trout, Isotope studies, Diets.*

RUSH, S.A.[1], PATERSON, G.[1], DROUILLARD, K.G.[1], JOHNSON, T.B.[2], ARTS, M.T.[3], LANTRY, B.F.[4], and FISK, A.T.[1], [1]Great Lakes Institute for Environmental Studies, University of Windsor, Windsor, ON, N9B 3P4; [2]Ontario Ministry of Natural Resources, Glenora Fisheries Station, Picton, ON, K0K 2T0; [3]Environment Canada, National Water Research Institute, Burlington, ON, L7R 4A6; [4]USGS Lake Ontario Biological Station, Oswego, NY, 13126. **Round Gody Introduction Drives Diet Shift in a Laurentian Great Lake System Apex Fish Predator.**

Great Lakes' prey fish species have historically influenced energy cycling between benthic and pelagic zones. However, over the last three decades multiple factors have altered

prey fish abundance and diversity in the Laurentian Great Lakes. Employing naturally occurring chemical tracers (stable isotopes of carbon and nitrogen (δ^{13}C and δ^{15}N) and fatty acids), we explored trophic relationships of lake trout and major prey species in the Great Lakes. We show that fatty acids can be used to infer diet of lake trout and how these relationships may be modified by temperature and habitat. Carbon isotope values and fatty acid proportions measured in 2008 suggest that younger lake trout incorporated higher proportions of nearshore prey relative to similar aged individuals from 1995. These findings shed light on the impacts of introduced species, predator-prey dynamics, and the ecology of large lake systems. In particular, if the change in habitat use and inclusion of round goby in the Lake Trout's diet represents a substantial shift in this species' bioenergetics, then this change could have long-term implications for the Lake Trout's health, reproduction and population stability. *Keywords: Diets, Round goby, Lake trout, Isotope studies, Prey fish.*

RUSH, S.A., Great Lakes Institute for Environmental Studies, University of Windsor, Windsor, ON, N9B 3P4. **What Citizen Science can tell us About the Distribution of Waterbirds and Waterfowl Overwintering Within the Great Lakes Watershed.**

River-inhabiting avifauna represent an often overlooked component of the Laurentian Great Lakes watershed. Although the five main rivers of these Great Lakes (Ottawa, St. Marys, St. Clair, Detroit, Niagara and St. Lawrence), all support various species and numbers of breeding waterbirds and waterfowl, wintering distributions of these species are less well-known. Using data collected during Christmas Bird Counts spanning the decade 2001 - 2010 this study presents an analysis of species and community distributional patterns within these river systems. It is shown that interannual variability in species diversity differed between river systems with trends in species and community metrics likely reflecting a combination of land use and climatic conditions. Tracking temporal and spatial differences, this presentation will cover components influential to the structuring of these avian communities while also providing future predictions about these assemblages. *Keywords: Avian ecology, Rivers, Biodiversity.*

RUTHERFORD, E.S.[1], MASON, D.M.[1], VANDERPLOEG, H.[1], PEACOR, S.[2], and BOURDEAU, P.[2], [1]NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI; [2]Michigan State University, East Lansing, MI. **Modeling Larval Fish Feeding, Growth and Potential Recruitment in the Newly Illuminated, Spatially Complex Food Web of Lake Michigan.**

Invertebrate invaders are thought to have lowered the recruitment potential of key fish species in Lake Michigan. The recent expansion of dreissenid mussels into deep water has re-engineered nutrient and carbon flows, greatly reduced the phytoplankton food base, and increased water clarity and thus light penetration, potentially altering vertical migrations and densities of zooplankton and fish larvae. Although zooplankton abundance as a whole has decreased, abundance of the visual predator Bythotrephes has increased, creating a potential bottleneck to fish recruitment through competition for zooplankton. We developed a bioenergetics-based optimization model to predict effects of altered light and zooplankton prey regimes on larval alewife vertical movement, growth and survival. We configured the model

with spatially-explicit data on light, temperature, chlorophyll, zooplankton prey, and larvae densities, as well as diets and vital rates of larval fishes collected along cross-isobath transects in Lake Michigan in 2010, and calibrated the model against similar data collected in 2011. We discuss the consequences of the altered light regime, and spatial distributions and densities of zooplankton on fish larvae distribution, consumption, growth, survival, and potential recruitment. *Keywords: Recruitment, Invasive species, Fisheries.*

RUTHERFORD, E.S.[1], MASON, D.M.[1], ZHANG, H.[2], BRECK, J.[2], WITTMAN, M.[3], LODGE, D.M.[3], ROTHLISBERGER, J.[4], COOKE, R.[5], FINNOFF, D.[6], JOHNSON, T.B.[7], and ZHU, X.[8], [1]NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI, Ann Arbor, MI; [2]University of Michigan CILER, Ann Arbor, MI; [3]University of Notre Dame, South Bend, IN; [4]Resources for the Future, Washington, DC; [5]US Forest Service, Milwaukee, WI; [6]University of Wyoming, Laramie, WY; [7]Ontario Ministry of Natural Resources, Picton, ON; [8]Fisheries and Oceans Canada, Winnipeg, MB. **Assessing Risk of Asian Carp Invasion and Impacts on Great Lakes Food Webs and Fisheries.**

Bighead and silver carp ('AC') threaten to invade the Great Lakes and disrupt aquatic food webs and fisheries. We used a risk-based bioeconomics model to evaluate the potential impact of AC on food web structure, fish production and fisheries in Lake Erie's central basin, which supports important recreational and commercial fisheries and provides nursery habitats for many ecologically or economically important fishes. We used the Ecopath with Ecosim (EwE) food web model to evaluate AC impacts on Lake Erie's food web. We used data collected from 1994-2005 to configure and balance the food web in Ecopath, then used Ecosim to simulate potential AC impacts on food web structure and fish production under current conditions of nutrient loading, fish stocking and harvest. We quantified uncertainty in Ecopath model inputs using expert judgement solicitation, which was incorporated into Ecosim to evaluate uncertainty in model forecasts. To forecast regional economic impacts of AC invasion, we will create and link a regional economic model (Computable General Equilibrium) to the EwE model. This novel approach will include feedbacks between ecological and economic systems. *Keywords: Biological invasions, Asian carp, Food chains, Uncertainty, Fisheries.*

RYDER, J.L.[1] and DAHL, T.A.[1], [1]Department of Earth and Atmospheric Sciences, Central Michigan University, Mount Pleasant, MI, 48859; [2]U.S. Army Corps of Engineers, Great Lakes Hydraulics & Hydrology Office, 477 Michigan Ave, Detroit, MI, 48226. **Non-Stationarity in Key Hydrologic Components of Michigan's Lower Penninsula.**

Streamflows in Michigan's Lower Peninsula have changed over the past century, both in total amount of annual flow and response time to runoff events. Dahl et al. (2008 and 2010) previously demonstrated that a regime shift occurred in the 1960's resulting in increased peak flow and flood frequency. Precipitation across lower Michigan also shows an increasing trend which is expected to impact the overland hydrologic cycle. Evidence that precipitation increases are resulting in a widespread increase in total annual flow volume will be presented using data from 68 gaged sites, including 5 HCDN sites. The average record length is 65 years, spanning both positive and negative phases of the North Atlantic Oscillation pattern. The Richards-Baker

Flashiness Index was applied to the gage data on an annual basis. The Mann-Kendall non-parametric statistical trend analysis of the annual flashiness index shows that most sites are becoming less flashy despite increases in flow and flood events. The exceptions to this trend occur primarily in developed areas. Examination of baseflow trends supports the idea that there has been a shift in the total annual water volume cycling through overland routes to the Lakes. These trends in streamflow have implications for analyses of the hydrologic cycle and water management. *Keywords: Climate change, Hydrologic cycle, Water level fluctuations.*

RYDER, M., PATERSON, G., and HAFFNER, G.D., Great Lakes Institute of Environmental Research, University of Windsor, Windsor, ON, N9B3P4. **Non Steady State Bioaccumulation of PCBs in Lake Trout (Salvelinus Namaycush).**

This study examined the role of contaminant hydrophobicity in the bioaccumulation of polychlorinated biphenyls (PCB's) in lake trout (*Salvelinus namaycush*) populations of Lake Huron. Lake trout (n=114) were captured between April 2010 and November 2011 from 5 sites within the lake. The fish ranged in age from 0 to 11 years. Sum PCB of 24 congeners ranged from 49 to 279 ng/g wet weight, however in our analysis we examined individual congeners for differences in bioaccumulation patterns. The more hydrophobic congeners (Log K_{ow}>6.5) bioaccumulated in a manner that reflected non-steady state kinetics. We further observed that variability among individuals also increased with hydrophobicity. We hypothesize that high individual variability in PCB body burdens is regulated by both prey selection and the amount of energy expended to obtain prey. *Keywords: Lake trout, Bioaccumulation, PCBs.*

SAFAIE, A., JALILVAND, E., and SEDIGHI, A., Department of Civil engineering, Sharif University of Technology, Tehran, Iran. **Investigating the Seiche Phenomenon in Lake Michigan Using GIS.**

The seiche phenomenon is a stationary wave that happens in enclosed or partially enclosed bodies of water at the natural resonant period of the basin. This period is a function of lake's geometry and depth and is independent of the external forcing mechanism. Seiches happen frequently in Lake Michigan. In this study, water level data were obtained from NOAA stations around Lake Michigan and GIS tools were used to determine frequency and spatial characteristics of some observed modes corresponding to seiche oscillations. Water level information reported in six-minute time intervals (for the periods that seiches had happened) were employed to produce water elevation contours of the lake at different times. Based on the lake bathymetry DEM and water level profiles, the number of nodes and consequently the main oscillation mode for each seiche were obtained. Also, signal processing was performed on each station during a specific seiche and the results were compared with the results of the GIS analysis. This study has revealed new potentials for the use of GIS as a promising tool in the investigation of lake seiches by applying spatial and temporal distribution of water elevation data. *Keywords: Water level, Seiche, Lake Michigan, Signal processing, GIS.*

SAKAI, T.[1] and REDEKOPP, L.G.[2], [1]School of Civil and Environmental Engineering, Cornell University, Ithaca, NY, 14853-3501; [2]Department of Aerospace and Mechanical Engineering, University of Southern California, Los Angeles, CA, 90089-1191. **Lagrangian Particle Transport Driven by Basin-scale Internal Waves in a Circular Lake.**

Effects of the second vertical modes and nonlinearity of the basin-scale internal wave field on Lagrangian particle transport in a large lake are studied by employing an idealized, wind-forced circular lake model with continuous stratification. The Kelvin wave of the first vertical mode can transport a cloud of particles near the basin perimeter for a distance comparable to the lake length after several inertial periods following a single wind event, whereas the Poincare wave stretches and squeezes the cloud in on/offshore directions as frequent as the inertial period. The Kelvin wave of the second vertical mode often possesses significantly small energy relative to the mode-one Kelvin wave. However, due to the disparately slow eigenspeed of the mode-two Kelvin wave, the resultant along-shore particle transport can become comparable to that driven by the mode-one Kelvin wave after several internal periods. It is found that nonlinear interaction between the Kelvin-Poincare wave pair can generate a solitary-like wave of large amplitude in an offshore region. This new type of wave possesses a large horizontal current and co-propagates with the Kelvin wave in a cyclonic direction and, eventually, can cause a burst of particle transport in an off-shore direction.
Keywords: Hydrodynamics, Particle transport, Waves, Model studies.

SANDSTRÖM, A.[1] and NORRGÅRD, J.[2], [1]Stångholmsvägen 2, Drottningholm, SE-17893, Sweden; [2]c/o Länsstyrelsen i Jönköpings län, Jönköping, Se-551 86, Sweden. **Participatory Research - Bridging the Gap between Scientists and Stakeholders in Inland Fisheries?**

Evolving management regimes have changed the role of fishermen and the interactions between fishermen and scientists. In order to bridge an emerging gap between fishermen and scientists there has been several initiatives in recent years to enhance the participation of fishermen in research. These initiatives have included management issues as well as the process of providing scientific advice, often through various co-management bodies. We present a case study in Swedish Lake Vättern testing approaches to involve fisheries stakeholders in research. The participation of fishermen in various research projects was mediated through a recently started fisheries co-management group. Issues of interest to fishermen that were explored spanned from applied projects such as selectivity of gear to more fundamental ecological issues such as the development of resource-polymorphism in sympatric fish populations. We summarize our experiences from participatory research in this specific case study and compare it with other ongoing efforts to involve stakeholders in the science that influences the governance of European fisheries. *Keywords: Co-management, Participatory research, Fisheries.*

SATTERLEE, S.R. and DIGGINS, T.P., Youngstown State University, One University Plaza, Youngstown, OH, 44555. **Landscape and Successional Influences on Plant Invader Success in a Lower Great Lakes Tributary.**

The Zoar Valley Canyon of Lake Erie tributary Cattaraugus Creek (6th-order) contains a pristine riparian zone that encompasses >11 river km and 500 ha of New York State protected old- and first-growth hardwood forest. We address here the roles of Eltonian ecological resistance vs. invasive species access (e.g. bush honeysuckle, multiflora rose, black locust, Japanese knotweed) via the river corridor. Specifically, we addressed the following: 1) Does invader success change over successional time? 2) Are there biotic and/or abiotic stand characteristics associated with invader success? 3) What degree and type of (natural) disturbance promotes invader success? In addition to distribution/abundance of major invasives, recipient ecosystem variables such as stand age and composition and landform history (e.g. active channel, old channel, floodplain) were quantified. Invasives were rarely found on landforms >60 years old (stand ages >50 years), which may reflect both successional time and the temporal introduction of the invaders. Old channels (40 - 60 years old) were heavily invaded, especially by honeysuckle, but mature-forest canopy gaps never were. Advanced age (150 - 300+ years) riparian stands were free of invasives, except at very localized natural disturbances such as alluvial fans and seepage-created nascent wetlands. *Keywords: Riparian zone, Species composition, Exotic species.*

SAWYER, J.M.[1], ARTS, M.T.[2], ARHONDITSIS, G.B.[3], KOOPS, M.A.[4], and DIAMOND, M.L.[1], [1]Department of Geography and Program in Planning, University of Toronto,100 St. George St., Toronto, ON, M5S 2E5, Canada; [2]Water Research Institute, Environment Canada, 867 Lakeshore Road, Burlington, ON, L7R 4A6, Canada; [3]4Department of Physical and Environmental Sciences, University of Toronto, 1265 Military Trail, Scarborough, ON, M1C 1A3, Canada; [4]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, 867 Lakeshor, Burlington, ON, L7R 4A6, Canada. **Evaluating the Transfer and Accumulation of Polychlorinated Biphenyls (PCBs) and Polyunsaturated Fatty Acids (PUFAs) through the Bay of Quinte's Food Web.**

Many fish populations in the Bay of Quinte are subject to human consumption restrictions due to elevated PCB concentrations. The consumption of fish with elevated PCB concentrations is correlated with adverse effects, including an increased risk of certain cancers. However, the negative aspects of fish consumption must be balanced against the nutritional benefits from high concentration of PUFAs. Highly concentrated in fish, PUFAs have been associated with health benefits such as lowered risk of heart disease. Previous research has focused on modeling risk; however, it is necessary to also consider the beneficial aspect of fish and ecosystem health to gain a more balanced perspective. We have quantified and compared each chemical's movement through the food web to quantify and better understand the factors leading to the transfer of PCBs and PUFAs through the Bay of Quinte's food web. As both chemicals biomagnify through the aquatic food web, we examined the impact that ecosystem structure has on their transfer through and concentrations in higher trophic level organisms. We considered food chain length, consumption/digestion rates and the contribution of organism age

to increased PCB and PUFA concentrations in top predators. *Keywords: Bay of Quinte, PUFAs (polyunsaturated fatty acids), PCBs, Ecosystem modeling.*

SAYERS, M.J.[1], SHUCHMAN, R.A.[1], VANDER WOUDE, A.J.[1], BROOKS, C.N.[1], FAHNENSTIEL, G.[2], and LESHKEVICH, G.[2], [1]MTRI, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [2]NOAA GLERL, 4840 South State Road, Ann Arbor, MI, 48108. **Mapping Harmful Algae Blooms (HABs) in the Great Lakes Using MODIS and MERIS Satellite Data.**

Harmful Algal Blooms (HABs) in the Great Lakes are becoming increasingly problematic as these events are happening more often, in more areas, and lasting longer. Satellite remote sensing can be effectively used to map and monitor HAB events in the Great Lakes to help resource managers and decision makers address the problem. A satellite based HAB mapping algorithm has been developed and tested in the Western basin of Lake Erie where severe HAB events have regularly occurred. The algorithm has been developed from in situ spectral reflectance measurements and coincident concentration samples and has been applied to both MODIS and MERIS satellite imagery. The algorithm also utilizes ancillary data to help differentiate harmful from non- harmful algal blooms that can occur simultaneously. Also examined is the utility of hyperspectral (HICO) satellite imagery from the Space Station for mapping HABs and a comparison to ship based hyperspectral radiometric measurements was made. Extent and duration were derived for a time series of satellite images during the 2011 summer HAB event in Lake Erie. Also presented is a comparison of Cyanobacteria shipborne in situ spectral profiles and measured concentrations collected during the Lake Erie summer field season. *Keywords: Remote sensing, Harmful algal blooms, Lake Erie.*

SCARBROUGH, K.A.[1], BOURGEAU-CHAVEZ, L.L.[1], KOWALSKI, K.P.[2], CARLSON MAZUR, M.L.[2], POWELL, R.B.[1], BROOKS, C.N.[1], HUBERTY, B.[3], JENKINS, L.K.[1], BANDA, E.C.[1], GALBRAITH, D.M.[2], LAUBACH, Z.[1], and RIORDAN, K.[1], [1]3600 Green Court Suite 100, Ann Arbor, MI, 48105; [2]USGS GLSC, 1451 Green Road, Ann Arbor, MI, 48105; [3]USFWS, 5600 American Blvd. W. Suite 990, Bloomington, MN, 55437. **Mapping Invasive *Phragmites Australis* in the Coastal Great Lakes with ALOS PALSAR Satellite Imagery for Decision Support.**

Phragmites australis (common reed) has an invasive variety not native to North America that forms dense stands which cause negative impacts on coastal Great Lakes wetlands including habitat degradation and reduced biological diversity. Early treatment is key to controlling *Phragmites*, therefore a map of the current distribution is needed. ALOS PALSAR imagery was used to produce the first basin-wide distribution map showing the extent of large, dense invasive *Phragmites*-dominated habitats in wetlands and other coastal ecosystems along the U.S. shore of the Great Lakes. PALSAR is a satellite imaging radar sensor that is sensitive to differences in plant biomass and inundation patterns, allowing for the detection and delineation of tall (up to 5 m), high-density, high-biomass invasive *Phragmites* stands. Classification was based on multi-season ALOS PALSAR L-band data. Seasonal datasets improved discrimination of *Phragmites* by taking advantage of phenological changes in vegetation and inundation patterns. Extensive

field collections of training and randomly selected validation data were conducted in 2010-11 to aid in mapping and for accuracy assessments. Overall map accuracy was 87%, with 86% producer's accuracy for invasive *Phragmites. Keywords: Remote sensing, Phragmites, Coastal wetlands, Invasive species.*

SCHAEFFER, J.S.[1], NELSON, J.C.[2], and LARSON, J.H.[2], [1]USGS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105; [2]USGS Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Road, LaCrosse, WI, 54603. **Characterizing and Classifying Great Lakes Rivermouths.**

We developed a database to examine variability among Great Lakes Rivermouths. Approximately 114 variables characterizing each rivermouth or its watershed were acquired or derived for 2092 rivermouths representing nearly all permanent streams on the US Great Lakes shoreline. We developed a two-tier hierarchical classification that will group rivermouths into functional categories using categorical variables assigned from distributions. The resulting classification will be quantitative, but expressed in terms that are useful to managers and stakeholders. Results suggest that rivermouth density is consistent among Great Lakes shorelines, but the amount of rivermouth habitat available among Lakes varies substantially; rivermouth habitat is more common in Lakes Michigan and Superior compared to other Lakes. The majority of Great Lakes rivermouths occur as single channels draining small lakeside coastal watersheds; other estuary types such as bar-built lagoons or braided channels are rare. Large rivermouths are orders of magnitude rarer than small rivermouths; most large rivermouths drain large low-relief interior watersheds with intensive land use, and nearly all have been altered as shipping ports. However, several less-altered rivermouths of moderate size remain, and may be candidates for restoration efforts. *Keywords: Great Lakes basin, Rivermouths, Coastal processes, Classificaiton, Watersheds.*

SCHLOESSER, D.W.[1] and SERVEISS, V.B.[2], [1]USGS, Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105-2807; [2]International Joint Commission, 2000 L Street, NW; Suite #615, Washington, DC, 20036. **Burrowing Mayfly: A Sentinel Water Quality Indicator for Nearshore Waters of the Great Lakes.**

The burrowing mayfly, Hexagenia, is important to fish populations and as an indicator to monitor water quality. These mayflies all but disappeared from most nearshore waters of the Great Lakes in the 1950s because of impacts from increased nutrients which came from urban and industrial activities. The increased nutrients triggered a series of events resulting in increased growth of algae, settlement of these plants to bottom substrates, low dissolved oxygen created from decomposition of these plants, and loss of mayflies and other fauna caused by a lack of oxygen in the water. In western Lake Erie, the location with the best records in the Great Lakes, the mayfly disappeared in 1953, were absent for 40 years, began to recover in the mid-1990s, and have sustained a recovery over the past 15 years. Continued reductions of pollution and monitoring are likely to confirm 'recovery' of mayflies in western Lake Erie and other areas of the Great Lakes. Therefore, continued monitoring of Hexagenia in suitable habitat is

recommended because they are important to fish and reflect the status of water quality. *Keywords: Benthos, Western Lake Erie, Bioindicators, Nutrients.*

SCHMIDT, J.R. and BOYER, G.L., SUNY-ESF, 1 Forestry Drive, Syracuse, NY, 13210. **Development of a New Extraction Protocol and Cleanup Procedure for Microcystins in Fish Tissues.**

Microcystins are peptide toxins produced by the cyanobacteria *Microcystis aeruginosa* . This toxin inhibits protein phosphatase, forming a permanent covalent linkage within the active site. This can lead to cell hemorrhage and death. Microcystins can be transferred to piscivorous fish through the foodweb. Improved methods for detection of microcystins in these fish tissues are essential to protect human health. A new extraction protocol which included use of activated charcoal to remove proteins and lipids was developed for several microcystin congeners. Using 5% formic acid in methanol to elute, recovery of microcystin-LR from fish tissue was 85% by LCMS. This protocol was also tested against the protein phosphatase inhibition (PPIA) and enzyme-linked immunosorbent (ELISA) assays. In both cases, it significantly decreased the level of false positive responses observed with fish tissues. These results indicate cleanup with activated charcoal may be beneficial when used with all three (ELISA, PPIA, LCMS) commonly used techniques for analysis of microcystins in tissue. Further optimization of this method is in progress. *Keywords: Food chains, Microcystis.*

SCHOCK, N.T., WEBSTER, W.C., and UZARSKI, D.G., Institute for Great Lakes Research, CMU Biological Station, Department of Biology, Central Michigan University, Mount Pleasant, MI, 48858, United States. **Stream/Drainage Ditch Impacts on Great Lakes Coastal Wetland Macroinvertebrate Community Composition.**

Great Lakes coastal wetlands are subject to many types of anthropogenic disturbances. Agricultural, non-point source pollution has been an area of concern pertaining to the increased rate of eutrophication in many aquatic systems. Pesticides and herbicides have also been linked to a loss of wetland faunal biodiversity. Pollutants are washed off of the landscape during rain events and in the Great Lakes region, often enter drainage systems that empty into Great Lakes waters. We sampled macroinvertebrates and accompanying chemical and physical characteristics of Lakes Huron and Michigan coastal wetlands near (<800 m) and far from (>1500 m) the mouths of drainage systems. Non-metric multi dimensional scaling in conjunction with a multi-response permutation procedure revealed differences in marcoinvertebrate community compositions near and far from drainage outlets. Principal components analysis of abiotic characteristics exposed more variation than expected when we compared habitat conditions of sites near drainages to sites far from drainages. The biological response to habitat degradation observed in this study suggests that the management of Great Lakes watershed land use should be of great importance to coastal wetland managers and agricultural best management practices should be implemented. *Keywords: Macroinvertebrates, Environmental contaminants, Coastal wetlands.*

SCHUBERG, D.H., CARRICK, H.J., and UZARSKI, D.G., Institute for Great Lakes Research, CMU Biological Station, Department of Biology, Central Michigan University, Mount Pleasant, MI, 48859. **Algal Community Composition in Response to Spatial and Temporal Physico-Chemical Gradients within an Emergent Great Lakes Coastal Wetland of Northern Lake Michigan.**

Algal presence and distribution, surface and pore-water nutrients, and hydrological energy effects were quantified within a *Schoenoplectus tabernaemontani* (softstem bulrush) dominated, Great Lakes coastal wetland. Weekly data from July, 2011 showed a chemical and physical gradient was present from near to off-shore. Average NO_3 values were consistently lower near-shore (5.00-67.95ug/L), compared with the open water (134.73-181.42ug/L), and increased at all stations throughout the month. Surface NH_3 levels in mid-summer were 2.5-fold lower on the outer edge of the bulrush compared with an up-wind station 10m from the macrophyte edge. SRP levels showed the opposite pattern, such that values were nearly eight-times higher on the outer edge of the bulrush compared with the adjacent up-wind site. Epiphyte biomass and bulrush stem-density was greatest furthest from shore in this wetland. Temperature, dissolved oxygen, turbidity, pH, wave-action, and other chemical and physical parameters known to affect algal growth, varied predictably on a diurnal and seasonal basis. The size of the wetland, fetch, and landscape inputs, structured abiotic gradients and likely explained variability in algal productivity and community composition from near-shore to off-shore
Keywords: Coastal wetlands, Algae, Lake Michigan.

SCHULZ, T.[1], HU, D.[1], THORNE, P.S.[2], DEWALL, J.[2], and HORNBUCKLE, K.C.[1], [1]Dept Civil and Environmental Engineering, University of Iowa, Iowa City, IA, 52242; [2]Dept Occupational and Environmental Health, University of Iowa, Iowa City, IA, 52242. **Comparison of PCBs in East Chicago, IN and Columbus Junction, IA in Indoor and Outdoor Air.**

We have deployed and collected polyurethane foam based passive samplers (PAS-PUF) at residential homes in two communities: East Chicago, Indiana and Columbus Junction, Iowa. At each residence, a sampler was deployed inside the home and outside the home. 280 samples deployed in 2008 and 2009 have been extracted and analyzed for the full suite of polychlorinated biphenyls (PCBs). Higher levels were expected to be found in East Chicago compared with Columbus Junction due to a higher level of current and historical industrial activity in Northwest Indiana relative to rural Iowa. However, results indicate that the two communities do not have statistically significant differences in outdoor air concentrations. Total PCB concentrations in indoor air are approximately three times the outdoor concentrations. Congener distributions are examined to elucidate sources of PCBs from building materials and/or nearby industrial activity.
Keywords: PCBs, Airsheds, Human health.

SCHWAB, D.J.[1], BELETSKY, D.[2], and MCCORMICK, M.J.[3], [1]NOAA Great Lakes Environmental Research Laboratory, 4840 S. State Rd., Ann Arbor, MI, 48108; [2]University of Michigan/ CILER, Ann Arbor, MI, 48108; [3]Sibley Rd., Chelsea, MI, 48118. **The Role of Lake Circulation in the Development of the 2011 Algal Bloom in Western Lake Erie.**

A massive algal bloom that began in western Lake Erie in July, 2011 eventually expanded to cover over 1000 square miles of the lake surface (about 1/10 of the total surface area of Lake Erie) with green scum. Satellite imagery is used to examine the progression of the bloom from its initiation in the western basin in early July to its maximum extent covering a large part of the western basin and extending considerably into the central basin in September. The satellite imagery is compared to results from a hydrodynamic model of lake circulation and to direct observations of surface currents from several drifting buoys released during the event to examine to role of surface currents in the spread of the bloom. *Keywords: Hydrodynamics, Lake Erie, Harmful algal blooms.*

SCHWALB, A.N.[1], BOUFFARD, D.[2], OZERSKY, T.O.[3], and SMITH, R.E.H.[1], [1]Biology Dept., U. Waterloo, Waterloo, ON, N2L 3G1; [2]Dept. Civil Engineering, Queens University, Kingston, ON, K7L 3N6; [3]Ont. Min. Nat. Res., 2140 East Bank Dr., Peterborough, ON, K9J 7B8. **Variation in Phytoplankton Distribution in Lake Simcoe - The Effect of Benthic Communities and Hydrodynamics.**

Grazing by dreissenid mussels can alter horizontal and vertical distributions of phytoplankton. Hydrodynamics can modulate mussel effects, but studies to date have ignored spatial variations of mussel biomass. We compared the vertical and horizontal distribution of phytoplankton (inferred from chlorophyll a fluorescence) in Lake Simcoe among sites of differing depth, mussel biomass, and density structure to infer the joint effects of hydrodynamics and mussel grazing. Hydrodynamic modeling and high resolution temperature profiling helped examine horizontal currents and vertical diffusivity. Results showed that mussel grazing can deplete phytoplankton in near-bottom strata even at locations with moderate mussel biomass when vertical mixing is low due to stratification and horizontal currents are weak. Phytoplankton were not consistently diminished at nearshore sites with high mussel biomass compared to offshore sites, but lower concentrations were observed at some nearshore sites with low mussel biomass. This result may be explained by the west-southwest wind induced horizontal currents during our sampling period, which carry water from the offshore through nearshore areas with high mussel biomass and then to nearshore areas of low mussel biomass. *Keywords: Productivity, Dreissena, Hydrodynamics.*

SEAMAN, L.M., 20 N. Wacker Dr., Suite 2700, Chicago, IL, 60606. **Assessing Cumulative Water Use Impacts for the Great Lakes-St. Lawrence River Basin.**

An ongoing challenge for water managers is how to measure and manage the cumulative impacts of multiple and ongoing water uses over time. While work of this kind has been done on some local riverine systems, large-scale systems like the Great Lakes--St. Lawrence River Basin represent a new and different challenge. By December 8, 2013, the Great Lakes Governors and

Premiers will conduct the first ever assessment of cumulative water use impacts for the Basin. This groundbreaking effort is being undertaken pursuant to the Great Lakes--St. Lawrence River Basin Sustainable Water Resources Agreement and the companion "Great Lakes Compact." The assessment will be the first ever performed on a scale of this magnitude anywhere in the world and will employ new and innovative approaches. This presentation will discuss the unique partnership that will be used for the assessment, identify data and information challenges, and present "lessons learned" that may be instructive for future work in the region and in other parts of the world. *Keywords: Great Lakes basin, Assessments, Regional analysis.*

SEELBACH, P.W.[1] and LARSON, J.H.[2], [1]U.S. Geological Survey, Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI, 48105; [2]U.S. Geological Survey, Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Road, La Crosse, WI, 54603. **Cafe Session (4 slots): Great Lakes Rivermouth Ecosystems: Understanding Connections between Ecosystem Structure, Function and Services.**

Rivermouth ecosystems are the transition zone between riverine processes and lentic nearshore processes. These systems are at the center of many Great Lakes communities, are important in the life-cycles of many Great Lakes fish and wildlife species, and many are the focus of intense restoration efforts. Despite the importance of these systems, relatively few studies have investigated the structure and function of rivermouths in the Great Lakes, hampering our ability to effective restore and manage these systems. This extended session is designed to foster a discussion among participants (i.e., the audience) on our understanding of Great Lakes rivermouths, how gaps in our understanding can be addressed with future research efforts and the importance of these ecosystems to the Great Lakes ecological and economic systems. As an introduction, we will provide a brief presentation of a conceptual synthesis developed by the Rivermouth Collaboratory over the course of the past two years. This will be followed by a facilitated discussion focused on developing a better understanding among participants and presenters of the issues facing rivermouths and the approaches that can be taken to address those issues. *Keywords: Coastal ecosystems, Economic evaluation, Estuaries.*

SEGLENIEKS, F.[1] and MACKAY, M.[2], [1]1Meteorological Service of Canada, Environment Canada, Burlington, ON, L7R 4A6; [2]Science and Technology Branch, Environment Canada, Toronto, ON, M3H 5T4. **Future Great Lakes Water Levels Simulated with Dynamically Downscaled GCM Data Using the Canadian Regional Climate Model.**

Environment Canada is currently developing a Climate Modelling System to support the IUGLS based on the Canadian Regional Climate Model (CRCM) coupled with the latest version of the Canadian Land Surface Scheme and a lake level-river routing scheme. 8 simulations using 3 GCMs were downscaled using the CRCM. The actual and simulated current climates were compared for precipitation, evaporation, runoff into the lakes, NBS for the lakes, and lake levels. Data for the 2050 time slice was used to examine the expected differences in these factors for each of the simulations. On an annual basis the future time slices showed an increase in precipitation and evaporation with a smaller increase in runoff. The annual NBS showed a decrease that was relatively small. Unlike previous lake level predictions with dramatic drops in

lake levels in the order of metres, the change in lake levels from this study ranged between 40 cm below to 15 cm above current levels. When examining the differences on a seasonal basis, the future time slices were wetter during the winter and early spring and drier during the summer. This was also seen in the lake levels where there was a shift to higher spring levels and lower winter levels. These seasonal shifts may have an impact on the regulation plans currently being developed for the great lakes. *Keywords: Hydrologic cycle, Lake levels, Climate change, Lake model.*

SELEGEAN, J.P.[1], RIEDEL, M.S.[2], and STONE, A.G.[2], [1]U.S. Army Corps of Engineers - Detroit District, 477 Michigan Ave, Detroit, MI, 48226; [2]Baird & Associates, 2981 Yarmouth Greenway Drive, Madison, WI, 53711. **Managing Legacy Sediment Deposits for Removal of Three Dams on the Boardman River, Tributary to Lake Michigan.**

Four dams currently impound water on the main stem of the Boardman River near Traverse City, MI. This tributary to Lake Michigan discharges to Grand Traverse Bay and is a Class A cold water Salmonid Fishery. While these dams protected the river system from Lamprey, they fragmented river habitat for Potamodromous fishes. Removal of the upper three dams, and modifications to the lowest dam are being planned to restore the native fishery while protecting the river system from Sea Lamprey (*Petromyzon marinus*). However, over 100 years of sediment accumulations (~1.4M cubic meters) behind the dams threaten to blanket downstream river habitat if they are released during dam removal. Compounding matters, these sediments are contaminated with heavy metals. A large team of professionals have been thoroughly studying fisheries, hydraulics, geology, sediment transport, socio-economics, and habitat benefits to determine the best alternatives for restoration of the fisheries and removal of the dams. This talk will present analyses to determine sediment management and design approaches for dam removal alternatives. *Keywords: Sediment transport, Sediment load, Dam removal, Fisheries.*

SERVEISS, V.B., 2000 L Street, NW #615, Washington, DC, 20036. **Overview of Assessment of Progress Session.**

The International Joint Commission (the Commission) initiated an effort to assess progress in restoring and maintaining Great Lakes water quality, since 1987, when the Great Lakes Water Quality Agreement was last amended. Fourteen indicators were used to assess progress and a draft report was released in October 2011. This session will provide a summary of the results which were mostly favorable for the indicators of chemical integrity but biological indicators showed declining conditions. This opening presentation will also provide an introduction to the subsequent presentations in this session which will discuss several indicators of chemical of biological integrity in more detail. *Keywords: Bioindicators, Assessments, Indicators.*

SESTERHENN, T.M.[1], GOTO, D.[1], RUCINSKI, D.K.[2], DEPINTO, J.V.[2], SCAVIA, D.[3], BELETSKY, D.[3], LUDSIN, S.A.[4], and HÖÖK, T.O.[1], [1]Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN, 47907; [2]LimnoTech, 501 Avis Drive, Ann Arbor, MI, 48108; [3]School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI, 48109; [4]Aquatic Ecology Laboratory, Department of Ecology, Evolution, and Organismal Biology, The Ohio State University, Columbus, OH, 43212. **Individual-based Modeling to Forecast Population-level Effects of Increasing Hypoxia and Temperature on Fish Species in Lake Erie's Central Basin.**

Increasing seasonal hypoxia in Lake Erie, combined with increasing temperatures due to climate change, will potentially have strong effects on various ecologically and economically important fish species. Hypoxia alters habitat use, potentially leading to occupation of inferior thermal and light environments and novel overlap among competitors, predators and prey. We developed a spatially-explicit, 1-dimensional (1D), individual-based model to forecast how effects of increasing hypoxia and temperature would translate from individual fish to potential population-level impacts on yellow perch *Perca flavescens*, walleye *Sander vitreum*, rainbow smelt *Osmerus mordax*, and emerald shiner *Notropis atherinoides*. The model environment is a 1D representation of the central basin of Lake Erie, incorporating vertical and temporal variation in physical, chemical, and lower trophic level variables. Simulations include conditions before, during, and after the occurrence of hypolimnetic hypoxia. The fish community is tracked on a sub-daily time scale with vertical movement, growth, and survival simulated via a bioenergetics approach incorporating oxygen level, temperature, and prey availability. We will describe predicted effects of expected future levels of hypoxia and temperature on the focal fish species. *Keywords: Model studies, Lake Erie, Oxygen.*

SHERMAN, J.J., CLEMENT, T.A., SCHOCK, N.T., and UZARSKI, D.G., Institute for Great Lakes Research, Department of Biology, Central Michigan University, Mount Pleasant, MI, 48859. **A Comparison of Abiotic and Biotic Parameters of Diked and Adjacent Open Wetland Complexes of the Erie Marsh Preserve.**

Erie Marsh Preserve, located in North Maumee Bay, Lake Erie, contains 990 acres of marsh within a dike. Diked wetlands are common along the Lake Erie shoreline and offer a unique opportunity to compare faunal assemblages and habitat characteristics within the dike to adjacent wetland area outside the dike. We surveyed and compared aquatic macroinvertebrate and fish assemblages as well as chemical and physical water quality characteristics from habitats inside and outside the dike in June 2011. Species richness, Shannon Diversity, and Hurlburt's PIE were calculated using rarefied numbers to allow for an accurate representation of species assemblages, since each zone produced highly varied total catch for fish. Richness, diversity, and evenness of biotic communities inside of the dike were higher compared to communities outside of the dike. Diversity numbers were higher inside, but 40 % of fish and 49% of macroinvertebrate taxa surveyed in Erie Marsh Preserve were found only in habitat outside of the dike. Conversely, the dike contained 3 species of fish and 6 macroinvertebrate taxa that were exclusive to diked habitat. A principle component analysis revealed differences in overall habitat characteristics distinguishing the diked wetland from the undiked wetland. These data suggest

substantial wetland change due to dikes. *Keywords: Coastal wetlands, Dike, Coastal ecosystems, Lake Erie.*

SHERMAN, R.K. and CHIANDET, A.S., Severn Sound Environmental Association, 67 Fourth St, Midland, ON, L4R 3S9. **Changes in Hypolimnetic Chemistry with the Onset of Summer Hypoxia in Honey Harbour, Georgian Bay.**

The Honey Harbour area of Georgian Bay is made up of many small bays that have variable morphometry and limited exchange with the open waters of Georgian Bay. The area is heavily used by cottagers and boaters, and as such there have been concerns raised about the impact of recreational use on water quality. We examine data for three bays (North, South and Honey Harbour). Over 7 years of biweekly monitoring during the ice-free period we observed no significant changes in trophic status indicators, which included total phosphorus, water clarity, chlorophyll a, and total nitrogen. Strong stratification leads to bottom water hypoxia (dissolved oxygen <2 mg/L) by mid-summer in two of the bays. Bottom water phosphorus, ammonia, iron, zinc and manganese concentrations increase over euphotic zone values, often by orders of magnitude. Although strong stratification restricts mixing of bottom waters with the euphotic zone in the summer, erosion of the thermocline in late summer and fall may represent an internal source of nutrient loading to the Bays. *Keywords: Eutrophication, Hypolimetic chemistry, Oxygen.*

SHIMODA, Y.[1], ARHONDITSIS, G.B.[1], and YERUBANDI, R.R.[2], [1]University of Toronto, Department of Physical & Environmental Sciences, Toronto, ON, M1C 1A4, Canada; [2]Environment Canada, Canada Centre for Inland Waters, Burlington, ON, L7R 4A6, Canada. **Modelling Cyanobacteria Dominance: How Useful are the Complex Mathematical Models?**

Hamilton Harbour (Ontario, Canada) has recently experienced erratic outbreaks of noxious and toxin-producing cyanobacteria blooms (Microcystis sp.), although the ambient phosphorus levels are reduced due to the remedial actions implemented. These patterns of cyanobacteria dominance may seem counterintuitive as the existing paradigm predicts that their capacity to outcompete the usual eukaryotic residents of the summer phytoplankton communities decreases under low phosphorus availability. Our hypothesis is that despite the relative improvement of the water quality conditions in the system, there are still micro-environments in the nearshore shallow zone that favour cyanobacteria dominance which then proliferate to the offshore sites through hydrodynamic transportation. We developed a spatially explicit 3-D eutrophication model forced with the outputs from the hydrodynamic model ELCOM. Finally, our study emphasizes the importance of a more "fine-grained" approach that will integrate aspects of all the single-factor hypotheses presented in the literature to explain cyanobacteria dominance, such as the buoyancy regulation, ability to fix molecular nitrogen, N-P ratios, minimization of mortality through an immunity to grazing by zooplankton, ability to outcompete most other phytoplankton for ammonium nitrogen. *Keywords: Risk assessment, Ecosystem modeling, Cyanophyta.*

SHORT, S.M.[1], STANIEWSKI, M.A.[2], and SHORT, C.M.[1], [1]University of Toronto Mississauga, Department of Biology, Mississauga, ON, L5L 1C6; [2]University of Toronto, Department of Ecology and Evolutionary Biology, Toronto, ON, M5S 3B2. **The Molecular Ecology of Algal Viruses in and Around Lake Ontario.**

Studies freshwater phytoplankton viruses have led to surprising results that highlight our limited knowledge of their ecology in the Great Lakes basin. For example, 194 of 195 virus gene sequences from Lake Ontario were most closely related to Prasinoviruses despite the fact that their hosts, prasinophyte algae, have not been noted in Lake Ontario phycological records. DNA sequences related to other types of phycodnaviruses have been recovered in recent surveys, yet the preponderance of prasinovirus sequences remains puzzling. Quantitative methods were used to monitor specific virus populations and demonstrated that different viruses had variable peak abundances and phenology, yet almost all persisted at low abundances throughout the year. Seasonal persistence was surprising since aquatic viruses decay rapidly outside their hosts, Lake Ontario phytoplankton assemblages are seasonably variable, and phycodnaviruses are host specific. Nonetheless, we speculate that a common aspect of phycodnavirus ecology is survival at low abundances as "seed-bank" populations. Combined with our work demonstrating that viruses are a significant yet variable source of algal mortality, our observations illustrate our naïve understanding of the ecology of freshwater algal viruses despite their apparent importance in these ecosystems. *Keywords: Microbiological studies, Biodiversity, Viruses, Phytoplankton.*

SHUCHMAN, R.A.[1], SAYERS, M.J.[1], BROOKS, C.N.[1], FAHNENSTIEL, G.[2], and LESHKEVICH, G.[2], [1]MTRI, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105; [2]NOAA GLERL, 4840 South State Road, Ann Arbor, MI, 48108. **Satellite Derived Primary Productivity Estimates for Lake Michigan.**

A new MODIS based satellite algorithm to estimate Primary Productivity (PP) has been generated and evaluated for Lake Michigan. The Great Lakes Primary Productivity Model (GLPPM) is based on the work of Morel and first utilizes the CPA algorithm developed by Pozdnyakov et al. to obtain an accurate chlorophyll (chl) satellite based retrieval value for Lake Michigan. The new algorithm then utilizes this chl estimate combined with water temperature, Kd, solar illumination, and carbon fixation rates to generate the primary productivity estimate. Comparisons of the satellite derived PP estimates to in situ measurements made by NOAA-GLERL show for spring and fall dates when there is no stratification the estimates are within 10%. The new algorithm can be easily adapted to work on all the Great lakes and therefore can be used to generate time series dating back to late 1997 (launch of SeaWifs). These time series can significantly contribute to improved assessment of Great Lakes primary productivity changes as a result of biological events, such as dreissenid mussel invasions, recent climatic variations and potential future climate change. *Keywords: Remote sensing, Chlorophyll, Phytoplankton, Lake Michigan.*

SILKE, R.[1], ROCHE, J.M.[1], AUDET, M.[1], HARTWIG, D.[1], ETHIER, A.L.M.[1], CORBETT, S.[1], STUART, M.[1], SHULTZ, C.[1], WILLS, A.[1], LEE, D.R.[1], ROWAN, D.J.[1], MACCAFFERTY, M.[1], WILSON, R.[2], and JONES, C.[3], [1]Atomic Energy of Canada Limited, Chalk River, ON; [2]Wilson Scientific Consulting Inc., Vancouver, BC; [3]Sea Engineering Inc., Santa Cruz, CA. **Nuclear Legacy Liabilities on the Ottawa River: Risk Assessment and Remediation Strategy for Ottawa River Sediment.**

The Ottawa Riverbed Remediation Project is one of the legacy liabilities currently being managed by Atomic Energy of Canada Limited (AECL) and Natural Resources Canada under the Nuclear Legacy Liabilities Program. Process water from Chalk River Laboratories' (CRL) operational activities has been entering the Ottawa River via the Process Outfall for over 60 years. The Process Outfall effluent has met and continues to meet regulatory requirements. However, sampling and analysis of river sediments adjacent to, upstream and downstream of the Process Outfall has detected above-background levels of radiological and non-radiological substances adjacent to the CRL site. This presentation discusses the characterization and risk assessment work currently underway to thoroughly evaluate the sediment for potential human health and ecological impacts. Under current conditions, assessments done to date indicate that risks are low and acceptable. Results from this work will be used as input to an effective remediation decision-making assessment process. The end goal of this process is to determine a recommended remediation strategy for contaminated sediment in the Ottawa River adjacent to AECL's CRL site. *Keywords: Sediments, Remediation, Risk assessment.*

SINGH, A., JENNIFER, D., HAYES, K., and WILHELM, L., Credit Valley Conservation Authority, 1255 Old Derry Road, Mississauga, ON, L5N 6R4. **Background On-Near-Offshore Water Quality of Lake Ontario under Credit Valley Conservation Authority's Jurisdiction.**

Credit River Conservation Authority (CVCA) initiated Lake Ontario Integrated Shoreline Strategy (LOISS) study in 2009. This multi-disciplinary study aims to improve ecological environment of Lake Ontario shoreline that is under CVC's jurisdiction. The LOISS study area comprises highly urbanized landuse that was developed in the era when stormwater management techniques like stormwater ponds and LID were not implemented. As a result the tributaries draining the urban dwellings are very flashy and bring high contaminant loads to the Lake. The water quality component of LOISS study focuses on identifying sub-catchments that contribute high contaminant loads to the lake. The recommendations of the background study suggested conducting water quality sampling, onshore water quality modeling to simulate loads of pollutants to the Lake, and lake modeling to understand hydro and pollutant dynamics. In the Phase-1 of the study intensive water quality monitoring was launched. The sampling design included wet and dry period sampling at mouth of the tributaries, four beaches, and offshore variable depth transect sampling. On-shore modeling and lake modeling studies have also been initiated. The water quality monitoring results and methodology of modeling exercises would be discussed in the presentation. *Keywords: Water quality, Nutrients, Lake Ontario.*

SLAWECKI, T.A.D., DEKKER, T.J., DEPINTO, J.V., and PETERSON, G.W., LimnoTech, 501 Avis Driive, Ann Arbor, MI, 48108. **Data Management and Communications (DMAC) for Observing Systems.**

The Great Lakes Observing System (GLOS) is a Regional Association of the US NOAA Integrated Ocean Observing System (IOOS). IOOS has developed many requirements and guidelines for data handling that are realized in the Data Management and Communications (DMAC) layer. This presentation will explain key DMAC components and how they support the GLOS mission and effective decision support. *Keywords: Data acquisition, Data storage and retrieval, Decision making.*

SMART, A.M.[1], MCNAUGHT, A.S.[1], and OGREN, S.A.[2], [1]Central Michigan University, Brooks Hall, Mt. Pleasant, MI, 48858; [2]Little River Band of Ottawa Indians, 375 River Street, Manistee, MI, 49660. **Ecological Requirements of Wild Rice (*Zizania spp.*) in Michigan.**

Zizania aquatica and *Z. palustris* (wild rice) are historically significant aquatic plants in Michigan and were once an important component of drowned river mouth and inland wetlands throughout the state. Native Americans traditionally harvested wild rice in the fall as a food resource to use throughout the winter months. The purpose of this study is to determine which environmental factors facilitate or inhibit wild rice growth in Michigan. Thirty-six sites (18 locations with rice-no rice pairs) were selected in the Upper and Lower Peninsulas. Water and sediment samples were collected 4 times from each site May-September 2011. Water samples were tested for nutrients, alkalinity, pH, conductivity, oxygen and temperature. Sediment samples were tested for nutrients, particle size distribution, and percent organic matter. Depth variation was recorded and water movement was calculated using clod cards. Several abiotic factors differed between locations; however so far no difference between rice and non-rice sites are visible. Land use and shoreline development rather than specific water and sediment characteristics may govern the success of wild rice in Michigan. *Keywords: Wild rice, Ecosystems, Nutrients.*

SMITH, A.[1], DELANEY, C.[1], GULKA, A.[1], LE FÉON, S.[1], MARTY, J.[1], TWISS, M.R.[2], CRITOPH, C.[3], MORLEY, A.[4], and RIDAL, J.J.[1], [1]St Lawrence River Institute, 2 St Lawrence Drive, Cornwall, ON, K6H 4Z1; [2]Great Rivers Center, Clarkson University, Potsdam, NY, 13699; [3]Raisin Region Conservation Authority, Cornwall, ON; [4]Ontario Ministry of the Environment, Eastern Region, Program Services Section, Kingston, ON. **Assessing Temporal and Spatial Variability in Water Quality in the Nearshore Area of the Fluvial Lake St Francis, Cornwall AOC.**

Water quality was monitored in the nearshore zone of the fluvial Lake St Francis (St Lawrence River, Cornwall AOC) to identify the influence of 8 tributaries on the spatial variability in water quality parameters over a 3 year period, between May to October of each year. Discrete samples (2009) and measurements from a multi-probe meter (2010-2011) were collected for turbidity, specific conductivity, temperature, algal biomass as chlorophyll a and phycocyanine fluorescence. A predictive model for total phosphorous (TP) based on turbidity,

specific conductivity and temperature was developed as a tool to map TP at a larger spatial scale and identify nutrient rich areas exceeding the 20 µg.L-1 provincial guidelines. Overall, TP ranged from 9 µg.L-1 (clear waters) to above 200 µg.L-1 associated with the eutrophic tributary Pattingale. Average TP concentrations doubled between 2009 and 2010 and were lowest in 2011 due to reduced flow conditions in tributaries. Additional variation in TP was explained spatially by to the influence of nutrient rich tributaries (Raisin, Pattingale, Sutherland and Westleys). This study highlights the importance of considering spatial and temporal variations in the design of water quality monitoring programs to provide reliable recommendations to manage nutrients in flowing waters. *Keywords: Water quality, Phosphorus, GIS.*

SNYDER, R.J.[1], BURLAKOVA, L.E.[2], KARATAYEV, A.Y.[2], and MACNEILL, D.B.[3], [1]Biology Dept., Buffalo State College, 1300 Elmwood Ave., Buffalo, NY, 14222; [2]Great Lakes Center, Buffalo State College, 1300 Elmwood Ave., Buffalo, NY, 14222; [3]New York Sea Grant Extension, SUNY Oswego, Oswego, NY, 13126. **Evaluating Ponto-Caspian Fishes for Risk of Great Lakes Invasion.**

A majority of invasive species discovered in the Great Lakes since 1985 are native to the Ponto-Caspian region, and these include species that have had strong negative impacts in the Great Lakes (for example, dreissenid mussels and the round goby). The rich biota of the Ponto-Caspian region coupled with a high volume of commercial shipping traffic strongly suggests that this region will continue to be a major source of invasive species to the Great Lakes. Although previous studies have identified several high risk invasive fishes from the Ponto-Caspian region including the tyulka, the Eurasian minnow, and the monkey goby, it is likely that other potential fish invaders have yet to be identified because of a lack of information available to western scientists. To update lists of potential high risk fish invaders from the Ponto-Caspian region, we first reviewed and translated primary scientific literature from the former Soviet Union. We then analyzed a suite of physiological and ecological parameters using multivariate statistical techniques to identify new Ponto-Caspian fishes with a high risk of successful Great Lakes invasion. *Keywords: Invasive species, Risk assessment, Ponto-Caspian basin.*

SPEAR, P.A.[1], GENDREAU-BERTHIAUME, E.[1], AVERILL, A.[1], BRODEUR, P.[2], and BOILY, M.[1], [1]Department of Biological Sciences, University of Québec at Montreal, Montreal, QC, H3C 3P8; [2]Ministre des Ressources naturelle et de la Faune du Québec, Trois-Rivières, QC, G9A 5S9. **Investigations into Oxidative Stress, Antioxidants and Retinoids in Brown Bullheads, Yellow Perch, and American Bullfrogs in the Yamaska River and Lake Saint-Pierre.**

The Lake Saint-Pierre aquatic ecosystem has been chronically subjected to multiple pressures leading to fish population declines. In order to improve the situation, it is essential to identify key stressors. A series of experiments was conducted using three aquatic vertebrates to examine possible impacts on retinoid (vitamin A), antioxidants and lipid peroxidation (as indicated by malonaldehyde concentrations). Yellow perch (Perca flavescens) and brown bullheads (Ameiurus nebulosus) collected from Lake Saint-Pierre had lower malonaldehyde concentrations in liver, but significantly greater malonaldehyde levels in axial muscle, when

compared to fish at reference site and a moderate agricultural site on one of the lake's tributaries, the Yamaska River. In addition, the Saint-Pierre fish had lower plasma levels of two retinoic acid metabolites. Studies conducted in parallel with bullfrogs (Lithobates catesbeianus), focused on the lipid peroxidation - antioxidant balance in skin. Among the results, the antioxidants α-tocopherol and zeaxanthine were significantly elevated in 'agricultural' sites compared with two reference sites in the Yamaska River. *Keywords: Environmental effects, Antioxidants, Amphibians, Retinoids, Oxidative stress, Yellow perch.*

SPENCE, C.[1], BLANKEN, P.D.[2], HEDSTROM, N.[1], LENTERS, J.D.[3], and VAN CLEAVE, K.[3], [1]Environment Canada, Saskatoon, SK; [2]University of Colorado, Boulder, CO; [3]University of Nebraska, Lincoln, NE. **Changes in Autumn and Spring Climate Led to Increases in Lake Superior Evaporation.**

Recent measurements taken as part of the International Upper Great Lakes Study have provided new information on the physical controls on Lake Superior evaporation. Observational data at the Stannard Rock Light show that evaporation from Lake Superior can react within hours to days to a change in synoptic conditions. However, the large heat capacity of the lake creates a definite seasonal cycle of energy storage and release. The now four year record of evaporation rates and meteorological conditions at Stannard Rock permits the testing of hypotheses of how evaporation from such a large lake responds to atmospheric conditions over the longer time frames of months to years. Feedbacks with ice cover have long been suspected to be important for evaporation because it is during winter when latent heat fluxes are highest. Results show there is a complex interaction between heat storage, evaporation, and ice cover that is highly susceptible to atmospheric conditions in the spring and autumn. Even small differences in synoptic scale events during November and March have profound impacts on annual evaporation, the extent of ice cover and the length of the ice covered period. These results imply that sound prediction of future Laurentian Great Lakes evaporation regimes will require robust information on expected c *Keywords: Hydrologic budget, Lake Superior, Evaporation, Climate change.*

STACEY, J.A.[1], PRATT, T.C.[2], and FOX, M.G.[3], [1]1Environmental & Life Sciences Graduate Program, Trent University, Peterborough, ON, 1159 Northridge St. Oshawa, ON, Peterborough, ON; [2]2Fisheries and Oceans Canada, Sault Ste. Marie, ON, Sault Ste. Marie, ON; [3]3Environmental and Resource Studies Program and Department of Biology, Trent University, Peterborough, ON. **Characterization and Comparison of American Eel (*Anguilla rostrata*) Diets in Two Stocking Locations in Lake Ontario and the Upper St. Lawrence River.**

To offset the widespread decline of American eels (Anguilla rostrata) in Lake Ontario and the St. Lawrence River, the DFO and OPG have implemented stocking programs in the regions of the Thousand Islands (TI) and Bay of Quinte (BQ). As these two locations may vary in their suitability for eel growth and development, the aim of this study was to i) characterize the dietary components of eels in both regions, and ii) compare prey items and the amount consumed by eels between regions. Boat-electrofishing was used to capture eels in May and September, 2010-2011. Stomach contents were identified to order and quantified based on their

percent by weight, volume, and number and stomach fullness index was compared between locations and seasons using a two-way ANOVA. The condition factor, mean length at age, and dietary diversity were also compared between the two stocking locations and the same comparisons were drawn between eels collected from two streams that flow into the Bay of Quinte, and eels collected from sites within the Bay itself to compare lentic and lotic habitats. The initial results suggest that both stocking locations are comparatively adequate for feeding and growth and indicate that both are equally suitable for future stocking efforts. *Keywords: Lake Ontario, Fish diets, Bay of Quinte.*

STAINSBY, E.A. and MACRITCHIE, S.M., 125 Resources Road, Etobicoke, ON, M9P 3V6, Canada. **Lake Simcoe Watershed Climate Change Vulnerability Assessment: Water Quantity and Quality.**

Climate change projections from 10 climate models were used as input to a simple water balance model to determine the impact of climate change on the hydrologic cycle in the Lake Simcoe watershed. The current sensitivity of Lake Simcoe and its 18 subwatersheds was evaluated using a variety of indicators for water quantity and water quality. These analyses were used to evaluate the vulnerabilities, stressors and potential adaptation measures in the Lake Simcoe watershed. Climate change impacts on Lake Simcoe itself were estimated along with potential consequences. A method for assessing adaptive capacity for water quality and quantity is suggested. *Keywords: Climate change, Water quality, Lake Simcoe.*

STAMMLER, K.L.[1], MOHAMED, M.[2], and TAYLOR, W.D.[1], [1]University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1; [2]Ontario Ministry of the Environment, 125 Resources Road, Etobicoke, ON, M9P 3V6. **Linking Long Term Trends in Stream Nutrient Concentrations and Changing Agricultural Practices in Southern Ontario.**

In Ontario, there have been recent changes in agricultural intensity (e.g. increased livestock/hectare), the type of land use (e.g. increased cropland, decreased pasture and woodlot) and conservation practices (e.g. increased conservation tillage). However, the effects of these changes on water quality are poorly understood. This study examines long-term (1978-2010) trends of nutrient concentrations (total nitrogen and total phosphorus) in streams with varying degrees and types of agricultural practices and the relationships between these practices and surface water quality over time. Sample stream sites were selected from the Provincial Water Quality Monitoring Network, which collects water quality data approximately 8 times each year from April to November. Land use data were obtained from the Census of Agriculture, which is conducted by Statistics Canada every 5 years (1981-2006). Using ArcGIS, census data (e.g. land use, livestock, and conservation practices) for each year will be used to describe the sample watersheds in order to relate changes in agricultural practices to observed trends in nutrient concentrations. This research will help to define the role of agricultural practices in contributing nutrients to the Great Lakes and whether certain practices amplify or mitigate those contributions. *Keywords: Temporal trends, Agriculture, Nutrients.*

STANFIELD, L.W., Ontario Ministry of Natural Resources, 41 Hatchery Lane, Picton, ON, K0K 2T0. **Quantifying Assimilative Capacity of all Tributaries to Lake Simcoe Based on Cumulative Impacts to Biological Integrity.**

This project developed landscape models to quantify the factors that are correlated with metrics of fish and benthos communities in tributaries to Lake Simcoe. The premise for this study is that healthier food chains are likely contributing lower volumes of phosphorus to Lake Simcoe. General linear modeling is used to generate models from a correspondence analysis metric of the fish assemblages and a Hilsenhoff Index for benthic invertebrates. The analysis incorporates a measure of the cumulative effects of both fragmentation due to barriers and land use to each site, after accounting for primary catchment conditions of area, geology, slope and climate. Site condition is compared to a hindcasted reference condition of total forest cover in order to classify segments as impaired, likely impaired and unimpaired. Modeling results are compared to outlet loads of phosphorus to Lake Simcoe as a means of identifying priority areas for stewardship activity. The study and the findings will be described and a demonstration provided of how this approach facilitates better decisions about managing impacts to both Lake Simcoe and its tributaries will be provided. Finally, how this project is linked to the broader initiatives of monitoring cumulative effects assessment in southern Ontario will be discussed. *Keywords: Environmental effects, Watersheds, Computer models.*

STEIN, S.R.[1], ROSWELL, C.R.[1], WILSON, A.E.[2], BOWEN, G.J.[1], TROY, C.D.[1], and HÖÖK, T.O.[1], [1]Purdue University, 715 West State St., West Lafayette, IN, 47907; [2]Auburn University, Department of Fisheries and Allied Aquacultures 203 Swingle Hall, Auburn, AL, 36849. **Habitat Characterization of Southern Lake Michigan River Plumes: Implications for Fish Recruitment.**

Great Lakes rivermouths and river plumes provide unique transitional habitats between tributary and lake systems. Previous research has demonstrated that in some estuarine and lacustrine ecosystems, river plume habitats enhance young fish growth and survival, thus increasing subsequent recruitment. In Lake Michigan, fish recruitment is undoubtedly influenced by spatial and temporal environmental heterogeneity, and the relative importance of rivermouth habitats to fish recruitment is poorly understood. To thoroughly characterize the environmental conditions that young fish may experience in Lake Michigan river plumes, we measured physical parameters, collected water, zooplankton, benthic macroinvertebrates, and larval fish at four rivermouths in southern Lake Michigan during 2011. We analyzed nutrient concentrations of water samples, and identified, enumerated and measured invertebrates and larval fish. Additionally, we quantified hydrogen and oxygen stable isotopes of water samples and invertebrates, and analyzed RNA:DNA ratios (an index of recent growth) of larval fish. Preliminary results indicate that 1) lower trophic level patterns varied among tributary mouths and 2) interestingly, larval fish species composition, density, and RNA:DNA ratios did not differ considerably between plume and non-plume sites. *Keywords: Tributaries, Coastal ecosystems, River plumes, Fish.*

STEWART, T.J.[1] and LANTRY, B.F.[2], [1]Ontario Ministry of Natural Resources, Lake Ontario Management Unit, Picton, ON, K0K2T0; [2]USGS Great Lakes Science Center, Lake Ontario Biological Station, Oswego, NY, 13126-1025. **Lake Ontario Ecosystem Surveillance Using Large Vessels: Challenges and Opportunities.**

Management for sustained benefits requires that information from Great Lakes surveillance programs (water quality, contaminants, lower trophic levels and fish) be integrated into knowledge of the interactions and influences among the biotic and abiotic components. Bi-national inter-agency planning and reporting initiatives such as Lakewide Management Plans have fostered improved co-operation, synthesis, and communication. Building on these successes, a whole-lake integrated Lake Ontario surveillance program is in the planning stages for 2013. We review recent Lake Ontario large vessel surveillance activities and discuss the challenges and opportunities for a renewed integrated ecosystem surveillance program. We propose elements of a 2013 sampling and modeling framework for discussion. *Keywords: Assessments, Biomonitoring, Lake Ontario.*

STOCKWELL, J.D.[1], YULE, D.L.[2], HRABIK, T.R.[3], SIERSZEN, M.E.[4], and ISAAC, E.J.[5], [1]University of Vermont, Rubenstein Ecosystem Science Laboratory, Burlington, VT, 05401; [2]USGS Lake Superior Biological Station, 2800 Lakeshore Drive Eas, Ashland, WI, 54806; [3]University of Minnesota Duluth, 211 Life Science, Duluth, MN, 55812; [4]US Environmental Protection Agency, 6201 Congdon Boulevard, Duluth, MN, 55804; [5]Grand Portage Band of Lake Superior Chippewa, PO Box 428, Grand Portage, MN, 55605. **Native Fish Communities and Habitat Coupling: Delivery of a Nearshore Energy Subsidy by an Offshore Planktivore.**

In systems where native fishes have been greatly reduced or extirpated, processes such as transport of energy and nutrients across habitats may be lost to the detriment of remaining native species. We hypothesized that fall spawning migrations of rehabilitated Lake Superior cisco provide a spatial resource subsidy from offshore pelagic to nearshore benthic communities over winter, in the form of energy-rich eggs, when alternate prey production is likely low. We tested this hypothesis using population demographics, diet and stable isotope analyses, and bioenergetics modeling. Our results suggest that cisco eggs represent 16% of lake whitefish annual consumptive demand on a biomass basis, but 35% on an energetic basis because of their high energy density (>10 kJ/g wet). Stable isotopes corroborated these results, and suggest other nearshore fish species also may rely on cisco eggs. Cisco eggs likely play an important role for post-spawn recovery and future reproductive output of whitefish. In the other Great Lakes where cisco populations remain low, this offshore-to-inshore ecological link has been replaced by non-native planktivores which spawn in spring, have smaller eggs, and shorter incubation periods. Our work suggests rehabilitation of native fishes may provide additional benefits beyond simple predator-prey considerations. *Keywords: Stable isotopes, Food chains, Lake Superior.*

STOKES, Y.F., WAGNER, C.A., and WILLIAMS, V.A., Wild Goose Chase, Inc., 106 W. Calendar Court PMB 171, LaGrange, IL, 60525. **The Impact of Summer Gull Management Programs on *Escherichia coli* Levels at Two Chicago Beaches.**

Historically, 63rd Street Beach in Chicago, IL has been plagued with excessive *Escherichia coli* levels. *E.coli* is often used as an indicator of the presence of fecal and possibly pathogenic bacteria. Numerous studies have been conducted throughout the Great Lakes to identify the nature and potential sources for these levels, and have linked the high levels in gull feces with levels in sand and water samples. Wild Goose Chase, in conjunction with the Chicago Park District, implemented a gull management program for both the 63rd Street and 57th Street Beaches every summer from the end of May through August since 2007 (except 2009), with the objective of reducing exceedances. We accomplished this with either daily dawn to dusk patrols or an abbreviated chase program, using trained Border collies to mimic a natural predator, preventing gulls from foraging or loafing. Dog Handlers also educated patrons feeding gulls and picked up trash to reduce food attractants. This can, for the duration of the program, condition gulls to choose another site entirely, leading to significantly reduced levels in *E.coli* (χ^2=60.5, df=4, p<0.0001), therefore exceedances. Even an abbreviated program, though less effective, can significantly reduce overall gull numbers and *E.coli* levels (χ^2=35, df=4, p<0.0001). *Keywords: Lake management, Human health, Water quality.*

STONE, A.G., HANSON, P.C., and CARPENTER, S.R., UW-Madison Center for Limnology, 680 N Park St, Madison, WI, 53706. **From Sensors to Drivers: Understanding Potential Drivers of Algal Blooms Using in-situ Fluorescence Measurements as a Response Variable.**

Spatio-temporal dynamics of algal blooms remain poorly understood, largely due to multiple drivers, sampling limitations, and spatial variability itself. With the advent of rapid sampling technologies, sampling regimes can be augmented with rapid fluorescence sampling of algal pigments (chlorophyll and phycocyanin) that can substantially improve spatial and temporal sampling scopes. We measured algal fluorescence weekly during the open water season on Lake Mendota to quantify mixed-layer chlorophyll and phycocyanin. Phycocyanin and chlorophyll showed markedly different seasonal patterns; temporal patterns of biomass better matched phycocyanin patterns than chlorophyll, as 74% of biomass was cyanophytes during this period. These fluorescence measurements were modeled using a suite of potential driver variables. Major drivers of fluorescence were seasonal succession, stability, elevated winds over several days, and calm winds on the sampling day; these results suggest the importance of internal mixing of nutrients and a stable water column for buoyancy regulation of algal bloom development. *Keywords: Water quality, Harmful algal blooms, Algae.*

STOW, C.A., HAWLEY, N., RUBERG, S.A., and CONSTANT, S.A., NOAA GLERL, 4840 South State Road, Ann Arbor, MI, 48108. **Rapid Summertime Oxygen Depletion in Saginaw Bay.**

Saginaw Bay can be divided into an inner and an outer bay based on differences in physical characteristics and water quality. The outer bay is cold, deep, nutrient-poor and strongly

influenced by the main body of Lake Huron while the inner Bay is warm, shallow, nutrient-rich and strongly influenced by inputs from the Saginaw River. Because of its long fetch and shallow depth the inner bay has been thought to be vertically well-mixed and isothermal. However, sensors deployed in 2009-2011 in the deep area of the inner bay reveal periodic summer stratification, with rapidly declining oxygen levels near the bottom. Measurements in 2010 indicate that cold water from the outer bay entered the deep area in August, temporarily elevating oxygen levels, but subsequent rapid oxygen depletion occurred even at temperatures of approximately 14 degrees C. No such cold pulse was observed in 2011, but bottom oxygen conditions fluctuated regularly, with the lowest levels occurring in October as temperatures were also declining. The spatial extent of these low oxygen levels is unknown, but the declines occur so regularly and rapidly that the potential exists for conditions to occur that promote sediment phosphorus release, in a basin that has never met the target phosphorus load established by the Great Lakes Water Quality Agreement. *Keywords: Anaerobic conditions, Lake Huron, Bottom currents.*

STUMPF, R.P.[1], WYNNE, T.W.[1], TOMLINSON, M.C.[1], FAHNENSTIEL, G.[2], and BAKER, D.B.[3], [1]NOAA National Ocean Service, 1305 East-West Highway, Silver Spring, MD, 20910; [2]NOAA Great Lakes Environmental Research Lab, 1431 Beach St, Muskegon, MI, 49441; [3]Heidelberg University, National Center for Water Quality Research, Tiffin, OH, 44883. **10 Years of Variation in Cyanobacteria Blooms in Lake Erie.**

Using satellite imagery from the Medium-spectral Resolution Imaging Spectrometer (MERIS), we have estimated the extent and concentration of cyanobacteria blooms in Lake Erie from 2002 to 2011. The results allow us to characterize these blooms for timing, location, and severity. Six years (2003, 2004, 2008-2011) had well-defined cyanobacteria blooms. For five of these years, the bloom peaked between mid-August and mid-September. In 2011, the largest and most extensive bloom, the peak did not occur until the beginning of October. This bloom covered some 5000 square km of the lake at its peak, and contained as much as 2-4 times the biomass of the next most severe bloom. The severity of the blooms can be equated with nutrient loads, providing a means to better understand the causative factors. *Keywords: Climatology, Harmful algal blooms, Lake Erie.*

STURTEVANT, R.A. and FUSARO, A.J., NOAA Great Lakes Environmental Research Laboratory, 4840 South State Road, Ann Arbor, MI, 48108. **GLANSIS : An Enhanced Tool for Rapid Response.**

The Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS - http://www.glerl.noaa.gov/res/Programs/ncrais/glansis.html) is a Great Lakes specific node of the USGS Nonindigenous Aquatic Species (NAS) system. GLANSIS has been selected as the backbone for AIS information reporting for the Great Lakes region under the Great Lakes Restoration Initiative. Enhancements that have come online in recent months include enhanced bibliographic information (via ingestions of the defunct Sea Grant Nonindigenous Species - SGNIS - database), standardized impact assessments for established nonindigenous species, non-technical versions of fact sheets for high impact species, overviews of current state and federal

regulations and management practices, and improved information resources for range-expansion and watchlist species. Taken together, these enhancements greatly improved the capacity of the database to support early detection and rapid response as well as improved database support for decision making and priority setting by Great Lakes resource managers. *Keywords: Invasive species, Management, Outreach.*

SUBICH, C.J.[1], STASTNA, M.[1], WELLS, M.G.[2], and COSSU, R.[3], [1]University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1; [2]University of Toronto, 1265 Military Trail, Toronto, ON, M1C 1A4; [3]University of Toronto, 22 Russell Street, Toronto, ON M5S 3B1. **Numerical Studies of Near-Boundary Currents in Lake Simcoe.**

Using both the MIT General Circulation Model (MITgcm) and two-dimensional, high-resolution, fully nonhydrostatic numerical simulations, the dynamics of near-boundary motion in Lake Simcoe in response to internal seiching are studied. With an internal temperature profile corresponding to Lake Simcoe in the late summer of 2011, three-dimensional simulations with MITgcm show strong near-boundary currents on the order of 10 cm/s developing in response to a gentle seiching motion. From rest, the initial thermal stratification of the lake was disturbed by a ±2.5 m vertical variation over the entire horizontal (north/south, east/west) extent and allowed to freely adjust. Boundary currents were the greatest in regions where the thermocline intersected the bathymetry. High-resolution, two-dimensional studies subsequently undertaken reveal more detail of the resulting near-boundary velocity structure. This is presented along with a discussion of the shear stress at the boundary, with implications for sediment resuspension. Additionally, qualitative comparisons are made with observed data taken from several thermistor chains and ADCP sites along the southeastern slope of Lake Simcoe from the 2011 late summer/early fall season. *Keywords: Boundaries, Lake Simcoe, Nonhydrostatic simulation, Computer models, Bottom currents.*

SULLIVAN, J.M. and BOYER, G.L., State University of New York College of Environmental Science and Forestry, 1 Forestry Drive, Syracuse, NY, 13210. **Nutrient Effects on Spectral Properties of Phytoplankton.**

Microcystis is a cyanobacterial genera present in the Great Lakes and other freshwater systems which is capable of forming blooms and producing toxins. These cyanobacterial blooms often occur as a mixture of different genera. It would be beneficial to detect potentially toxin producing genera by *in situ* autonomous techniques. Cultures of the cyanobacteria *Microcystis* and *Anabaena* and the chlorophyte *Chlorella* were grown in BG11 and ASM media. Pigments from cultures were extracted in acetone and identified by reverse-phase HPLC. The light spectrum, 350 nm to 800 nm, from each culture was also analyzed by capillary cell spectrometry and converted to its fourth derivative. Similarity indexes clearly separated *Chlorella* from the two cyanobacterial genera. *Anabaena* and *Micricystis* could also be distinguished under controlled conditions. The effects of nutrients and light on these similarity indexes are currently being assessed.

SUN, Y.[1], WELLS, M.G.[1], and BAILEY, S.A.[2], [1]Department of Physical and Environmental Sciences, University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A4; [2]Fisheries and Oceans Canada, 867 Lakeshore road, Burlington, ON, L7R 4A6. **The Influences of Physical Flushing Timescales on the Spatial Distribution of Plankton in Lake St. Clair.**

The physical mixing in Lake St. Clair shows marked difference in its spatial distribution, characterized by a fast-flushing northwestern region and a low-flushing southeastern region. To investigate the influences of physical flushing on other ecological properties, six transects across Lake St. Clair were measured in June 2011 using CTD probes and an Laser Optical Plankton Counter (LOPC), which is able to count plankton with size range of 20-22,000 um. Results confirmed the significant basin-scale differences in terms of temperature, conductivity, turbidity, chlorophyll a, plankton density and concentration. These indices are lower in the northwestern region relative to the southeastern region. Relative to biological properties (e.g., plankton density), physical and chemical properties (e.g., temperature) show more significant the basin-scale differences across Lake St. Clair. Within either the northwestern region or the southeastern region the results confirm the existence of considerable sub-scale heterogeneities. These sub-scale heterogeneities indicate distinct water masses that can be defined by salinity, which is calculated based on temperature and conductivity. Both basin-scale and sub-scale heterogeneities in Lake St. Clair are closely related to the inflows of the St. Clair River and the Thames River. *Keywords: Lake St. Clair, Plankton.*

SWEENEY, S.J., THUSS, E.P., ROTH, K.S., DAVEY, C., VAN GERVEN, B., BUTTENHAM, M., ASPINALL, J.D., and BIRCHMORE, J., Ontario Ministry of Agriculture, Food and Rural Affairs, 1 Stone Road West, Guelph, ON, N1G 4Y2. **Healthy Great Lakes Supported by Healthy Watersheds: Monitoring Agricultural Activity Field-by-Field in Rural Ontario.**

Detailed understanding of tributary water quality comes from detailed knowledge of the temporal and spatial changes in the agricultural landscape. A new Ontario Agricultural Resource Inventory (AgRI) has been developed incrementally by OMAFRA since 2005. Presently, it is a high-resolution, digital polygon framework for Ontario's farm landscape with associated multi-temporal databases of cropping and tillage system attributes for cropped fields. Farm field observations are the key ground truth data for expansion of these databases for each cropping season. Other AgRI polygons, that further characterize Ontario's rural landscape, include farmsteads, fencerows, on-farm ditches and roadways, rural residential, rural business, recreational and institutional features. Development work for the AgRI includes conservation practice (grassed waterways, berms, water and sediment control basins, windbreak/shelter belt characterization, etc.) and special agricultural feature delineation (greenhouses, ginseng stands, orchards, vineyard blocks, farm implement dealerships, grain elevators, etc.). Recent subwatershed-level intensive water quality investigations have incorporated field-by-field cropping and tillage systems monitoring and characterization of farmstead commodities and manure management systems as study components. *Keywords: Crops, Watersheds, Agricultural landscape mapping, GIS, Data acquisition, High-resolution digital polygon framework.*

TALL, L.[1], ARMELLIN, A.[2], PINEL-ALLOUL, B.[1], and MÉTHOT, G.[1], [1]Université de Montréal, Département des sciences biologiques, GRIL, Montréal, QC, H3C 3J7; [2]Environnement Canada, Direction des sciences et technologie de l'eau, Montréal, QC, H7E 2E7. **Multiscale Effects of the Hydrology and Environmental Variables on Macroinvertebrates in Wetlands of the Lake Saint-Pierre, St. Lawrence River.**

In the St. Lawrence River, wetlands are affected by multiple stressors which act at various scales: global climate-induced hydrological changes, regional impact of watershed land use, and local variations in nutrient enrichment or water chemistry. Macroinvertebrates have been extensively used in biomonitoring programs, and are considered as a potential indicator of ecological integrity of littoral wetlands of Canadian large rivers. However, no study has attempted to assess the cumulative impacts of multiple stressors, acting at different scales, on macroinvertebrates in littoral wetlands. This study describes lake-wide distribution and composition of macroinvertebrate communities in emergent vegetation of high marsh wetlands in Lake Saint. Pierre. Sampling was carried on September 2004, 2005 and 2006 in sixty-one sampling sites located in the littoral wetlands and distributed in the different water masses of the St. Lawrence River. Macroinvertebrates were collected using a rectangular kick-net sampler during three minutes. We performed a redundancy analyses (RDA) to explain multi-scale variation in macroinvertebrate community structure. By order of importance, local environmental factors have predominant influence, closely followed by global environmental factors, and finally by regional environmental factors.

TAN, J.[1], CHERKAUER, K.A.[1], CHAUBEY, I.[1], TROY, C.D.[2], and ESSIG, R.R.[2], [1]Agricultural & Biological Engineering, Purdue University, West Lafayette, IN, 47906; [2]Civil Engineering, Purdue University, West Lafayette, IN, 47906. **Application of Satellite Remote Sensing to Monitor Episodic River Inflow Plumes in Southern Lake Michigan.**

The delivery of nutrients and sediments to Lake Michigan is a great concern in the agriculturally dominated Midwestern United States. Monitoring water quality of Lake Michigan related to heavy precipitation events has been found to be important since this part contributes significantly to the total inputs, especially these storm events are projected to be more frequent and intense in the future. In this study, we utilize multispectral remote sensing imagery, which is able to capture large-scale spatial information, to monitor and analyze episodic river inflow plumes in Southern Lake Michigan after storm events. Landsat 5 and 7 images provide regular high-resolution observations of water quality, while MODIS imagery is used to study plumes throughout Southern Lake Michigan. Concurrently, field measurements of spectral and water quality information are also collected to supplement the analysis. Boundaries of river plumes are first identified and visualized from the remote sensing images. Concentrations of optically sensitive water quality parameters such as Chlorophyll-a, dissolved organic carbon and total suspended solids are quantified by setting up the relationship between in-situ observations to the spectral reflectance acquired from both spectroradiometer and remote sensing images. *Keywords: Remote sensing, Water quality, Lake Michigan.*

TENNANT, T.A.[1], MOLOT, L.A.[1], WINTER, J.G.[2], and GINN, B.K.[3], [1]York University, 4700 Keele Street, Toronto, ON, M3J 1P3; [2]Ontario Ministry of the Environment, 125 Resources Road, Toronto, ON, M9P 3V6; [3]Lake Simcoe Region Conservation Authority, 120 Bayview Parkway, Newmarket, ON, L3Y 3W3. **Seasonal and Long-Term Trends in Diatom Composition in Lake Simcoe.**

Diatoms have dominated the ice-free phytoplankton community of Lake Simcoe since 1980 and long-term trends reflect a decrease in *Stephanodiscus* spp. and an increase in *Fragilaria* spp. biovolume. Ice-free season composite samples from each site were used in the study, which precluded a detailed analysis of how trends were related changes in phytoplankton seasonality, and diatom species were only identified to the genus level. Only 27% of the variance in the phytoplankton data was explained by chemical variables, water clarity, water column stability and the presence or absence of zebra mussels. The current study identified diatoms to the species level from seasonal (May-Nov and Nov-May) sediment trap samples collected from 2009 through 2011. In terms of relative abundance, S. *minutulus/parvus* dominated the ice-free community composition by up to 88.5%. Late fall-spring samples were dominated by S. *minutulus/ parvus*, S. *bideranus*, F. *crotonensis*, and T. *flocculosa*. Relationships between the abundance data and physical/chemical data will be analyzed. Seasonal pelagic samples will also be analyzed in relation to environmental variables. This study provides additional insight into factors that regulate seasonal and long-term trends in phytoplankton species composition
Keywords: Species composition, Seasonal trends, Lake Simcoe, Long-term trends, Diatoms.

THIEBERT, M.[1], PATERSON, G.[1], BHAVSAR, S.P.[2], and DROUILLARD, K.G.[1], [1]Great Lakes Institute for Environmental Research, University of Windsor, 401 Sunset Ave, Windsor, ON, N9B 3P4; [2]Sport Fish Contaminant Monitoring Program, Ontario Ministry of Envrionment, 125 Resources Rd., Toronto, ON, M9P 3V6. **Assessing Temporal Changes in Lake Simcoe Yellow Perch Growth and Contaminant Bioaccumulation.**

Yellow perch are an ecologically and economically valuable species as both a forage resource for top predators and a commercial and recreational fishing target in Canada. We collected multiple ages of yellow perch from two southern Ontario lakes to contrast temporal changes in perch growth, and PCB and mercury bioaccumulation in a population subject to a range of stressors (Lake Simcoe), to those in a less impacted population (Sharbot Lake). No difference in Sharbot Lake perch growth was evident between 2002/2003 and 2010 collections. This contrasts Lake Simcoe perch whose growth were significantly lower ($p < 0.001$; ANOVA) between collection periods. Sharbot Lake perch from 2010 averaged higher Hg bioaccumulation (0.11 ± 0.06 µg/g) relative to Lake Simcoe fish (0.06 ± 0.02 µg/g). However, age normalized concentrations indicated a higher Hg bioaccumulation rate for Lake Simcoe yellow perch. Likewise, PCB 180 bioaccumulaton rates increased in Lake Simcoe fish between 2002/2009 but not in Sharbot Lake fish. No differences in chemical bioaccumulation rates were evident between Lake Simcoe and Sharbot Lake in 2002, but higher bioaccumulation rates were evident for Lake Simcoe in 2009. The data suggest reductions in growth and increased foraging costs (bioaccumulation rate) occurred for Lake Simcoe perch in the past decade.
Keywords: Bioaccumulation, Lake Simcoe, Fish populations.

THOMPSON, J.A.[1], GHARABAGHI, B.[1], and WARNER, R.C.[2], [1]University of Guelph, Guelph, ON; [2]University of Kentucky, Lexington, KY. **Comparing the Particle Size Distribution of Parent and Eroded Soil at Construction Sites in the Grand River and Lake Simcoe Watersheds.**

Two construction sites were monitored in the Grand River and Lake Simcoe watersheds between April and October 2011 to determine the relationship between the particle size distribution (PSD) of the parent soil and the PSD of soil eroded from the site by water. Sediment leaving a site may contain nutrients, such as phosphorus, attached to the particles. These sediment bound pollutants travel downstream and may degrade ecosystem habitat. An enrichment ratio (ER) is used to describe the relationship between parent and eroded soil and is defined as the percent of material in the eroded divided by the percent of material in the parent. Preliminary work shows that at the field scale in Southern Ontario when water leaves the construction site the proportion of sand has decreased substantially in eroded sediment with an ER of 0.2, while both silt and clay have ERs well above 1 (6.8 and 7.3 respectively). This relationship can be used to predict the eroded PSD from future construction sites and allow for the design of best management practices (BMPs) that capture that specific range of particle sizes. By more effectively targeting the expected range, BMPs may increase their removal rate and subsequently reduce the downstream impact of the eroded sediment. *Keywords: Sediment transport, Sediment particle size, Lake Simcoe, Phosphorus.*

THUSS, E.P., ASPINALL, J.D., and SWEENEY, S.J., Ontario Ministry of Agriculture, Food and Rural Affairs, 1 Stone Road West, Guelph, ON, N1G 4Y2. **Soil Resource Information Renewal for Five Southwestern Lake Simcoe Watersheds.**

Current Ontario digital soil map polygons were digitized from legacy paper maps. The county-level soil survey maps covering the southwestern Lake Simcoe watershed region were printed at a scale of 1:63,360 (1 inch to 1 mile) and date from 1953 to 1962. The five subwatersheds that drain approximately 100,000 hectares in this area are the West and East Holland Rivers, the Maskinonge River, the Georgina Creeks and the Black River. Problematic issues with the legacy digital soil polygons for this region include oversimplified and over-smoothed boundaries, missed or inaccurate soil landscape unit groupings, lack of soil unit continuity across county boundaries and soil polygon displacement from correct landscape feature positions due to the "rubbersheeting" digital map production techniques. Morphologic characteristics of the landscapes for all named soil units in the study region are critical "soil concept" elements for renewal of the digital soil map polygons. Innovative digital landscape morphometric analyses were applied to the sub-metre vertical accuracy digital elevation model (DEM) for this region to renew the digital soil map polygons. Results obtained faithfully capture the distinct morphologic aspects of the original soil landscape concepts for each named soil unit in the study area. *Keywords: Predicitve digital soil mapping, Watersheds, Soil landscapes, Lake Simcoe, Spatial distribution, GIS.*

TONINGER, R., STILLE, J., and TKACZUK, V., 5 Shoreham Drive, Downsview, ON, M3N 1S4. **Strategic Restoration of Atlantic Salmon (*Salmo salar*) Habitat - A Case Study of a Partnered Approach to Restoring a Subwatershed in the Greater Toronto Area.**

The landscape and watercourses of the Greater Toronto Area have been altered affecting natural ecological processes. Toronto and Region Conservation (TRCA) has developed a process using desktop and field techniques based on hydrology to identify and prioritize restoration opportunities. This tool identified a 700ha catchment area of Mitchell Creek subwatershed. Atlantic salmon (*Salmo salar*) recovery was targeted as an initiative for the restoration of Mitchell Creek. A restoration implementation plan was created that would create a critical mass of ecological restoration. Through the plan roughly 6km of watercourse will be connected, to date 4.6km of this has been achieved through restoration projects by TRCA in partnership with Transport Canada, MNR, and OFAH. The case study will focus on a series of projects to enhance Atlantic Salmon and contributing habitat at the priority area. Restoration to date has included; decommission of three online ponds reinstating 325m of natural watercourse, creation of fish habitat, planting of 6ha of riparian zone, and enhancement of 2ha of wetland habitat. Pre and post monitoring conditions on a catchment level can be calculated to determine the overall benefit to the system. This process can be instrumental in measuring ecological benefits of restoration implementation. *Keywords: Watersheds, Atlantic salmon, Water quality, Restoration, Habitats, Ecosystem health.*

TOZER, D.C. and BADZINSKI, D.S., Box 160, 115 Front Street, Port Rowan, ON, N0E1M0. **Population Trends of Wetland Birds in Great Lakes Connecting Channels.**

Using data from Bird Studies Canada's Great Lakes Marsh Monitoring Program (GLMMP), we plan to estimate population trends of 7 wetland bird species (American Bittern, American Coot, Common Gallinule, Least Bittern, Pied-billed Grebe, Sora, and Virginia Rail) in the Great Lakes connecting channels, Great Lakes coastal wetlands, and across the entire Great Lakes basin between 1995 and 2011 using hierarchical modeling. Volunteers visited 1-8 points in emergent wetlands, twice per breeding season during the morning or evening. Call broadcasts of each species were used to increase detections. We plan to compare abundance and trends in abundance over time for each species among the channels, coastal wetlands, and across the entire Great Lakes basin. Bayesian precision analysis will be used to estimate the minimum detectable difference in annual population trends that the GLMMP is able to detect for each species in each of the three areas. We also plan to discuss future models that will attempt to correct abundances and trends in abundances for differences in detection probability, observer effects, and spatial autocorrelation; and explore whether abundance or trends in abundance vary with habitat. *Keywords: Wetlands, Marshes, Coastal ecosystems.*

TREMBLAY, K.A., Anishinabek/Ontario Fisheries Resource Centre, 755 Wallace Road, North Bay, ON, P1A 0E7, Canada. **The Anishinabek/Ontario Fisheries Resource Centre (A/OFRC) is Building Capacity amongst First Nations through Incorporating Scientific Method and Traditional Fishing Knowledge.**

The Anishinabek/Ontario Fisheries Resource Centre (A/OFRC) is a non profit organization that works with member First Nations of the Union of Ontario Indians, in regards to fisheries assessment and management. Since our inception in 1995, we have had the privilege of working with 18 different First Nations across Lake Huron and Lake Superior, and we have completed 58 projects in the Great Lakes basin. Projects varied from fish population assessments, investigations into species at risk, habitat mapping, gathering traditional fisheries knowledge, and educational workshops, to name but a few. The Pic River Lake Sturgeon telemetry project, Lake Huron Lake Whitefish index netting project, and Whitefish River Walleye tagging project are examples of successful projects that have incorporated scientific method and aboriginal traditional knowledge. Building capacity amongst our First Nation clientele is one of the goals of the A/OFRC, and success has been measured through the development of independent community fisheries departments. Our experience has shown that there is valuable information that can be gained from First Nations, and that communities are eager to gain scientific knowledge concerning their lands and waters. *Keywords: Fisheries, First Nations, Aboriginal.*

TRUMPICKAS, J., DOLSON, R., HANNIKAINEN, P., LA ROSE, J., LANGLEY, T., LIDDLE, G., and ROBILLARD, M., Lake Simcoe Fisheries Assessment Unit, Ontario Ministry of Natural Resources, 26465 York Rd. 18, Sutton West, ON, L0E 1N0. **Characteristics of the Round Goby Population of Lake Simcoe.**

Lake Simcoe is a large inland lake that has been invaded by a number of non-native aquatic species over the past 100 years. Among the most recent invaders is the round goby (*Neogobius melanostomus*), a species which is found throughout the Laurentian Great Lakes and is spreading into inland waters. It was first detected in a tributary of Lake Simcoe in 2004 and is now found throughout the lake. As of 2011, the round goby has been observed throughout the nearshore zone of the lake, in the profundal zone and has been captured in increasing numbers by recreational anglers. A variety of invertebrates, including *Dreissenid* mussels, were observed in the diet of Lake Simcoe's round gobies in 2009. Round gobies were found in the diets of piscivores such as black crappie (*Pomoxis nigromaculatus*), smallmouth bass (*Micropterus dolomieu*), rock bass (*Ambloplites rupestris*) and yellow perch (*Perca flavescens*). Preliminary results examining the spread, relative abundance, diet and life history characteristics of the Lake Simcoe round goby population are presented and compared to Great Lakes' populations. These are among the first results characterizing a round goby population from an inland lake in Ontario. *Keywords: Biological invasions, Lake Simcoe, Round goby.*

TUCKER, C.[1], MILFORD, L.[2], and GARRAWAY, M.[2], [1]Ministry of the Environment, 2 St. Clair avenue W, 8th Floor, Toronto, ON, M4V 1L5, Canada; [2]Ministry of Natural Resources, 300 Water Street, Peterborough, ON, K9J 8M5, Canada. **Climate Change and Source Water Protection.**

The Ontario government has introduced the Clean Water Act to protect drinking water at the source. The intent of the Act and its regulations is to ensure communities are able to protect their drinking water supplies through the development of locally driven, science-based protection plans. In order to assist with the evaluation of the impacts of Climate Change for Source Water Protection, the province has developed the "Guide for Assessment of Hydrologic Impacts of Climate Change", which contains an approach for developing Local Future Climate Data series, a summary of Potential Hydrologic Impacts of Climate Change, a step-by-step Climate Change Impact Assessment and a Case Study. The province has developed an approach to re-evaluating advanced water budgets and the Water Quantity Risk Assessments using the provincial Future Climate Data Series to determine the impact of climate change on quantity threats to drinking water and to assist Source Protection Committees on writing Source Protection Plan policies with considerations to Climate Change. This presentation will outline the Risk Management and Climate Change Evaluation Process to conduct an assessment of hydrologic effects of climate change and its relevance within source protection planning for Ontario's Source Protection Authorities and Municipalities. *Keywords: Climate change, Drinking water, Watersheds.*

TULUMELLO, B.L.[1], BURLAKOVA, L.E.[2], and KARATAYEV, A.Y.[2], [1]Biology Department, Buffalo State College, 1300 Elmwood Ave., Buffalo, NY, 14222; [2]Great Lakes Center, Buffalo State College, 1300 Elmwood Ave., Buffalo, NY, 14222. **Estimating the Change in Weight of *Dreissena polymorpha* and *Dreissena r. bugensis* Fixed in Ethanol.**

Invasive bivalves quagga and zebra mussels are ecosystem engineers that change the structure and function of many freshwater ecosystems including the Great Lakes. Although most physiological processes of bivalves are non-linear and dependent on size structure, often only total population densities of dreissenids are reported causing serious challenges in assessing their population dynamics and environmental impacts. Due to the common practice of preserving samples in ethanol that changes animal weight, re-calculation of initial biomass in fixed samples is complicated. To estimate the change in total wet weight of dreissenids fixed in ethanol we collected samples of zebra and quagga mussels in the summer of 2011 from Lake Erie. Shell length and live total wet weight (soft tissue and shell) of each specimen were recorded, along with the date of collection and time of fixation in 70% ethanol. Each specimen was then weighed at predetermined intervals to monitor the progression of weight loss due to preservation in ethanol. We found that the dreissenid weight changed significantly during the first two months since fixation. A correction factor derived from these data would allow the re-calculation of the initial biomass for historical data to compare studies over time. *Keywords: Dreissena, Biomass, Biological invasions, Weight.*

TURSCHAK, B.A. and BOOTSMA, H.A., School of Freshwater Sciences, 600 E. Greenfield Ave., Milwaukee, WI, 53204. **Food Web Changes in Lake Michigan as Revealed by Stable C and N Isotopes.**

Stable carbon and nitrogen isotopes are ecological tracers that can be used to elucidate primary energetic source(s) and trophic position of organisms within a food web. We used stable C and N isotopes to determine whether the Lake Michigan food web structure has changed in the past decade, coincident with the expansion of dreissenid mussels and a decrease in phytoplankton production. Fish samples collected near the port of Milwaukee, WI were analyzed to determine the 13C:12C (δ13C) and 15N:14N (δ15N) ratios. Sampling took place during two distinct periods 2002-2003 and 2010-2011, and species included lake trout, lake whitefish, bloater, yellow perch, alewife, rainbow smelt, slimy sculpin, and round goby. Fish δ13C and δ15N values were adjusted relative to primary consumers (dreissenid mussels) to facilitate meaningful temporal comparison. A similar shift in δ13C and δ15N was observed for both fish and invertebrates. Generally, δ13C shifted toward heavier benthic signatures while δ15N decreased between the study periods. These shifts may reflect the increased reliance upon nearshore benthic C as well as fewer trophic transfers, or changes in N cycling following the expansion of Dreissena in Lake Michigan. *Keywords: Food chains, Dreissenids, Stable isotopes, Round goby.*

TURSCHAK, B.A. and BOOTSMA, H.A., School of Freshwater Sciences, 600 E. Greenfield Ave., Milwaukee, WI, 53204, USA. **Preliminary Evidence of Round Goby (Neogobius melanostomus) Mucus as a Rapid Turnover Ecological Tracer.**

Stable C and N isotopes provide a time integrated measure of primary energetic source and trophic position of long lived aquatic organisms such as fish. While this provides obvious advantages to diet analyses, classical usage of C and N isotopes may overlook short term seasonal shifts in energetic source and trophic position. We compared seasonal changes in $^{13}C:^{12}C$ ($\delta^{13}C$) and $^{15}N:^{14}N$ ($\delta^{15}N$) ratios of round gobies using epidermal mucus relative to muscle tissue. Round gobies were collected from several depths in Lake Michigan during three time periods from June-Oct, 2011. Preliminary results suggest seasonal disparities between mucus and muscle tissue with respect to both $\delta^{13}C$ and $\delta^{15}N$, probably due to faster turnover rate of mucus. Generally, $\delta^{13}C$ of mucus was isotopically similar to muscle in June but became lighter by Aug. and Oct. $\delta^{15}N$ of mucus was slightly heavier than muscle in June but became lighter by Aug. and Oct. Seasonal diet shifts related to foraging location and/or prey abundance may be the cause of the observed differences. *Keywords: Food chains, Stable isotopes, Round goby.*

TWISS, M.R.[1], KINLOCK, N.[1], LOFTUS, S.[1], SMITH, D.E.[1], MARSHALL, N.F.[2], and SKUFCA, J.D.[2], [1]Great Rivers Center, Clarkson University, Potsdam, NY, 13699; [2]Department of Mathematics, Clarkson University, Potsdam, NY, 13699. **Saint Lawrence River Water Quality and Phytoplankton across Environmental Gradients.**

A consistent feature in the 180 km reach of the International Section of the St. Lawrence is the 2-4-fold decrease in phytoplankton biomass and a 10-fold decrease in zooplankton biomass in the river by the time water reaches the Brockville Narrows, with a slight recovery in phytoplankton with transit through fluvial Lake St. Lawrence. Water residence time in the main channel of the ISSLR is 5 d but the hydraulic residence time of the entire ISSLR is 12 d, proving that there are slackwater zones that could impact water quality. Through a combination of discrete water quality measurements along the entire reach and investigative mapping surveys to assess nearshore regions, which include tributary inputs, we show that water quality is significantly different between nearshore (< 2 m) and main channel zones. By comparing phytoplankton dynamics (growth rates and microzooplankton grazing rates) we demonstrate that phytoplankton growth and loss rates are the same in nearshore and main channel zones. Water temperature and the presence of nutrients are good predictors of growth rates, grazing rates, and biomass. These results have important implications for assessing changes in dynamics due to water level regulation as well as illustrating areas in which to place instrumentation for remote water quality monitoring. *Keywords: St. Lawrence River, Coastal ecosystems, Water quality.*

TYLER, J.A.[1], RUTHERFORD, E.S.[2], WILEY, M.[3], RESING, C.[3], PIJANOWSKI, B.C.[4], and HYNDMAN, D.[5], [1]Fisheries Projections, Farmington, CT; [2]NOAA-GLERL, Ann Arbor, MI; [3]University of Michigan, School of Natural Resources and the Environment, Ann Arbor, MI; [4]Purdue University, Purdue Climate Change Research Center, West Lafayette, IN; [5]Michigan State University, Department of Geological Services, East Lansing, MI. **Effects of Changes in Climate and Land Use on Steelhead Production in the Muskegon River: A Multi-Modelling Analysis.**

We examine how changes in land use and climate change affect age-0 steelhead populations in the Muskegon River watershed using the Muskegon River Environment Modelling System (MREMS). MREMS combines models of regional climate, high-resolution GIS models of the watershed landscape and land transformation, hydrologic process models, high resolution models of instream hydrodynamics and spatially explicit maps of macroinvertebrates. These combined models create the environment used by the Fisheries Projections River Analysis System Individual-Based Model (FPRAS-IBM) of age-0 steelhead dynamics. FPRAS-IBM follows age-0 steelhead from spawning until the end of the first growing season in early October and simulates fish foraging, growth, movement, and mortality on a daily time-step. We use FPRAS-IBM to simulate varying scenarios of land use patterns and climate change on age-0 steelhead production in Muskegon River. Simulation results show that slow rates of urbanization produce higher age-0 steelhead production compared to fast urbanization rates, and that the size of the effects differ based on river discharge. Simulated warming climate scenarios had detrimental effects on age-0 steelhead production which masked the beneficial effects of reduced urban growth. *Keywords: Model studies, Fish populations, Climate change.*

UPSDELL, B.L.[1], VELIZ, M.[1], YANG, W.[2], and LAPORTE, J.[3], [1]Ausable Bayfield Conservation Authority, 71108 Morrison Line, Exeter, ON, N0M 1S1; [2]University of Guelph, 50 Stone Road East, Guelph, ON, N1G 2W1; [3]Ontario Ministry of Agriculture, Food and Rural Affairs, 100 Don Street, Clinton, ON, N0M 1L0. **Evaluating Rural Best Management Practices in Huron County.**

The Watershed Based Best Management Practices Evaluation in Huron County is assessing economic decision-making and environmental effects related to multiple best management practices (BMPs). Farmers in small (<25 km^2) pilot watersheds have been encouraged to adopt BMPs (conservation tillage, cover crops, erosion control structures, reduced nitrogen application) and to provide data on inputs and outputs of crop and livestock production systems and BMP-related changes (*e.g.*, costs, revenue). Information collected from farmers regarding costs and benefits of BMPs will provide insights to economic decisions by farmers that influence interest in BMPs. Land management information, combined with water quantity and quality monitoring and modelling, will help to determine the environmental efficacy of BMPs at both field and watershed scales. A nitrogen fertilizer reduction BMP was implemented by two farmers; in both cases, yield and revenue were lower with reduced fertilizer application, despite cost savings on fertilizer. While environmental effects of BMPs at the field scale are still being assessed, watershed-scale monitoring shows the importance of event-based water quality monitoring. Other lessons learned include the importance of meeting one-on-one with farmers and of documenting detailed land use information. *Keywords: Water quality, Best management practices, Economic evaluation, Environmental effects.*

URBAN, N.R.[1] and MCKINLEY, G.A.[2], [1]Michigan Technological University, 1400 Townsend Dr., Houghton, MI, 49931; [2]University of Wisconsin - Madison, 1225 W. Dayton Street, Madison, WI, 53706. **CO$_2$-driven Acidification of the Great Lakes: Equilibrium and Kinetic Bounds on the Magnitude.**

The pH of lakes is governed by an interplay of physical (air-water mass transfer), chemical (carbonate equilibrium), and biological (photosynthesis, respiration) processes. Climate change may alter all of these processes. Carbonate equilibrium will be shifted due to increasing atmospheric carbon dioxide; over-lake atmospheric stability is altered by lake warming and increasing windspeeds will affect air-water exchange of gases; altered temperatures and nutrients if not altered food webs will causes affect rates of photosynthesis and respiration. There is little reason to expect the Great Lakes to be fundamentally different from the oceans where CO2-driven acidification is being observed. In this talk we first explore the range, variability and trends in historical pH of the Great Lakes. Models coupling physical, biological and chemical processes are then used to demonstrate that it is likely to be the kinetics of environmental processes rather than carbonate equilibrium that determines the extent of acidification of the Great Lakes. *Keywords: Biogeochemistry, Air-water interfaces, Climate change.*

UZARSKI, D.G.[1], SCHOCK, N.T.[1], CLEMENT, T.A.[1], SHERMAN, J.J.[1], MURRY, B.A.[1], and COOPER, M.J.[2], [1]Institute for Great Lakes Research, CMU Biological Station, Department of Biology, Central Michigan University, Mount Pleasant, MI, 48859, USA; [2]Department of Biological Sciences, University of Notre Dame, Notre Dame, IN, 46556, USA. **Changes in Lake Huron Coastal Wetland Health Measured Over a Ten Year Period During Exotic Species Invasion.**

Formed in 2000, the Great Lakes Coastal Wetlands Consortium began developing a basin wide monitoring plan to determine status and trends of ecosystem health using indices of biotic integrity. The plan was finalized in 2008 and implementation for preservation and restoration purposes began in 2010. Chemical/physical parameters, invertebrates, and fish were collected from Schoenoplectus sp. (Bulrush) dominated wetlands using standard protocols during this time. In the mid-2000s, wetlands of Saginaw Bay and Les Cheneaux Islands, Lake Huron experienced drastic changes due to invasions of exotic species, specifically Phragmites australis (common reed) and Neogobius melanostomus (round goby). The most pronounced change to Saginaw Bay wetlands was structural due to common reed invasions. However, round gobies were rarely captured in remaining stands of bulrush. The opposite was true for the Les Cheneaux Islands area. The common reed invasion was minimal in these bulrush dominated wetlands, but during this period, the round goby invasion began and by 2010 they were often collected from these wetlands. IBI scores from the early 2000's were compared to those of the late 2000's, and suggested that remaining bulrush stands of Saginaw Bay have improved in health while bulrush wetlands of Les Cheneaux have degraded. *Keywords: Coastal wetlands, Indicators, Invasive species.*

VACHON, N.[1], DUMONT, P.[1], LECLERC, J.[1], DESLOGES, S.[1], MASSÉ, H.[1], GRONDIN, P.[2], BERNATCHEZ, L.[3], and HATIN, D.[1], [1]Ministère des Ressources naturelles et de la Faune, 201, Place Charles-Le Moyne, Longueuil, QC, J4K 2T5; [2]Ministère des Ressources naturelles et de la Faune, 880, chemin Sainte-Foy, Québec, QC, G1S 4X4; [3]Université Laval, 1030, Avenue de la Médecine, Local 1145, Québec, QC, G1V 0A6. **25 Years of Research, Management and Protection of an Endangered Freshwater Fish: the Copper Redhorse.**

Copper redhorse (*Moxostoma hubbsi*) is an endangered freshwater fish found exclusively in a very restricted area in southwestern Québec. The species was first described in 1866 by Pierre-Étienne Fortin but its official discovery is attributed to Vianney Legendre in 1942. Its rarity and its extremely precarious situation were quickly identified by biologists. Protection and recovery activities are the result of concerted efforts involving surveys, research, expertise and methods development, which guided the policies and their prioritization in the recovery plans. This presentation discusses the overall approach, the main steps and activities of research, management and protection targeted on the copper redhorse recovery that were conducted over the past 25 years. The legal aspects, habitat protection, stewardship, as well as monitoring of the population and the level of knowledge of the species life history will be presented. Our experiences highlight the importance of a team work involving many partners from different backgrounds and interest. *Keywords: Fish management, St. Lawrence River.*

VALENTA, T.J.[1], KENNEDY, J.A.[1], KLUMP, V.[2], DOLAN, D.M.[3], and SAGER, P.E.[3], [1]2231 North Quincy Street, Green Bay, WI; [2]600 East Greenfield Avenue, Milwaukee, WI; [3]2420 Nicolet Drive, Green Bay, WI. **Thermal Stratification and Oxygen Depletion in the Hypolimnion of the Deep Waters of Green Bay.**

The majority of the research that has been conducted on the Green Bay ecosystem has focused on documenting the impact of nutrient loadings from the Fox River on water quality in lower Green Bay. To date, very little is known about thermal stratification in the deep waters of the mid-bay and to what extent hypoxia may be occurring. Data collected by continuous water quality monitoring devices deployed in southern Green Bay show intrusions of cold, hypoxic water continually move in to lower Green Bay throughout the summer. These intrusions are thought to have originated in the thermally stratified waters of the mid-bay. In order to gain a better understanding of the thermal structure of the mid-bay and to determine if oxygen depletion is occurring in the hypolimnion, vertical profile data was collected late in summer of 2009 and on several cruises throughout the summers of 2010 and 2011 by the Great Lakes Water Institute (GLWI) and Green Bay Metropolitan Sewerage District (GBMSD). Preliminary data indicates the mid-bay thermally stratifies as early as the end of June with depletion of oxygen taking place in the hypolimnion during the months of July and August. Vertical mixing of the water column is believed to have taken place in early September. *Keywords: Oxygen, Green Bay, Monitoring.*

VALIPOUR, R.[1], BOEGMAN, L.[1], BOUFFARD, D.[1], and YERUBANDI, R.R.[2], [1]Civil Engineering Department, Queen's University, Kingston, ON, K7L 3N6; [2]National Water Research Institute, Burlington, ON, L7R 4A6. **Evidence of Sediment Resuspension in Central Lake Erie.**

Sediment resuspension plays a crucial role in the near bed oxygen depletion in central Lake Erie. Sediment resuspension may result from different processes with different timescales. We investigate the ability of these processes to re-suspend sediments using high-resolution water level, surface wave, turbidity, current velocity, and temperature data recorded during the summers of 2008-2009. To clarify dominant factors driving sediment resuspension, we quantify the conditions under which the bottom shear stress increases. Induced shear stress from large scale process is estimated by fitting the well-known log-law of the wall equation to the observed current profiles. Induced shear stress resulting from surface waves is estimated using the variance of near bottom velocity fluctuations and applying linear wave theory. Temporal changes in near bottom sediment resuspension are calculated using changes in acoustic backscatter signals from the current profilers and time series of turbidity measurements. Results using rotary spectra and continuous wavelet analysis show that in the summer, during the storm episodes, surface waves with periods of more than 5s induce strong shear stress causing sediment resuspension. When there is no significant wind event, Poincare waves causes increases in shear stress leading to sediment resuspension. *Keywords: Sediment resuspension, Surface and internal waves, Stratification period, Lake Erie.*

VAN CLEAVE, K., LENTERS, J.D., and SUYKER, A.E., School of Natural Resources, University of Nebraska-Lincoln, Lincoln, NE, 68583. **Seasonal Variability in Sensible and Latent Heat Fluxes over Lake Superior: Direct Observations from a Nearshore Eddy Covariance Station.**

Evaporative and sensible heat fluxes play a significant role in the energy and water balance of lakes. This is particularly true for deep lakes in mid to high latitudes, where large amounts of heat are stored and released over the course of the annual cycle. This leads to significant lags between water and air temperature and, therefore, strong gradients in temperature and vapor pressure at the lake surface. Despite the importance of sensible (H) and latent (LE) heat fluxes, direct, year-round observations of H and LE are rarely made - particularly over large lakes with seasonal ice cover. Only recently have such observations been made for the Great Lakes, and the initial results from a nearshore, island-based site on Lake Superior are presented in this study. Using data from an eddy covariance station deployed on Granite Island, Michigan (19 km north of Marquette), we investigate seasonal variations in H and LE from July 2009 to the present. The results show a general progression from weak fluxes in summer to high H and LE values in autumn and winter (>300 W/m2), interspersed with episodic events. Although LE typically exceeds H during the fall season, increasingly colder air masses by late November cause H to escalate and eventually exceed LE. These contrasts highlight the different limiting factors that affect H and LE. *Keywords: Atmosphere-lake interaction, Climatic data, Hydrologic cycle.*

VAN WIEREN, J.F., St. Lawrence Islands National Park. 2 County Rd. 5, Mallorytown, ON, K0E 1R0. **Conserving the Complex Thousand Islands Ecosystem: St. Lawrence Islands National Park.**

The Thousand Islands region is an ecological jewel located in the St. Lawrence River. The area is a mixing zone of northern, southern, coastal and island habitats, which results in high biodiversity including over 40 COSEWIC listed species at risk. The area is also the most important connection in the Algonquin to Adirondack corridor. The islands themselves serve as important stepping stones for fauna and flora and can facilitate not only species migration but also species (re)colonization. There are also a number of significant threats and challenges to ecosystem conservation including alien invasive and hyperabundant species, habitat loss, wind farms and a loss of natural processes. There is a complex land ownership mosaic creating a fragmented landscape. Jurisdictional overlap between various governments along with over 100 environmental groups creates a dynamic and complex conservation environment with both advantages and pitfalls. St. Lawrence Islands National Park (SLINP) lies in the heart of the Thousand Islands and is responsible for over 20 islands and various properties adjacent to the St. Lawrence River. This presentation will look at the various ecological and jurisdictional challenges presented to SLINP in managing this fragile island ecosystem and look at some current projects underway at the park. *Keywords: St. Lawrence River, Thousand Islands, Coastal ecosystems, Species at Risk, Invasive species, Restoration.*

VANDER WOUDE, A.J., SAYERS, M.J., SHUCHMAN, R.A., JESSEE, N.L., BROOKS, C.N., and RAYMER, Z., MTRI, 3600 Green Ct., Ste. 100, Ann Arbor, MI, 48105. **A Satellite Algorithm for River Plume Mapping within the Great Lakes Basin.**

A robust river sediment plume algorithm that utilizes color satellite data has been developed for the Great Lakes. The algorithm, which utilizes any ocean color satellite that has a blue, red, green and NIR band such as MODIS and the recently launched NASA NPP VIIRS satellite sensor, first generates a Total Suspended Sediment Index (TSSIGL) that is used to map the extent of the plume. The TSSIGL represents the total suspended solids (TSS) which includes both the organic and inorganic constituents of the plume. The Normalized Difference Vegetative Difference (NDVI) is calculated to generate a representation of the organic dominated concentration at the water surface. The highest TSSIGL values indicate heavy suspended sediment concentration (SSC or total suspended mineral). By comparing the TSSIGL output to the NDVI result, the composition of the plume can be ascertained (sediment dominated versus organic material). The relative concentration of the plume is obtained by examination of the index values. Given the area of the plume and its relative concentration, along with bathymetry, an estimate of the sediment load within the plume can be made. This new approach to mapping plumes in the Great Lakes is applicable to plumes in river mouths, embayment areas, and hydro-dynamically complex basins such as Western Lake Erie. *Keywords: Remote sensing, Sediments, Algae.*

VANDERGOOT, C.S.[1], KRAUS, R.T.[2], KOCOVSKY, P.M.[2], ZINN, L.J.[2], and ROGERS, M.W.[2], [1]Ohio Division of Wildlife, Sandusky Fish Research Unit, Sandusky, OH, 44870; [2]U S Geological Survey, Great Lakes Science Center, Sandusky, OH, 44870. **Comparative Analysis of Three Experimental Gill Nets Used to Assess Lake Erie Walleye.**

Experimental gill nets provide the primary fishery independent demographic data used in stock assessments of Lake Erie walleye. Due to multiple historical factors, gears used for this purpose vary among resource management agencies with substantial differences in material and mesh size combinations. Thus, any divergent demographic views of walleye from these differing gears are difficult to reconcile and have been further complicated spatial and temporal differences in sampling effort. To better understand these differences, we conducted an experiment using triplet sets with the three primary survey gears in 2010 and 2011. Overall, variations in catch per unit effort and size distribution of walleye were influenced much more by mesh size than material and construction of the gear. Size selection curves emphasized substantial differences in how each gear sampled the population. The results suggested some simplifying assumptions that can be used to scale length and age distribution data for more direct gear comparisons. This analysis has implications both for correcting demographic data from a single gear and for reconciling differences among multiple gears used to sample the same population. *Keywords: Walleye, Fisheries, Lake Erie.*

VANNIER, R.G.[1], LONG, D.T.[1], ROBINSON, A.M.[1], GRIEVE, P.L.[2], and GIESEY, J.P.[3], [1]Michigan State University, East Lansing, MI, 48824; [2]Pennsylvania State University, University Park, PA, 16802; [3]University of Saskatchewan, Saskatoon, SK. **Historical Distribution and Recovery of DDT as Interpreted from Michigan Inland Lake Sediments.**

Concentrations of DDT, DDD, and DDE were measured in sediment cores collected from 39 inland lakes in Michigan for examination of spatial and temporal trends in accumulation and degradation. It was hypothesized that the peak concentrations of DDT in the sediment cores would coincide with the 210Pb determined time frame of peak US production of the chemical in the late 1950's and values should be shown to be decreasing in younger sediment since this time period . While it is clear that US production and usage are the overriding determinants of the general DDT profiles, results show significant variation of peak concentrations and dates of the peaks amongst the individual lakes. This is thought to be the result of both independent watershed-scale and regional sources of DDT recorded in the lake sediment. However, both the summed concentrations of DDT and DDT found in recent sediment (top 4 cm) in each sediment core correlated well to latitudes of Michigan with higher populations, even if the lake watershed itself wasn't especially populace. This suggests a significant regional component to DDT both historically and since its ban. Degradation half-life calculations of DDT in Michigan lakes were determined to average approximately 20 yrs, longer than most reported DDT half-lives in other literature. *Keywords: Sediments, DDT, Chemical analysis, Half-life, Environmental contaminants, Land Use.*

VERHAMME, E.M.[1], DEPINTO, J.V.[1], REDDER, T.M.[1], KRAMER, S.[2], and YOUNG, E.[2], [1]LimnoTech, 501 Avis Drive, Ann Arbor, MI, 48108; [2]W. H. Miner Institute, 586 Ridge Road, Chazy, NY, 12921. **Long Term Phosphorus Management in Missisquoi Bay, Lake Champlain.**

Missisquoi Bay is a protected embayment on the north end of Lake Champlain. Over the last several years the bay has seen an increased recurrence of nuisance cyanobacteria blooms that have produced toxins and severely limited use of the bay for drinking water supply and recreation. The primary objective of this project is to develop a fine-scale, time-variable linked hydrodynamic-water quality model that captures the major cycling pathways of phosphorus (P). The Missisquoi Bay Phosphorus Model, termed MBPHOS, uses available atmospheric, hydrologic, and nutrient monitoring data to simulate the transport of phosphorus from the major tributaries, deposition and release from the sediment bed, and export through the bay, and out into the Northeast Arm of Lake Champlain. Over the 2001 to 2010 simulation period, the mass of phosphorus released from the sediment averaged over 40% of the total P inputs during the summer period. The calibrated model shows that in order to meet the 25 ug/L target P concentration it is necessary to reduce tributary inputs close to 75%. In the absence of sediment inputs, only a reduction 20% would be required. The presentation will discuss the findings of the model and implications for future management of the system. *Keywords: Phosphorus, Lake Champlain, Model studies.*

VERREAULT, J.[1], GENTES, M.L.[1], CARON-BEAUDOIN, E.[1], HELIE, J.F.[2], GIROUX, J.F.[3], and LETCHER, R.J.[4], [1]Environmental Toxicology Research Centre (TOXEN), Department of Biological Sciences, University of Quebec in Montreal, Montreal, QC, Canada; [2]Geochemistry and Geodynamics Research Center (GEOTOP), University of Quebec in Montreal, Montreal, QC, Canada; [3]Behaviour and Animal Ecology Research Group (GRECA), Department of Biological Sciences, University of Quebec in Montreal, Montreal, QC, Canada; [4]Wildlife and Landscape Science Directorate, Science and Technology Branch, Environment Canada, National Wildlife Research Centre, Ottawa, ON, Canada. **GPS-Based Biotelemetry and Stable Isotope Profiling Meets Ecotoxicology: a Novel Approach for Understanding the Exposure of Avian Species to Organohalogen Contaminants.**

Contaminants research in birds from the Great Lakes/St-Lawrence has been hampered by the lack of characterization of the individual's habitat-use strategy and feeding ecology. These knowledge gaps have led to misinterpretations of exposure sources and temporal/spatial trends. In this study, we combined the use of a novel GPS-based biotelemetry technology and stable isotopes (carbon and nitrogen) to identify the major sources (environmental, dietary) of PBDEs and emerging halogenated flame retardants (HFRs) in ring-billed gulls (RBGUs) breeding in the Montreal area. Moderate but highly variable concentrations of PBDEs (most abundant was BDE-209) and a few emerging HFRs [e.g., bis(2-ethylhexyl)-tetrabromophthalate, Dechlorane plus, etc.] were determined in RBGU liver and blood. GPS-tracking showed that birds that visited, and thus foraged predominantly in human-impacted areas (landfills, cities, wastewater plant, etc.) accumulated significantly higher levels of BDE-209 relative to other PBDE congeners. These birds also had stable isotope signatures that indicated dietary preference for transformed foods (low $\delta15N$ and highly negative $\delta13C$). These results demonstrated that the combined usage of geolocation and stable isotopes may be promising to explain the large intra-specific variations in contaminant profiles in gulls. *Keywords: PBDEs, Halogenated flame retardants, Biotelemetry, Isotope studies, Environmental contaminants, Birds.*

VET, R., BLUKACZ-RICHARDS, E.A., SUKLOFF, B., and BLANCHARD, P., Environment Canada, 4905 Dufferin St., Toronto, ON, M3H 5T4. **Statistical Analysis of PM2.5 Instrument Comparison.**

Health concerns resulting from elevated levels of atmospheric PM2.5 are well documented and this pollutant is monitored on a world-wide scale. The US-EPA reference method (RM) PM2.5 measures are labour intensive. Continuous instruments, equivalent to the RM, are currently used in network monitoring. This study evaluated three continuous instruments (Beta Attenuation Mass (BAM), Synchronized Hybrid Ambient Real-Time Particulate (SHARP), Tapered Element Oscillating Monitor (TEOM)) operated in duplicate at a rural Environment Canada site in Egbert (70 km north of Toronto) from April 2009 to September 2010. Daily average PM2.5 concentrations (ranging from 0.18 to 31µg/m3) from these instruments were compared with measurements from the reference method (Partisol Manual Dichotomous Sampler). Data capture ranged from 97% (TEOMs) to 67% (SHARPs). BAMs had the lowest precision with coefficients of variation (CoVs) ranging from 17 to 38%, followed by the SHARPs and TEOM-SESs. Variance components showed that differences between instruments, including seasonal effects, explained 80% of the variation. Multiple regressions

reveled that temperature and absolute humidity effects explained between 2-7% of the variation. The results from this study can guide management when selecting continuous instruments for network operations. *Keywords: Pollutants, Management, Airsheds.*

WALKER, J.F.[1], CHRISTIANSEN, D.E.[2], and HUNT, R.J.[1], [1]U.S. Geological Survey, 8505 Research Way, Middleton, WI, 53562; [2]U.S. Geological Survey, 400 South Clinton Street, Room #269, Iowa City, IA, 52244. **Estimating Climate Change Impacts on Streamflow in the Lake Michigan Basin Using the USGS PRMS Watershed Model.**

The U.S. Geological Survey (USGS) entered into an interagency agreement with the U.S. Environmental Protection Agency (EPA) as part of numerous Great Lakes Restoration Initiative (GLRI) projects in the Great Lakes Watershed. The projects are designed to provide a scientific basis to support management decisions as well as measure progress of the Great Lakes restoration efforts. The "Forecasting Great Lakes Watershed Responses to Future Change in the Lake Michigan Watershed" project involved building and calibrating a watershed model for the Lake Michigan basin. The USGS distributed-parameter, physically based, Precipitation-Runoff Modeling System (PRMS) was used to construct a coarse-scale model with 766 hydrologic response units and 245 subbasins for the Lake Michigan Watershed. The model was calibrated using the model-independent parameter estimation and uncertainty analysis (PEST) software suite. Calibration targets included daily streamflow observations at 148 USGS gaging stations, which were processed to reflect annual mean flow, monthly mean and maximum flow, and selected hydrographs for events. The model was used to predict the impacts of climate change on streamflows throughout the Lake Michigan basin using the output from four General Circulation Models run for four climate change emission scenarios. *Keywords: Hydrologic budget, Model studies, Climate change.*

WALSH, M.G.[1], MACNEILL, D.B.[2], WINGER, P.[3], WEIDEL, B.[1], and LANTRY, B.F.[1], [1]USGS Lake Ontario Biological Station, 17 Lake Street, Oswego, NY, 13126; [2]New York Sea Grant, Oswego, NY; [3]Memorial University CSAR, St. John's, NF. **A Synopsis of the 2011 Great Lakes Trawling Workshop.**

A Great Lakes Trawling Workshop, organized by USGS and NY Sea Grant, was conducted by Memorial University's Centre for Sustainable Aquatic Resources (CSAR) in November 2011. The 30+ participants from state, federal, and university institutions in the U.S. and Canada use trawls in a variety of sampling programs on the Great Lakes (e.g., fish population dynamics, contaminants). The three day workshop educated vessel staff and researchers on trawl design, construction, and behavior, as well as fish behavior and catchability associated with trawls. Group discussions allowed participants to recognize commonalities and differences across trawl-based sampling programs and share ideas for dealing with future and current sampling challenges. The highlight was viewing video of a 12-m Yankee bottom trawl, a design commonly used in the Great Lakes, evaluated in the CSAR flume tank. Post-workshop feedback indicated that trawling instruction, flume tank video, and group discussions were the most significant parts of the workshop, and participants were energized to put principles learned in the workshop into practice in their field work. Attendees agreed that this workshop was highly

valuable and should be repeated for a larger audience and funding sought for additional workshops on trawl-related topics. *Keywords: Fish behavior, Sampling, Trawl.*

WANG, J.[1] and BAI, X.[2], [1]NOAA Great Lakes Environmental Research Laboratory, 4840 S State Road, Ann Arbor, MI, 48108; [2]University of Michigan CILER, 4840 S State Road, Ann Arbor, MI, 48108. **Atmospheric Teleconnection Patterns Associated with Severe and Least Ice Cover in the Great Lakes, 1963-2011.**

Atmospheric teleconnection circulation patterns associated with severe and least ice cover over the Great Lakes are investigated using the composite analysis of lake ice data and NCEP reanalysis data for the period 1963-2011. The teleconnection pattern associated with the severe ice cover is the combined negative Arctic Oscillation and La Nina events, while associated with the least ice cover is the combined El Nino and positive phase of Arctic Oscillation (AO)/North Atlantic Oscillation (NAO) events. These two extreme ice conditions are associated with the North America ridge-trough variations. The intensified ridge-trough system produces strong northwest-to-southeast tilted ridge and trough and increase the anomalous northwesterly wind, advecting cold, dry Arctic air to the Great Lakes. The weakened ridge-trough system produces flattened ridge and trough, and promotes climatological westerly, advecting warm, dry air from the west America to the Great Lakes. The composite analysis shows that ice cover responds linearly and symmetrically to both phases of the AO, while responds nonlinearly and asymmetrically to El Nino and La Nina events. *Keywords: Ice, El Nino and Southern Oscillation, Climate change, Climate teleconnection patterns, Atmosphere-lake interaction, North Atlantic Oscillation/Arctic Oscillation.*

WANG, J.[1], ASSEL, R.A.[2], CLITES, A.H.[1], and BAI, X.[2], [1]NOAA Great Lakes Environmental Research Laboratory, 4840 S State Road, Ann Arbor, MI, 48108; [2]University of Michigan CILER, 4840 S State Road, Ann Arbor, MI, 48108. **Great Lakes Ice Climatology Update: Winter 2006 - 2011 Description of the Digital Ice Cover Data Set.**

Lake ice cover is a sensitive indicator of regional climate and climate change. Seasonal ice cover repeats each year with large interannual variability. For example, the maximum ice coverage over all of the Great Lakes was 95% in 1979 and only 11% in 2002. Possible contributors include interannual and interdecadal climate variability, and long-term trends, possibly related to global climate warming. Even in response to the same climate forcing, Great Lakes ice cover may experience different spatial and temporal variability due to individual lake's orientation, depth (i.e., water heat storage), and turbidity (i.e., albedo due to sedimentation). Since the last updated ice atlas in the Great Lakes (Assel 2005), there have been significant change in ice cover on the Great Lakes. Some studies using the updated dataset were conducted (Bai et al. 2012; Wang et al. 2012). Therefore, it is necessary to update the ice atlas to the present date for the research community and other users for decision making. We updated the ice atlas from 2006-2011 and made the time series since 1973 to 2011. This study presents the team effort in updating the ice atlas. Methods and final products are presented. Spatial coverage and temporal variability over five Great Lakes are available for public application. *Keywords: Ice, Climatic data, Climatology.*

WANG, L.[1], BRENDEN, T.[2], CAO, Y.[3], and SEELBACH, P.W.[4], [1]IJC Great Lakes Office, 100 Ouellette Avenue, Windsor, On, N9A 6T3, Canada; [2]Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI, 48824-1101, US; [3]University of Illinois, 1816 S Oak Street, Champaign, IL, 61820, US; [4]Great Lakes Science Center, US Geological Survey, 1451 Green Road, Ann Arbor, MI, 48105, US. **Delineation and Validation of River Network Spatial Units for Water Resources and Fisheries Management.**

One of the most common practices in river research and management is to divide river network into more ecologically meaningful and operationally manageable spatial units. The Great Lakes Regional River Database and Classification System was developed for the three-state region of Illinois, Michigan, and Wisconsin by dividing river network into confluence-to-confluence reaches, merging similar neighboring reaches into segments, and classifying segments into types. This presentation describes how the river reaches, segments, and segment types were developed using Michigan's data as an example and compares the variations in fish assemblages within and among river reaches, multiple-reach segments, and segment types where sampled fish data are available. Because the patterns of changes in physical and biological characteristics of river systems are spatial-scale dependent, our study focused only at the spatial scales that are meaningful for environmental assessment using fish assemblages and for fisheries management. We found that river reach within a segment explained the least, segment type explained moderate, and segment explained the most variances in fish assemblage metrics, fish abundance of all species, and fish abundance for the top-three dominant species. *Keywords: Fish, Watersheds, Assessments.*

WARWICK, C.A., International Joint Commission, 234 Laurier Avenue West, 22nd Floor, Ottawa, ON, K1P 6K6. **The International Joint Commission: Managing Flows and Levels in the 21st Century.**

The International Joint Commission was established by the Boundary Waters Treaty, 1909 with quasi-judicial responsibilities for the approval of works, such as dams, that affect the natural level or flow of waters across or along the Canada - United States boundary. Under this responsibility, the Commission has over 20 Orders of Approval that govern the maintenance and operation of structures on six transboundary watersheds. In the 1990's the Commission questioned whether these Orders still satisfied the requirements of the Treaty for suitable and adequate protection of all interests, particularly how older Orders considered the interests of the environment. The Commission therefore undertook to review its Orders, including the Orders that regulate the outflows from Lake Ontario down the St. Lawrence River and the Orders to regulate outflows from Lake Superior. This paper presents the role of the Commission in flow and level regulation, looking particularly at the review of Orders in the Great Lakes - St. Lawrence River system. The paper then discusses the challenges faced by the Commission in reviewing and attempting to update these Orders, particularly the science and politics of balancing new environmental concerns with the suitable and adequate protection of other interests in a multi-jurisdictional governance system. *Keywords: Great Lakes basin, International Joint Commission, Water level, Governance.*

WATKINS, J.M.[1], RUDSTAM, L.G.[1], and CRABTREE, D.[2], [1]Cornell Biological Field Station, 900 Shackleton Pt Rd, Bridgeport, NY, 13030; [2]Nature Conservancy, Allegheny College, Box 172, Meadville, PA, 16335. **Reduced Whiting Events in Lake Ontario: Has Material Flux to the Profundal Benthos Declined?**

The decline of the native benthic amphipod Diporeia has been attributed to a decline in spring diatom blooms driven by dreissenid mussel grazing and lower phosphorus. A three-year sediment trap study in the early 1990s suggested that the overall flux of organic carbon to the benthos in eastern Lake Ontario was more closely tied to late-summer whiting events (precipitation of calcium carbonate) than spring blooms. We present size distribution data for Diporeia from the early 1990s taken along three depth transects (55-130 m). This data demonstrate reproductive failure and population collapse between October 1994 and April 1995- a time period of documented low flux. Whiting did not occur in the summer of 1994 due to cool summer water temperatures but resumed in 1995. Whiting events may be less common due to lower primary productivity and dreissenid mussel uptake of calcium. We evaluate satellite imagery archives (Rrs 555, remote sensing reflectance at 555 nm) from 1998 to 2010 to test this hypothesis. We find that annual whiting events still occur, but were particularly weak in 2001, 2003, and 2009. Shipboard surveys often miss short-term whiting events. We contend that although whiting still occurs, a one-year gap could reduce the flux of organic carbon and have ramifications for fragile benthic populations. *Keywords: Biogeochemistry, Benthos, Lake Ontario.*

WATSON, S.B.[1], BOYER, G.L.[2], YANG, R.[1], and NEWBOLD, B.[3], [1]CCIW, 867 Lakeshore Rd, Burlington, ON, L7R 3A2; [2]State University of New York College of Environmental Science and Forestry, Syracuse, NY, 13210; [3]School of Geography and Earth Sciences, 1280 Main St. West, Hamilton, ON, L8S 4K1. **Algal Bloom Response and Risk Management: On-Site Response Tools.**

Cyanobacteria Blooms threaten drinking- and recreational water safety though the production of toxins, particularly microcystins (MCs). These blooms are unpredictable and vary in colour, appearance, toxicity and odour. Wind-blown shoreline material can contain toxin levels ranging over an order of magnitude. Recreational/health agencies and managers need reliable, cost-effective and rapid methods to detect toxins in bloom material for rapid decisions on beach closures and alerts, which cannot be met by most lab turnaround times. Commercial MC field test kits are available but there have been few rigorous evaluations of their application, reliability and practicality. We evaluated two kits, using samples from Hamilton Harbour, Lake Ontario and Bay of Quinte spanning a range of water quality, sample matrices and bloom composition. We compared these results against lab-based analyses by Enzyme-Linked Immunosorbent Assay (ELISA), protein phosphatase inhibition assay (PPIA) and LCMS. Both kits distinguished between toxin levels above and below 10ug MC/L, but were less reliable at lower levels. We conclude that the strips are suited for preliminary site screening but cannot reliably detect significant toxin levels <10ug/L, provide advance warning or allow informed

decisions on beach postings after visible blooms have disappeared *Keywords: Harmful algal blooms, Beach monitoring, Cyanophyta, Microcystin, Risk assessment.*

WATSON, S.B.[1], KLING, H.J.[2], HERBERT, C.[3], HENDZEL, L.[6], BOYER, G.L.[4], and KOTAK, B.[5], [1]CCIW Environment Canada, 867 Lakeshore Rd., Burlington, ON, L7R 4A6; [2]ATEI, 31 Laval Drive, Winnipeg, MB, R3T 2X8; [3]Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, MB, R3T 2N6; [4]State University of New York, College of Environmental Science and Forestry, Syracuse, NY, 13210; [5]AlgalTox International, P.O. Box 269, Pine Falls, MB, R0E 1M0; [6]North Kildonan, Winnipeg, MB, R2G 2N8. **Cyanobacterial Blooms in Lake Winnipeg and Lake of the Woods: Toxins, Nutrient Status and Species Composition.**

Two vast, multi-basin central Canadian Lakes, Lake Winnipeg (MN) and Lake of the Woods (ON), experience extensive summer-fall cyanobacterial blooms. While not new to these lakes, core data indicate an increase in bloom severity over the past 20 years. Both lakes are important drinking water, fisheries and tourist resources which exhibit signs of increasing eutrophication and similar bloom species composition. Their toxicity, however, is poorly characterized. This paper evaluates these events and their toxicity related to species composition and nutrient status, with implications for water quality and climate change. Multiagency data over the past few decades shows that most blooms are caused by N-fixing cyanobacteria, with early summer dominance by *Anabaena* spp. succeeded by strains of *Aphanizomenon flos-aquae* in late summer-fall. Toxin-producing cyanobacteria are present in both lakes but not predominant. *Aphanizomenon* blooms often contained low levels of *Microcystis* spp. and *Pseudanabaena rutilis-viridis*, strain of which are known toxin producers. The risk of toxins is strongly mitigated by physical processes. Trace microcystin levels in pelagic zones increased dramatically in concentrated net hauls, shoreline and surface scums, with some indication that nutrient status affects toxicity. *Keywords: Eutrophication, Lake Winnipeg, Harmful algal blooms, Lake of the Woods, Cyanophyta.*

WEBSTER, W.C. and UZARSKI, D.G., Institute for Great Lakes Research CMU Biological Station, Central Michigan University, Mount Pleasant, MI, 48859, United States. **Impacts of Anthropogenic Disturbance on Coastal Wetland Vegetation.**

Water levels in the Laurentian Great Lakes have reached near record low. Low water levels have triggered increased rates of fragmentation of coastal wetlands by encouraging many waterfront property owners to cut boat channels through wetland vegetation or deepen existing ones to maintain access to the open water. Thus, the primary objective of this study was to determine if disturbance from boat channels was having an effect on wetland vegetation adjacent to disturbances. Furthermore, over half of the boat channels sampled were part of channelized drainage systems emptying agricultural runoff from the adjacent land. This led to the second objective which was to examine the effects drainage ditches on wetland vegetation. The study was conducted by comparing areas adjacent to disturbance with intact coastal wetlands along Michigan shoreline in Lakes Huron and Michigan. An inventory of plant taxa and accompanying physical/chemical data were analyzed to relate coastal wetland vegetation to disturbance. Invasive species richness had a tendency to be higher at boat channels and had differences in the

abiotic environment. Additionally, drainage ditches increased nutrient levels and were associated with all sites that were dominated by *Typha spp.*, particularly *T. angustifolia*.
Keywords: Invasive species, Anthropogenic disturbance, Coastal wetlands.

WEICKSEL, S.[1], LUPI, F.[1], KAPLOWITZ, M.[2], and CHEN, M.[1], [1]Dept. of Ag., Food & Resource Economics, Agriculture Hall, Michigan State University, East Lansing, MI, 48824-1024; [2]CARRS, Natural Resources Bldg., Michigan State University, East Lansing, MI, 48824. **The Preferences for and Values of Changes in Water Quality at Great Lakes Beaches in Michigan.**

With over 600 public beaches and millions of visitors each year, beach visitation is among the most popular recreational uses of the Great Lakes in Michigan. The quality of Great Lakes beaches faces threats from many sources, such as nuisance algae, closures from high levels of E.coli, and development. Despite the importance of Great Lakes beaches, there are almost no published studies of the value of changes in water quality at Great Lakes beaches with the exception of Murray, Sohngen, and Pendelton (2001). We conducted a survey of 5600 Michigan residents who visited a Great Lakes beach in 2011. In the survey we elicited people's preferences for beaches with different levels of quality. Specifically, we administered a choice experiment wherein respondents were shown and asked to choose between beaches with varying levels of attributes (levels of algae, E.coli testing, etc.) and economic cost (driving distance). From the respondents' choices we estimate people's preferences and economic value of changes in water quality and other beach characteristics. Resource managers can use these preferences and values to predict the benefits of quality improvements, or to estimate the damages caused by decreases in beach quality. *Keywords: Economic evaluation, Preferences, Beaches.*

WEIDEL, B.[1], WATKINS, J.M.[2], RUDSTAM, L.G.[2], DOVE, A.[3], and WATSON, S.B.[3], [1]USGS - Lake Ontario Biological Station, Oswego, NY; [2]Cornell Biological Field Station, Bridgeport, NY; [3]Environment Canada, Burlington, ON. **Deep Green: Dynamics and Implications of a Deep Chlorophyll Layer in Lake Ontario.**

Elevated chlorophyll concentration levels associated with the metalimnion are common in oligotrophic lakes. Lake Ontario has often been considered to be dominated by epilimnetic production, but recent observations suggest a deep chlorophyll layer (DCL) frequently forms during summer months. In 2011, we quantified the vertical structure of nutrients, primary producers, zooplankton, and fish to describe the seasonal chlorophyll dynamics and determine implications to upper trophic levels. Fluroprobe and traditional filter analysis found a chlorophyll maximum around 25-35m beginning in June and extending through August. We found strong differences in zooplankton community and biomass density between epilimnetic and deep chlorophyll layers. When the DCL was present, we observed strong diel vertical migration in zooplankton. Historical depth-specific chlorophyll data collected in August of each year suggest the DCL appeared frequently beginning in the early 1990's. The persistence of a deep chlorophyll layer has important implications for monitoring programs some of which have primarily sampled epilimnetic waters for lower trophic levels. Additionally, changes in zooplankton community and production associated with deeper primary production may

influence the Lake Ontario pelagic prey fish community and energy pathways.
Keywords: Zooplankton, Phytoplankton, Lake Ontario.

WEISS, L.[1], GHARABAGHI, B.[1], THE, J.[2], and WINTER, J.G.[3], [1]University of Guelph, 50 Stone Road West, Guelph, ON, N1G 2W1; [2]Lakes Environmental, 60 Bathurst Drive Unit 6, Waterloo, ON, N2V 2A9; [3]125 Resources Road, Toronto, ON, M9P 3V6. **Using the Wind Erosion Prediction System (WEPS) to Model Atmospheric Sources of PM10 within the Lake Simcoe Airshed.**

A decline in water quality, attributed to the deposition of excessive nutrients (phosphorus), has been observed in Lake Simcoe over the past few decades. It is estimated that 25-50% of the total phosphorus entering the lake is from atmospheric deposition. The noticeable cyclic change in phosphorus loading is lowest during the winter months, followed by a sharp increase in the late spring and early summer with a decline in loads during the autumn season. Additionally, bare soil exposure, due to lack of vegetative cover, along with soil disturbance result in higher susceptibility to wind erosion and dust emission. A Wind Erosion Prediction System (WEPS) framework is developed using digital soil type mapping, crop type and management practice mapping, and climate data including precipitation and wind speed and direction. The WEPS model quantifies wind erosion risk on a discrete area and reports PM10 emissions. The verified WEPS model results and unit area repository will provide guidance for land use management regarding PM10 emission risks. The results can be integrated into geographic information systems (GIS) for planning purposes and atmospheric dispersion models for long-range sediment transport and deposition analysis. *Keywords: Computer models, Atmospheric circulation, Sediment transport.*

WEISZ, E. and STANLEY, E., Ontario Ministry of Natural Resources, Lake Simcoe Team, 50 Bloomington Rd., Aurora, ON, L4G 0L8. **Responding to the Threat of Aquatic Invasive Species in Lake Simcoe - a Pathway-Based Approach.**

Preventing aquatic invasive species (AIS) from being introduced into a waterbody requires knowledge of which pathways may actually pose a risk. A number of pathways could potentially transport AIS into Lake Simcoe (Ontario, Canada) due to its popular recreational fishery and close proximity to large urban areas. Suspected pathways for AIS into Lake Simcoe include recreational boating, the aquarium and water garden trades, live food fish, and movement of baitfish. In addition, its connection to the Great Lakes via the Trent-Severn Waterway has been assumed to be a potential conduit for the introduction of several AIS into Lake Simcoe. The feasibility of some these pathways had not been examined in the watershed, and thus several investigations were undertaken to gain further information on the dispersal of AIS via the Trent-Severn Waterway, the extent of the live food fish industry, and the presence of AIS in urban stormwater management ponds. The conclusions from these studies provided valuable information and insight into how to better prioritize management, education and outreach efforts within the watershed. *Keywords: Lake Simcoe, Invasive species, Risks.*

WELLEN, C. and ARHONDITSIS, G.B., University of Toronto, Department of Physical & Environmental Sciences, Toronto, ON, M1C 1A4, Canada. **Quantifying the Effects of Land use on Non-Point Source Phosphorus Delivery to Hamilton Harbour: a Bayesian Modelling Approach.**

Hamilton Harbour is large eutrophic embayment located at the western end of Lake Ontario that has been listed as an Area of Concern. With a mixed urban-agricultural watershed which is experiencing substantial population growth, Hamilton Harbour's basin serves as a microcosm for the land use changes occurring throughout the Great Lakes drainage basin. We develop a Bayesian calibration framework that enables the explicit consideration of the uncertainty of calibration data and model predictions, while incorporating prior information about watershed process rates. We apply this framework to both empirical and process-based watershed models of phosphorus export. Our results show that the delivery of phosphorus varies by land use. While urban export rates are lower than agricultural export rates, delivery of agricultural phosphorus to streams is significantly modulated by the presence of wetlands. We also present evidence that the interannual variability of phosphorus source areas is largely driven by the corresponding variability of in-stream phosphorus attenuation rates. Finally, we investigate the response of urban and agricultural subwatersheds draining to the Harbour to intense rainfall events. Such events export a significant proportion of phosphorus to the Harbour during the growing season. *Keywords: Model testing, Bayesian inference, Watersheds, Risk assessment.*

WELLS, M.G. and COMAN, M.A., Department of Physical and Environments, University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C1A4. **Turbulence and Temperature Variability in the Near Shore Benthic Region of Lake Opeongo, Canada.**

We report field observations of turbulence and temperature variability from the near shore benthic region of Lake Opeongo, Ontario. The 3 sites are located at the depth of the thermocline on slopes of S = 1%, 4% or 8%. Near bed currents are measured with an acoustic Doppler profiler. During strong upwelling events there are periods sustained temperature inversions, due to a combination of shear-driven convective turbulence and the passage of internal waves. The internal seiche period is 12 hours, so as the thermocline oscillates these inversions occur for 6 hour periods at alternating ends of the lake. The inversions only occur when the lake number is less than 1, and the number of temperature inversions is inversely proportional to the magnitude of the slope. We use the structure function method to estimate the rate of dissipation of turbulent kinetic energy at the low slope sites. We find that shear induced convection does not need to be present to measure elevated values of dissipation. In fact on the shallow slope we find that currents associated with strong downwellings of epilimnion water and dissipation rates of the order of 10^{-5} m^2 s^{-3}. We discuss the likely frequency and spatial distribution of pulses of nutrients released into the food web for other lakes on the Canadian Shield. *Keywords: Benthic turbulence, Stratification.*

WERDEN, L.[1], SHARP, A.[2], BARKER, I.K.[2], BOWMAN, J.[3], GONZALES, E.K.[1], LEIGHTON, P.A.[4], LINDSAY, L.R.[5], and JARDINE, C.[2], [1]Parks Canada, Mallorytown, ON; [2]University of Guelph, Guelph, ON; [3]Ontario Ministry of Natural Resources, Peterborough, ON; [4]University of Montreal, Montreal, QC; [5]Public Health Agency of Canada, Winnipeg, MB. **Factors Affecting the Abundance of Blacklegged Ticks (*Ixodes scapularis*) and the Prevalence of *Borrelia burgdorferi* Infection in the Thousand Islands Region.**

Numerous factors affect the prevalence and distribution of *Borrelia burgdorferi* (Bb), the bacterium that causes Lyme disease, and its vector, the blacklegged tick (*Ixodes scapularis*). The objective of this study was to assess the distribution of ticks and Bb in the Thousand Islands, a new endemic region, and to determine the relative roles of various factors in predicting the presence of ticks and Bb. Data were collected at 12 sites in 2009 and 2010. Infection status of ticks was determined using PCR. Model selection and multimodel inference were used to evaluate variable effects. We found dramatic inter-island variation in the abundance of ticks (<1-57 per hour of dragging) and the prevalence of Bb in ticks (0-63%). Interestingly, species richness and the proportion of mice in the small mammal population interacted to affect the prevalence of Bb. As predicted, deer and temperature had positive effects on tick numbers, and both ticks and infection prevalence declined with increasing distance from the United States, the presumed source of this new endemic population. Our results will help in devising management strategies to control blacklegged ticks and reduce the risk of Lyme disease in the Thousand Islands and will help predict future risk as this disease system becomes further established in Canada. *Keywords: Lyme disease, Disease ecology, Wildlife.*

WESELOH, D.V.C.[1], ADAMS, C.[2], DOBBYN, S.[3], DOBBIE, T.[4], FARQUHAR III, J.[7], HARPER, L.H.[5], HEBERT, C.E.[15], MATHERS, A.[6], MAZZOCHI, I.[7], MCDONALD, K.[8], MOORE, D.J.[9], QUINN, J.S.[10], SHERMAN, D.[11], SHUTT, L.[12], TONINGER, R.[8], TYERMAN, D.[13], and RIDGWAY, M.S.[14], [1]Canadian Wildlife Service, Downsview, ON; [2]New York State Department of Environmental Conservation, Buffalo, NY; [3]Ontario Parks, Hunstville, ON; [4]Point Pelee National Park, Environment Canada, Leamington, ON; [5]Riveredge Associates, Massena, NY; [6]Lake Ontario Management Unit, Ontario Ministry of Natural Resources, Picton, ON; [7]New York State Department of Environmental Conservation, Watertown, NY; [8]Toronto Region Conservation Authority, Toronto, ON; [9]Canadian Wildlife Service, Burlington, ON; [10]Department of Biology, McMaster University, Hamilton, ON; [11]Crane Creek Research Station, Ohio Department of Natural Resources, Oak Harbor, OH; [12]Canadian Wildlife Service, Hull, QC; [13]Presqu'ile Provincial Park, Ontario Parks, Brighton, ON; [14]Ontario Ministry of Natural Resources, Trent University, Peterborough, ON; [15]Canadian Wildlife Service, Ottawa, ON. **Effects of Management and Habitat Change on Trends in Nest Counts of Double-Crested Cormorants in the Lower Great Lakes, 1979-2011.**

Long-term monitoring efforts by individuals from many agencies have counted double-crested cormorant nests on colonies on Lake Ontario and Lake Erie each year from 1979 to the present day. During that time, attention directed at this species has shifted from relative indifference in the early years to 'management issues' in recent years because of their dramatic change in abundance. We summarize these patterns of change in nest counts at whole lake levels, basins within lakes and colonies receiving management actions or undergoing habitat changes.

Line segment regression was used to model trends, or trend segments, in the timeline of nest counts at each scale. Management actions can be effective at the colony level with 5 to 15% declines per year sustained over many years. Unplanned activities at some colonies have sharp downward effects on trends but last only for the duration of the disturbance. Colony level management has resulted in a westward shift of the Lake Ontario population in step with management timing. Joinpoints for trend segments from Tommy Thompson Park, Lake Ontario, align with periods of tree loss in areas and perhaps control measures at other locations. On Lake Erie, similar management efforts are reducing targeted colonies at similar annual rates to those observed on Lake Ontario. *Keywords: Cormorants, Lake Erie, Monitoring, Lake Ontario.*

WESELOH, D.V.C.[1] and MOORE, D.J.[2], [1]Canadian Wildlife Service, Environment Canada, 4905 Dufferin St., Toronto, ON, M3H 5T4; [2]Canadian Wildlife Service, Environment Canada, Canada centre for Inalnd Waters, Box 5050, Burlington, ON, L7R 4A6. **Roosting Habits, Post-Fledging Dispersal and Wintering Areas of Great Egrets from Southern Ontario.**

In Ontario, breeding Great Egrets (Ardea alba, GREGs) have increased from one pair in 1952 to over 350 pairs in the 2000s. Since 2000, >1400 egrets have been colour-marked in the Great Lakes, including >300 marked with wing-tags in 2010 & 2011. The objectives of this project were: 1) to track the dispersal of egrets from their natal colonies, 2) to locate and monitor post-breeding roosting sites and 3) to identify wintering areas of Great Lakes GREGs. A large roost (300+ individuals) was located at Luther Marsh, N.W. of Toronto, Ontario, and occupied from late June - late September, 2009-2011. Thirty-five other roosts were located or suspected. All roosts examined (N=16) were in or adjacent to water in live or dead trees, bushes or on mudflats. Roost size varied from 2 - 400+ individuals. Modal nearest neighbour distance for 24 roosts was 8 km (median = 24 km). For wing-tagged egrets, 126 reports were received on 38 individuals (32.2% re-sighting) during July - October (2010). The maximum number of sightings per individual was 15. The maximum duration of stay in a specific area was 45 days. Most reports came from southern Ontario with a few from western New York, Ohio, Michigan and Wisconsin. There was little northward dispersal in winter, tagged/banded egrets were reported from coastal Carolinas, Florida and the Caribbean. *Keywords: Migration, Coastal wetlands, Great Egrets, Avian ecology, Lake Ontario.*

WHEELER, R.L. and UZARSKI, D.G., Institute For Great Lakes Research, CMU Biological Station, Department of Biology, Central Michigan University, Mount Pleasant, MI, 48859. **Spatial Variation of Macroinvertebrate Communities within Two Emergent Plant Zones of Great Lakes Coastal Wetlands.**

Great Lakes coastal wetland assessment and monitoring has received considerable attention recently due to the recognition of the importance of these systems in maintaining the overall health of the Great Lakes ecosystem. As a result, the demand for detailed research focusing on the ecological processes and interactions within Great Lakes coastal wetlands has increased. Past research has described the changes in macroinvertebrate communities within Great Lakes coastal wetlands through a gradient of abiotic conditions from upland through the emergent wetland to true aquatic, or submersed aquatic habitats. However, spatial variation of

macroinvertebrate community characteristics within a given zone along this gradient is less understood. This study explores the spatial variation of macroinvertebrate communities within two types of Great Lakes coastal wetland plant zones. The results suggest relationships between macroinvertebrate communities and spatial variation that are relevant to current and future assessment and monitoring efforts in Great Lakes coastal wetlands.
Keywords: Macroinvertebrates, Assessment, Wetlands, Spatial distribution.

WHITE, D.D. and JUNG, J.A., Voyageur Provincial Park, 1313 Front Road, Box 130, Chute a Blondeau, ON, K0B 1B0. **Controlling an Alien Species at Voyageur Provincial Park: The Invasive Water Chestnut.**

Water chestnut (Trapa natans) is an aggressive aquatic annual, native to Eurasia. Introduced in the 1800s, it has spread throughout northeastern US and into Quebec. It was first found at Voyageur Provincial Park in 2005, and is the only known location in Ontario. Water chestnut displaces native communities by forming a dense canopy of rosettes. Control efforts began in 2008 by hand-pulling plants. In 2009-2010, a Biocapteur (boat with large rake) was added to the effort; this method pulled out the entire rooted plant, but proved inadequate. In addition to hand-pulling, two boats were specially designed in 2011, one with horizontal blades to cut floating rosettes and another with tines to move rosettes to shore. This new method removed rosettes before plants had a chance to produce flowers. It enabled the control of over half of the most heavily infested bays and two of the lesser infested bays. Voyageur has initiated outreach efforts to prevent further introductions into Ontario, including mail-outs to residences, signage and educating local bait harvesters. In 2012, we plan to modify both boats to improve efficiency and purchase an artificial barrier, eliminating the need to maintain a water chestnut buffer around control areas. With improved control methods, we hope to conserve and restore the aquatic communities at Voyageur. *Keywords: Water chestnut, Invasive species, Management, Ontario Ministry of Natural Resources.*

WILSON, C.C. and KIDD, A.G., Ontario Ministry of Natural Resources, Trent University, 2140 East Bank Drive, Peterborough, ON, K9J 7B8, Canada. **Genetic Assessment of Lake Ontario Atlantic salmon Strain and Lifestage Contributions and Fitness through Pedigree Reconstruction.**

Genetic tracking is a key component of the effort to re-establish Atlantic salmon in Lake Ontario by assessing the comparative performance of the different strains and life stages being stocked. Three allopatric populations with contrasting ecological characteristics are being used for stocking. Genetic tracking of single-pair matings and family-specific stocking at several juvenile life stages is being used to assess their relative survival and growth in tributaries, as well as their timing of emigration to Lake Ontario with respect to environmental cues. Combined individual assignment tests and parentage analyses are being used to identify the source strain(s), families and stocked life stages of adult Atlantic salmon captured during summer creels on Lake Ontario, as well as adults that were captured in tributary rivers from 2008 onwards. These genetic data are providing valuable information on optimal life stages to stock for juvenile survival and adult returns. Assessing the comparative performance and fitness of different strains

and life stages is helping to inform restoration efforts, and will provide ongoing assessment and feedback to help optimize and ensure the successful re-establishment of this extirpated population. *Keywords: Lake Ontario, Remediation, Conservation.*

WILSON, C.C. and WOZNEY, K.M., Ontario Ministry of Natural Resources, 2140 East Bank Drive, Peterborough, On, K9J 7B8, Canada. **Genetic Assessment of Muskellunge Restoration Efforts in Georgian Bay (Spanish River) and Lake Simcoe.**

Although known as a ferocious top predator, muskellunge are ecologically vulnerable due to their habitat specificity and low population densities. Historical populations in the Spanish River (North Channel of Lake Huron) and Lake Simcoe were lost through habitat degradation, as well as historical commercial overfishing and pike invasion in Lake Simcoe. We used microsatellite DNA analyses to assess the success and relative contributions of rehabilitation stocking efforts of muskellunge in the Spanish River, and identify the source(s) of recently-captured juveniles. The genetic data indicate that muskellunge captured in the Spanish River come from either a single neighbouring stocking source (Serpent Harbour) or from remnant survivors from the historical population. Rehabilitation options for muskellunge in Lake Simcoe were similarly assessed, using genetic tools to investigate the relationship between the historical population and contemporary stocking sources. Recent samples from Lake Couchiching show genetic characteristics consistent with the historical population from Lake Simcoe, which differed from stocking sources from Georgian Bay and the Kawartha Lakes. These results reinforce the habitat specificity of muskellunge, and highlight the value of adaptive management approaches for restoring extirpated populations. *Keywords: Conservation, Lake Huron, Remediation, Lake Simcoe, Biodiversity.*

WILSON, J.E., IJC - Great Lakes Regional Office, 100 Ouellette Ave, Windsor, ON, N9A 6T3. **Nuisance and Harmful Algae.**

Eutrophication, the excessive growth of algae and other aquatic plants due to large amounts of nutrients being released into water bodies, can have adverse effects on the economy, human health, recreational activities and ecosystems as a whole. In the 1960s, algae blooms in Lake Erie and the other Great Lakes were recognized as a serious problem. These algae blooms rob lakes of oxygen and cause unsightly, potentially toxic mats to wash up on the shoreline. With the signing of the Great Lakes Water Quality Agreement in the 1970s, algae issues in the Great Lakes were addressed and reduced. However, in the 1990s the algae problem returned and Lake Erie recently experienced its worst algae bloom in decades. Building on progress made by the Eutrophication Work Group in the 2007-2009 Priority Cycle, the Commission's Nuisance and Harmful Algae Work Group created a three-part work plan of scientific, management, and communication components. The scientific component built on the previous biennial work by conducting a literature review to confirm findings and comparing the weight of evidence from the last biennial work-shop to the current literature review in order to correlate the two. Both reports used the same concept mapping process to identify the significance of various drivers of change on different types of algal growth *Keywords: Great Lakes basin.*

WILSON, M.C.[1], BOEGMAN, L.[1], BOUFFARD, D.[1], and YERUBANDI, R.R.[2], [1]Civil Engineering Department, Queen's University, Kingston, ON; [2]National Water Research Institute, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **Physical Processes in the Nearshore Region on the North Shore of Lake Ontario.**

Nearshore regions in the Great Lakes are used for drinking water supply and disposal of wastewater effluents. To understand the hydrodynamic mixing and transport processes in nearshore Lake Ontario, we investigate data collected by Environment Canada from the north shore of the lake between Port Hope and Cobourg. Measurements collected from multiple locations extending approximately 12 km offshore where the lake is about 60 m deep include thermistor chains, acoustic Doppler current profilers (ADCP), and acoustic Doppler velocitometers (ADV) oriented in a cross-shore transect where the bed slope is 1:200. Local wind behaviour will be analyzed, and its effect on the local hydrodynamic processes will be investigated. In this region, Poincare wave-induced currents are expected to be shore-parallel as they are strongly influenced by the lake boundary. Previous research in the 1970s suggested that strong coastal jet, observed in the region, was associated with Kelvin wave activity; however, our data suggests that this current is a result of a wind-induced geostrophic balance. This preliminary research will be followed by an investigation on more complex processes such as non-linear wave degeneration and instability, which drive turbulent mixing and sediment resuspension. *Keywords: Atmosphere-lake interaction, Water currents, Lake Ontario.*

WIRES, L.R.[1], CUTHBERT, F.J.[1], WESELOH, D.V.C.[2], and MOORE, D.J.[3], [1]U of MN, Dept. Fish, Wldlf & Cons Bio, 1980 Folwell Ave., St. Paul, MN, 55108; [2]Environment Canada, Canadian Wildlife Service, 4905 Dufferin Street, Toronto, ON, M3H 5T4; [3]Environment Canada, Canadian Wildlife Service, 867 Lakeshore Road, Burlington, ON, L7R 4A6. **Monitoring Double-crested Cormorants in the Great Lakes: Forty Years of Coordination between the U.S. and Canada.**

In the U.S. and Canada, efforts to monitor Double-crested Cormorants (Phalacrocorax auritus) in the Great Lakes were independently initiated in the mid-1970s as part of a larger survey to assess status of colonially nesting waterbirds. This initial effort evolved into the decadal Great Lakes Colonial Waterbird Survey (GLCWS), and the Canadian Wildlife Service and the U.S. Fish and Wildlife Service have since worked closely to coordinate continued survey efforts. Presently, four GLCWSs have been completed, one approximately every ten years. Results document an enormous increase in abundance and distribution of cormorants, growing from 584 pairs in 1977 to 111,000 pairs in 2007, with colonies now occurring on all five lakes and connecting waterbodies. In addition to these decadal surveys, population size was estimated in 2000, and in 2005 coordinated bi-national surveys conducted biannually were initiated to monitor the population more frequently. These efforts indicate the cormorant population peaked in 2000 at 115,000 pairs, followed by declines in 2007 and 2009, when the population was last estimated at 102,500 pairs. Data obtained during these efforts identify the Great Lakes as a continentally important area for cormorants, and have been used to guide conservation, management and monitoring programs for cormorants. *Keywords: Cormorants, Monitoring, Management.*

WIRICK, R.E., KERETZ, K.R., and KOCOVSKY, P.M., U S Geological Survey, Great Lakes Science Center, Sandusky, OH, 44870. **Moon Phase Effects on Bottom Trawl Catch Rates in Lake Erie.**

Previous research has shown that bottom trawling at night is more effective for certain species, but whether this trend is due to decreased ability of fish to see the gear or a diel change in distribution remains unclear. To address this question, a long-term trawl data set (1961-2011) with a depth stratified design and paired day-night replicates was analyzed. Variation in trawl catch rate as a function of percent illumination and duration of moonlight hours was examined. Results may provide researchers with insights into factors influencing the catchability of different species during different times of the lunar cycle. Understanding how moon phase and available light influence catch per unit effort at varying depths is important for researchers tasked with interpretations and design of Great Lakes fish surveys. *Keywords: Fish behavior, Fisheries, Lake Erie.*

WITHERS, J.L., FOLEY, C.J., TROY, C.D., and HÖÖK, T.O., Purdue University, 195 Marsteller Street, West Lafayette, IN, 47906. **Examining Spatiotemporal Overlap and Potential Consumptive Demand of First-Feeding Larval Yellow Perch, Larval Alewife, and Predatory Zooplankton within Nearshore Lake Michigan.**

Yellow perch and alewife are ecologically and economically important species in Lake Michigan; however, a full understanding of mechanisms controlling early life survival and subsequent recruitment of both species is lacking. Both species spawn, hatch, and presumably begin first-feeding in the nearshore region; hence environmental conditions and prey availability in the nearshore zone may strongly influence their survival. Along with larval yellow perch and alewife, three species of zooplanktivorous zooplankton, Leptodora kindtii, Bythotrephes cederstroemi, and Cercopagis pengoi, inhabit nearshore Lake Michigan. These species consume small zooplankton prey and are therefore hypothesized to compete with first-feeding larval fish for prey resources. During 2010-2011, we indexed environmental conditions and examined spatiotemporal distributions of larval yellow perch, larval alewife, predatory zooplankton, and their potential prey in a nearshore region of Lake Michigan. We documented high spatiotemporal variability of environmental conditions, zooplankton prey, predatory zooplankton and larval fish. Patterns suggest that coincident Cercopagis and Leptodora densities tend to exceed first-feeding larval alewife densities, while resource competition between first-feeding larval yellow perch and predatory zooplankton may be limited. *Keywords: Zooplankton, Alewife, Predatory zooplankton, Lake Michigan, Yellow perch, Nearshore.*

WOOLNOUGH, D.A.[1] and BERGNER, J.L.[2], [1]Institute for Great Lakes Research and Department of Biology, Central Michigan University, Mt. Pleasant, MI, 48859; [2]Department of Biology, Central Michigan University, Mt. Pleasant, MI, 48859. **Imperiled Species: Declines Can Be Masked by Community Changes.**

In our changing environment ecological relationships are complex. This is especially true for host-parasite relationships. With the additional effects of climate-related change this complex struggle for existence can be accentuated. Freshwater mussels (Family: Unionidae) are unique because their adult stage is relatively sessile and their parasitic larval stage can be extremely motile because of their use of host fish as vectors for dispersal and means of development. In the last 40-50 years there have been significant changes in mussel communities that can be correlated with changes in host availability, fish community change, and temperature changes. We show that over 80% of the rivers in the study have a decline in the number of unionid species in the last 40-50 years. However, the decline in more evident when overall community shift is evaluated. Component analysis shows how the community shift correlates with the use of host fish and how knowledge of unionid genera can predict changes in unionid communities. *Keywords: Mussels, Community change, Biodiversity, Unionids.*

WYATT, K.H.[1], DAVISON, I.R.[1], TELLEZ, E.[2], WOODKE, R.L.[1], BIDNER, R.J.[1], and GIROLDO, D.[3], [1]Institute for Great Lakes Research, Central Michigan University Biological Station, Central Michigan University, Mt. Pleasant, MI, 48859; [2]Department of Biology, University of Dallas, Irving, TX, 75062; [3]Instituto de Ciências Biológicas, Universidade Federal do Rio Grande - FURG, Rio Grande, RS, 96201, Brazil. **Effects of Nutrients on the Release and Utilization of DOC from *Cladophora glomerata* in Lake Michigan.**

Compared to phytoplankton, there is relatively little information about the importance of benthic algae as a source of dissolved organic carbon (DOC) in large lakes. In this study, we enriched mesocosms with 10x ambient nitrogen (N) and phosphorus (P) in a full factorial design (ambient, +N, +P, N+P) to evaluate the role of nutrient limitation in regulating the release, composition, and decomposition of DOC from *Cladophora glomerata* (L.) Kütz in Lake Michigan. After 10 days of enrichment, photosynthetic rates were significantly greater in the N+P treatment compared to individual nutrient treatments or ambient. The percent of total primary productivity released as DOC was lowest in the N+P treatment and highest in the +N treatment. SUVA, an indicator of aromaticity, was also lowest in the N+P treatment and highest in the +N treatment. Exudates derived from the N+P treatment had a greater percent degradation and supported greater bacterial density compared to the +N treatment. These data will be informative for evaluating how changes in nutrient status affect carbon cycling and energy flow associated with benthic algal growth in the Laurentian Great Lakes. *Keywords: Algae, Nutrients, Carbon cycle.*

XU, M.[1], LIANG, X.Z.[2], and LOFGREN, B.M.[3], [1]5828 University Research Ct., Ste.4001, College Park, MD, 20740-3823; [2]5828 University Research Ct., Ste.4001, College Park, MD, 20740-3823; [3]4840 S. State Rd., Ann Arbor, MI, 48108-9719. **Comparison of Two Lake Models Implemented in CWRF.**

Lakes have significant impacts on climate at regional-local scales and are also extremely susceptible to climate change. It is essential to incorporate lake effects with two-way interactions into a regional climate model for realistic prediction. In the initial stage, we coupled the version of the Hostetler lake model implemented at the Great Lakes Environmental Research Laboratory with the Climate extension of the Weather and Research Forecast model (CWRF) and improved its mixing-layer physics. This study presents a validation against observations and a comparison with simulations from another lake model built into CWRF, focusing on the prediction of water temperature and surface fluxes. Preliminary results show that interactions between the Great Lakes and regional climate are substantial and both lake models need refinements to accurately represent such interactions. *Keywords: Model studies, Lake model, Climates.*

YACOOB, S.[1], DIAMOND, M.L.[1], and GUEGUEN, C.[2], [1]University of Toronto,, 200 College St, Toronto, ON, M5S2E5; [2]Trent University, Chemistry Dpt., 1600 West Bank Drive, Peterborough, ON, K9J 7B8. **Investigation of Toxicity Source at Ross Lake Flin Flon, Ma.**

Ross Lake in Flin Flon, Manitoba has received zinc and copper enriched mine tailing effluents for over 50 years. Due to re-suspension of sediments Ross Lake remains an overall net source of zinc to downstream water bodies. Ross Lake is also extremely low in biological populations. This has prompted concern over the direct cause of toxicity, which had long been suspected to be zinc. The geochemical model WHAM was used to estimate speciation in the system, specifically the free ion concentration, and results were evaluated with DGT data collected during sampling campaigns. Free ion LC50 values were estimated using the Biotic Ligand Model (BLM). The BLM estimated acute toxicities were then compared with the modeled and measured values for zinc and copper in the system. Results of individual toxicities show copper rather than zinc to be acutely toxic. In order to more accurately represent the system, we have incorporated metal mixture modeling after seeing experimental results showing the additive effects of zinc and copper on toxicity. *Keywords: Model studies, Toxic substances, Metals.*

YERUBANDI, R.R.[1], ZHANG, W.[2], WATSON, S.B.[1], and PADALA, C.[1], [1]NWRI, Water S&T, Environment Canada, Burlington; [2]University of Toronto, Scarborough. **Hydrodynamics and Water Quality in a Spatially Complex Lake (Lake of the Woods).**

Lake of the Woods is a large, multi-basin international waterbody within the Lake Winnipeg drainage basin which recently has been exhibiting significant late-summer algal blooms and a decline in water quality. As part of the Lake Winnipeg Basin initiative field measurements of meteorology, physical limnology and water quality were obtained during 2008-10. Two hydrodynamic models were developed to study the circulation and short term water level fluctuations in the lake. These models in conjunction with a mass-balance model for total

phosphorous (TP) and an empirical model for phytoplankton biomass were applied to the lake during the period 2000-09. Based on historical water quality data and hydrodynamic model results, the lake was divided into six segments to represent the lake's spatial environment for the water balance, TP mass balance, and eutrophication model. The exchange flows across each segment, estimated from circulation patterns, were incorporated into multiple-segments mass-balance model. The model results of water quality variables are in reasonable agreement with the observed data of total phosphorus and chlorophyll-a. The model reproduced spatial and temporal distribution features of water quality parameters, such as total phosphorus gradient, which decreased from the south segment to the north segment. *Keywords: Ecosystem modeling, Hydrodynamics, Lake management.*

YUCUIS, R.A., HORNBUCKLE, K.C., and STANIER, C., 4105 SC, University of Iowa, Iowa City, IA, 52246. **Organosiloxane Compounds in Urban and Rural Air.**

The organosilicon compounds octamethylcyclotetrasiloxane (D4), decamethylcyclopentasiloxane (D5), and dododecamethylcyclohexasiloxane (D6) are widely used in household goods and personal care products. Due to their prevalence and chemical behavior, cyclic siloxanes have been targeted for study as possible persistent organic pollutants. We have applied an active method to collect airborne siloxanes in urban and rural environments and analyzed the samples using the internal standard method (internal standard tetrakis trimethyl-siloxysilane, M4Q) and gas chromatography with electronic impact mass detection. The method was applied on board the EPA R/V Lake Guardian, in urban Chicago, and in rural and suburban Iowa. We have found siloxanes to be present in every environment tested with an increase in concentration with population density. The average concentrations of sum siloxanes (D4+D5+D6) in the rural, suburban, and urban environments are 31, 71, and 290 ng m-3 respectively. The compounds D5 and D6 are strongly correlated among the sample sets ($r2 = .98$, $p < .0001$). A diurnal trend is apparent in the results from Chicago, with siloxane concentrations approximately two times greater at night than during the day. *Keywords: Lake Michigan, Siloxanes, Urban areas, Airsheds.*

YUILLE, M.J.[1], JOHNSON, T.B.[2], and ARNOTT, S.E.[1], [1]116 Barrie St., Kingston, ON, K7L 3J9; [2]41 Hatchery Lane, RR #4, Picton, ON, K0K 2T0. **Energetic Effects of *Hemimysis anomala* on Yellow Perch (*Perca flavescens*) in Lake Ontario.**

Hemimysis anomala, a littoral freshwater mysid, is the newest invader to the Laurentian Great Lakes basin. Discovered in 2006, they have since been found in all of the Great Lakes (except Lake Superior) and could potentially offset the dietary energy sink caused by dreissenid mussels (Dreissena bugensis and D. polymorpha) in the littoral zone. Studies have shown multiple fish species consume Hemimysis within the Great Lakes and European literature indicates, diets of P. fluviatilis are comprised entirely of Hemimysis. Stable isotope (13C and 15N) analyses on three fish species in Lake Ontario support results from fish diets and suggests Hemimysis consumption increases with Hemimysis density. As Hemimysis populations continue to establish and stabilize, fish may incorporate this species into their diets at a higher capacity. Using bioenergetics modeling, we test multiple predictive scenarios of Hemimysis consumption

and incorporation into yellow perch (P. flavescens) diets to determine the energetic cost/benefit of consuming this new invader. Preliminary results suggest the consumption of Hemimysis will decrease growth rates of yellow perch. Due to their limited seasonal availability, diel migration and predator avoidance behaviours, consumption of Hemimysis will reduce current fish growth rates in Lake Ontario. *Keywords: Great Lakes basin, Invasive species, Bioenergetics.*

ZANATTA, D.T.[1], BERGNER, J.L.[1], MATHIAS, P.T.[1], and WILSON, C.C.[2], [1]Central Michigan University, Institute for Great Lakes Research, Mount Pleasant, MI, 48859; [2]Aquatic Biodiversity and Conservation Unit, Ontario Ministry of Natural Resources, Peterborough, ON, K9J 7B8. **Patterns of Post-Glacial Colonization for Freshwater Mussels (Unionidae) in the Great Lakes.**

Declines in North American freshwater mussel (Unionidae) populations have left 70% of species vulnerable to extinction. Continuous population declines in the last century have resulted in dire need for conservation actions; however, a good understanding of patterns in genetic population structure often inhibits conservation strategies and management. Two important hypothesized routes of entry for aquatic organisms into Laurentian Great Lakes at the end of the Wisconsin glaciation followed the paths of the Wabash-Maumee spillway and the Chicago-Illinois River spillway. We have tested these hypotheses and compared the post-glacial origin of three relatively common freshwater mussel species in the Great Lakes basin. We genotyped microsatellite DNA markers to analyze genetic diversity from three relatively common unionids in the Great Lakes and beyond and interpret their patterns of genetic population structure. Our findings indicate that the pattern of post-glacial colonization varies among species with some species entering following Chicago-Illinois River spillway and others following multiple routes. Understanding these patterns for unionids in the Great Lakes will help formulate evolutionarily sound management guidelines and provide insight for augmenting and re-establishing populations of species of conservation concern. *Keywords: Post-glacial colonization, Unionids, Molecular ecology, Mollusks, Conservation.*

ZANATTA, D.T.[1], BATEMAN, J.[2], BERGNER, J.L.[1], BOSSENBROEK, J.[3], BURLAKOVA, L.E.[4], CRAIL, T.[3], DE SZALAY, F.[5], GRIFFITH, T.[1], HICKIN, M.[5], KAPUSKINSKI, D.[5], KARATAYEV, A.Y.[4], KOLICH, L.A.[1], KREBS, R.A.[6], LONGTON, G.[2], MEYER, E.[7], PATERSON, W.[1], PRESCOTT, T.[6], ROWE, M.T.[1], SCHLOESSER, D.W.[8], SCOTT, M.W.[1], SHACKELFORD, M.[2], SHREVE, K.[5], and WALSH, M.[7], [1]Central Michigan University, Biology Department, Institute for Great Lakes Research, Mount Pleasant, MI, 48859; [2]DTE Energy, Detroit, MI, 48210; [3]Department of Environmental Sciences, Lake Erie Center, University of Toledo, Oregon, OH, 43618; [4]Great Lakes Center, Buffalo State College, Buffalo, NY, 14222; [5]Department of Biological Sciences, Kent State University, Kent, OH, 44242; [6]Department of BGES, Cleveland State University, Cleveland, OH, 44115; [7]Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Hollidaysburg, PA, 16648; [8]USGS, Great Lakes Science Center, Ann Arbor, MI, 48105-2807. **Survey and Reassessment of Unionidae in Lake Erie and Lake St. Clair, 25 Years After the Dreissenid Invasion.**

The invasions of Ponto-Caspian dreissenids (zebra mussels and quagga mussels) have caused massive change to the Great Lakes ecosystem. Among their more prominent and well documents effects was a major decline in the diversity and abundance of native unionid mussels in Lake Erie and Lake St. Clair. With support of funding from the Great Lakes Fish and Wildlife Restoration Act, our group conducted the most extensive surveys conducted to date of known and potential unionid refugia from dreissenid mussels. We visited 41 locations with replicate samples at each for a total of 117 sites in bays, coastal wetlands, and drowned rivermouths on the U.S. side of Lake Erie and Lake St. Clair. Using an identical sampling regime at each site we surveyed a 0.5 ha area for 2 person-hours with SCUBA, snorkeling, wading, and/or raking. At each site we recorded species presence, abundance, lengths; mass of infesting dreissenids; water depth; substrate type; and water chemistry. In total, we collected 1778 unionids belonging to 23 species. While species assemblages have shown major shifts, these findings are especially encouraging given that surveys shortly after the dreissenid invasion pointed toward total extirpation of the unionid fauna. Our continuing research will attempt to prioritize areas for continued management and monitoring. *Keywords: Dreissena, Lake St. Clair, Unionids, Lake Erie.*

ZASTEPA, A., PICK, F., and BLAIS, J.M., University of Ottawa, Laboratory for the Analysis of Natural and Commercial Environmental Toxins, 30 Rue Marie Curie, Ottawa, ON, K1N6N5, Canada. **Degradation of Particulate and Dissolved Microcystin-LA from a Senescing *Microcystis* bloom *in vitro* and *in situ*.**

The hepatotoxic microcystins (MC) comprised of 90+ variants, is the largest and most common group of cyanotoxins in freshwater. Majority of studies and water quality guidelines focus on MCLR, however the composition of MCs in surface waters appears to vary. We have observed MCLA to be the dominant MC in several Ontario and Quebec lakes. Following a spring bloom in a small lake, we determined degradation and persistence of the dominant MCLA both *in vitro and in situ*. Under laboratory conditions, the dissolved fraction was most susceptible to degradation under high light while the particulate MCLA showed faster degradation in response to high temperature. Concurrent sampling of the lake showed a more rapid degradation than observed in the laboratory, indicating the importance of other factors (eg. sorption, dispersion, UV) in the natural environment. MCLA concentrations exceeding recreational guidelines (10-20 µg/L) persisted in both lake and laboratory for 6 weeks and 6-25 weeks. Notably, dissolved MCLA was measured at these levels when cyanobacteria were no longer evident. Overall, MCLA appears to degrade slower and persist longer than MCLR. Considering the equivalent toxicity, the findings demonstrate the need to consider MCLA and other MCs in public health and lake management responses (beach closure/re-open) *Keywords: Water quality, Degradation and persistence, Lake management, Microcystin, Microcystis, Public health.*

ZHANG, H.[1], RUTHERFORD, E.S.[2], MASON, D.M.[2], BELETSKY, D.[1], ADAMACK, A.T.[3], HOFF, M.[4], FULTON, E.A.[5], and BARBIERO, R.P.[6], [1]CILER/SNRE, University of Michigan, Ann Arbor, MI, 48108; [2]NOAA GLERL, Ann Arbor; [3]Institute for Applied Ecology, University of Canberra, Canberra, Australia; [4]US Fish and Wildlife Services, Ft. Snelling, MN; [5]CSIRO Division of Marine and Atmospheric Research, Hobart, Tasmania, Australia; [6]CSC/Loyola University Chicago, Chicago, IL, 60660. **Forecasting Asian Carp Impacts on Lake Michigan's Food Web and Fisheries - Using the Atlantis Ecosystem model.**

Bighead (*Hypophthalmichthys nobilis*) and silver (*H. molitrix*) carps ('AC', Asian carps) threaten to invade the Great Lakes and may disrupt food webs and fisheries through the consumption of lower trophic levels. They may differentially impact food webs amongst habitats (i.e., offshore, nearshore, drowned river mouths and tributaries). To account for habitat heterogeneity, we are using the Atlantis modeling framework which incorporates spatially explicit 3-D information on biological (food web), geochemical, and physical processes and simulates the potential food web consequences as a function of stressors (e.g., AC invasion). The simulated food web includes algae, zooplankton, benthos, and fish species/groups. The model is forced by daily flow fields and water temperature from a 3D hydrodynamic model, and calibrated (without AC) with available time series data on selected species/groups. AC will then be added to the food web to forecast impacts of AC invasion for a range of scenarios: three AC biomass levels (none, low and high), with/without climate change, and high/low nutrient loading. By comparing the differences amongst forecasts, we will assess the likely impacts of AC on food webs, and production, recruitment and harvest of key prey and predator fish species among Great Lakes habitats *Keywords: Risk assessment, Exotic species, Ecosystem modeling.*

ZHANG, W.[1], MUGALINGAM, S.[3], YERUBANDI, R.R.[2], DITTRICH, M.[1], and ARHONDITSIS, G.B.[1], [1]University of Toronto, Department of Physical & Environmental Sciences, Toronto, ON, M1C 1A4, Canada; [2]Environment Canada, Canada Centre for Inland Waters, Burlington, ON, L7R 4A6, Canada; [3]Lower Trent Conservation, Toronto, ON, K8V 5P4, Canada. **Examination of the Capacity of the Bay of Quinte Phosphorus Model to Guide Future Management Decisions.**

We examine the applicability of the DFO predictive TP model to understanding Bay of Quinte RAP scenarios of most interest; whether the model parameters and inputs are well characterized and relevant to the current conditions in the Bay of Quinte and its drainage areas; data gaps and assumptions in regards to uncertainty of model outputs and achievability of RAP delisting objectives as well as long-term Bay of Quinte phosphorus management actions. Our focus is also to examine which factors unaccounted for by the original model are likely to modulate the response of the system as we reduce the exogenous phosphorus loading. We will also offer probabilistic predictions for the attainment of the designated TP water quality target of 30 µg/L that explicitly account for the uncertainty associated with the model inputs, model structure, weather variability, and data gaps from the system. Our probabilistic (Monte Carlo) approach will not only attempt to address the attainment of the designated TP water quality goal, if the Bay of Quinte RAP phosphorus loading reductions are actually achieved, but will also offer estimates of the likelihood of violating this target given the uncertainty of any modelling exercise. Finally, our study discusses directions of future model structure augmentation and ways

to optimize the spatial segmentation. *Keywords: Uncertainty analysis, Phosphorus, Decision making, Bay of Quinte, Model testing, Water quality.*

ZHAO, Y.[1], JONES, E.[2], CARIG, J.[3], and <u>SMITH, R.E.H.</u>[2], [1]Ont. Min. Nat. Res., Wheately, ON; [2]Biol. Dept., U. Waterloo, Waterloo, ON; [3]Dept. Civil Environ. Eng., U. Waterloo, Waterloo, ON. **Modeling Hydrodynamic Contributions to Inter-Annual Variation of Recruitment Success in Walleye of West Basin Lake Erie.**

Recruitment success of Stizostedion vitreum (walleye) in west basin Lake Erie varies greatly between years and almost independently of adult stock size. It has been hypothesized that good recruitment results when the vulnerable first feeding stage larvae are carried to a putative nursery area of high food (zooplankton) concentration along the southern margins of the west basin. We used a 3-D hydrodynamic model (ELCOM) coupled with an ecological model (CAEDYM) and a novel egg-larvae development model to simulate zooplankton and larvae distributions in years of widely varying recruitment success. Zooplankton simulations indicated that high zooplankton concentrations during the critical first feeding period were not found in the proposed nursery area. High concentrations did develop at the southeastern margin of the basin. In the limited sampling of years analyzed to date, larvae were predicted to overlap the higher food patches more in two good recruitment years than in a bad recruitment year. Results to date support a role for hydrodynamics and larval food supply in walleye recruitment success but also reveal inconsistencies in available observations of zooplankton in west basin Lake Erie. *Keywords: Recruitment, Hydrodynamic model, Fish.*

<u>ZHU, X.</u>[1], ZHAO, Y.[2], JOHNSON, T.B.[3], MATHERS, A.[3], and CORKUM, L.D.[4], [1]Central and Arctic Region, Fisheries and Oceans Canada, Winnipeg, MB, R3T2N6, Canada; [2]Aquatic Research and Development Section, Ontario Ministry of Natural Resources, Wheatley, ON, N0P2P0, Canada; [3]Aquatic Research and Development Section, Ontario Ministry of Natural Resources, Picton, ON, K0K2T0, Canada; [4]Department of Biological Sciences, University of Windsor, Windsor, ON, N9B3P4, Canada. **Exploration of Bayesian Statistical State-Space Model to Assess American Eel Biomass Dynamics and Precautionary Management Significance in the Upper St. Lawrence River -Lake Ontario System.**

American eel, Anguilla rostrata, a catadromous panmictic fish, once dominated Lake Ontario commercial fisheries in 1950-1970s. Since early-1990s, this stock has teetered near the brink of extirpation with only marginal changed following a closure of the fishery in the Province of Ontario in 2004. To support a precautionary management framework, we simulated an American eel fishery assessment and management plan including analyses of population dynamics, development of biological reference points, and formulation of harvest control rules. Firstly, we developed a state-space modeling and Bayesian approach for a generalized surplus production model of American eel to integrate historic datasets of fishery-dependent and -independent investigations during 1959-2003. Secondly, using the stock assessment model results, we developed a series of biological reference points for American eel, including a Limit Reference Point (LRP), Upper Stock Reference (USR) and Removal Reference Point (RRP). Thirdly, the resulting harvest control rules were developed to recommend American eel

precautionary strategies associated with uncertainties and risk assessments. These findings are fundamentally relevant for the restoration of the endangered species along with necessary improvement of indigenous species production in Lake Ontario systems.
Keywords: Precautionary Approach, Model studies, Bayesian State-Space model, Fish populations, Lake Ontario, American eel.

ZHU, X., HEDGES, K.J., HOWLAND, K.J., DAY, A.C., CARMICHAEL, T.J., and TALLMAN, R.F., Arctic Aquatic Research Division, Fisheries and Oceans Canada, Winnipeg, MB, R3T2N6, Canada. **Using Length-Weight Relation to Delineate Fish Population Status Synergized with Cumulative Anthropogenic Activities.**

Conventionally, fish fork length and round weight relationships are described by a power function. We challenge this allometric function of the log-transformed pairs of Lake Whitefish in Great Slave Lake (GSL) to fit four candidate numerical models: linear (LM), quadratic (QM), cubic (CM) and piecewise (PW, or broken-stick). In terms of AICs, model PW was considered the best for Whitefish in southern shallow waters, and model CM was the best in central and northern deep waters. Applying multi-model inference (MMI), the averaging model was derived from a reconciliation of the relative AICs, indicating that the assumption of linearity is more or less violated as the residuals of LM displayed either wider variation or evident curvature. It was found that a marked breakpoint, ranging from 372 to 460 mm, varied with the fish in particular habitats. Combined with the relevant information on fish biology and aquatic ecology, we presumed that there might be a transition in the ontogenic life history, such as maturity, of the species or fast ecological shifts. The results from this study can help us better understand the evident spatial variations in allometric growth of GSL Lake Whitefish, which largely related to both plastic and adaptive responses of fish populations to the increase of cumulative anthropogenic activities. *Keywords: Lake Whitefish, Bioindicators, Cumulative anthropogenic activities, Fish populations, Climate change, Great Slave Lake.*