THE SEVENTH BIENNIAL MEETING OF THE LAKE ERIE MILLENNIUM NETWORK

The Status of Lake Erie: Management Needs and Research Questions

29-31 October 2013
University of Windsor
Windsor, Ontario, Canada

Convened by

The University of Windsor
National Water Research Institute, Environment Canada
Ohio Sea Grant – F.T. Stone Laboratory, Ohio State University
Great Lakes Research Station, U.S. Environmental Protection Agency at Grosse Ile

Program and Abstracts

ORGANIZING COMMITTEE

LAKE ERIE MILLENNIUM NETWORK

Jan Ciborowski	Convener, University of Windsor
Russell Kreis	Convener, Large Lakes Research Laboratory, US EPA, Grosse Ile
Chris Marvin	Convener, National Water Research Institute, Environment Canada
Jeffrey Reutter	Convener, Ohio Sea Grant & F.T. Stone Laboratory, Ohio State University
Ellen Green	Convener, University of Windsor

We gratefully acknowledge the following University of Windsor offices for hosting the Meeting social events:

President – Dr. Alan Wildeman
Vice-President Academic – Dr. Leo Groarke
Vice-President Research – Dr. K.W. Michael Siu
Great Lakes Institute for Environmental Research – Dr. Daniel Heath, Executive Director
Faculty of Science – Dr. Marlys Koschinsky, Dean

MEETING PROGRAM

THE SEVENTH BIENNIAL MEETING OF THE
LAKE ERIE MILLENNIUM NETWORK
The Status of Lake Erie: Management Needs and Research Questions

Winclare A, Vanier Hall
University of Windsor
29-31 October 2013

MONDAY, OCTOBER 28th

8:00 a.m. – 5:00 p.m. **State of the Strait – Setting Ecological Endpoints and Restoration Targets**

5:00 p.m. – 7:00 p.m. Informal mixer with the State of the Strait participants

TUESDAY, OCTOBER 29th

11:30 a.m. **Registration and Poster/Display Setup**

12:45 p.m. Welcoming Remarks and Introductions
Dr. Marlys Koschinsky, Dean, Faculty of Science
Dr. Daniel Heath, Executive Director, Great Lakes Institute for Environmental Research

Theme #1: Identifying the Nutrient Challenges – Task Forces and Interim Needs
Moderator – Russell Kreis, U.S. Environmental Protection Agency

1:00 p.m. **GAIL HESSE,** Ohio Lake Erie Commission
Findings and recommendations of the Ohio Lake Erie Phosphorous Task Force Phase II

1:15 p.m. **SANDRA E. GEORGE, -** Environment Canada
LAMP nutrient management strategies – COA and the GLWQA

1:30 p.m. **RAJ BEJANKIWAR, G. Benoy, M. Child, and D. Dempsey**, International Joint Commission
A brief overview of the International Joint Commission's Lake Erie Ecosystem Priority Draft Report

Theme #2: Status of Lake Erie – Nutrients, Hazardous Algal Blooms and Nuisance Algae Moderator – Jeffrey Reutter, Ohio State University

1:45 p.m. **ELIZABETH (LIBBY) DAYTON**, Ohio State **University** and **K. King**, US Department of Agriculture – Agricultural Research Service
On-Field Ohio! Evaluation/revision of the Ohio Phosphorous Risk Index

2:00 p.m. **KEVIN KING,** US Department of Agriculture – Agricultural Research Service
Agricultural nutrient transport and current BMPs

2:15 p.m. **S. Sowa, DOUG PEARSALL, M.E. Herbert, M. Fales, A. Sasson, A. Froehlic, G. Annis, C. Vollmer-Sanders, B. Stanley, K. Hall, P. Doran,** The Nature Conservancy, **S. Ludsin, C. Keitzer**, Ohio State University, and **J. Reutter,** Ohio Sea Grant
Informing strategic conservation of streams in agricultural landscapes of the Great Lakes: An overview of the Great Lakes and Western Lake Erie Basin Conservation Effects Assessment Projects (CEAP)

2:30 p.m. **CRAIG F. DRURY, W.D. Reynolds, C. S. Tan, X. Yang, N.B. McLaughlin,** and **J. Yang,** Agriculture & Agri-Food Canada
Reactive nitrogen transformations and losses from agricultural soils

2:45 p.m. **SHAWN McELMURRY,** Wayne State University
Effectiveness of urban best management plans to reduce phosphorus runoff

3:00 p.m. **BREAK**

3:30 p.m. **ALICE DOVE** and **S. Backus,** Environment Canada
Water quality monitoring for Lake Erie Status and Trends and the Great Lakes Nutrients Initiative

3:45 p.m. **R. PETER RICHARDS,** Heidelberg University
Nutrient loading and Lake Erie: Recent learnings

4:00 p.m. **RUSSELL G. KREIS,** U.S. Environmental Protection Agency**, R. P. Richards,** Heidelberg Universit**y, D.M. Dolan,** University of Wisconsin**,** and **G. Warren,** U.S. Environmental Protection Agency
Status of Lake Erie phosphorus loads and concentrations

4:15 p.m. **DAVID BAKER, L.T. Johnson,** and **R.P. Richards,** Heidelberg University
The role of the Maumee River as a source of phosphorus supporting algal growth in the western basin of Lake Erie

4:30 p.m. **GERALD MATISOFF,** Case Western Reserve University
Sediment-water exchange processes in Lake Erie

4:45 p.m. **JOE DePINTO, E. Verhamme,** and **T. Redder,** LimnoTech
Development of a fine-scale ecosystem model for the western basin of Lake Erie

5:10 p.m. **Discussion and Comments**

5:30 p.m. – 7:00 p.m. **RECEPTION & POSTER VIEWING**

WEDNESDAY, OCTOBER 30th

Theme #3: Status of Lake Erie – Biota and Contaminants
Moderator: Russell Kreis, U.S. Environmental Protection Agency

8:45 a.m. **TOM BRIDGEMAN** and **J. Chaffin,** University of Toledo
An update on harmful algal blooms in Western Lake Erie

9:00 a.m. **DAVID DEPEW** and **V. Hiriart-Baer,** Environment Canada
A synopsis of the Great Lakes Nearshore Initiative attached algae program

9:15 a.m. **STUART LUDSIN, K.M. DeVanna,** Ohio State University, and **R.E.H. Smith,** University of Waterloo
Physical-biological coupling and the challenge of understanding fish recruitment in the Great Lakes

9:30 a.m. **LYUBOV BERLAKOVA, A.Y. Karatayev, C. Pennuto,** SUNY Buffalo State, and **C. Mayer,** University of Toledo
Changes in Lake Erie benthos over the last 50 years: historical perspectives, current status, and main drivers

9:45 a.m. **AARON FISK** and **H. Petit-Wade,** University of Windsor
The isotopic niches of invasive Gobiidae in the Lake Erie-Lake Huron corridor

10:00 a.m. **BREAK**

10:30 a.m. **CHRIS VANDERGOOT,** Ohio Department of Natural Resources
Status of the Lake Erie fish community 2013

10:45 a.m. **MEGAN BELORE, L. Witzel, A. Cook, and B. Locke,** Ontario Ministry of Natural Resources
Relative abundance of invasive fish species in the Ontario Ministry of Natural Resources Lake Erie Management Unit

11:00 a.m. **KIM CUDDINGTON,** University of Waterloo, **W. Currie,** and **M. Koops** Great Lakes Lab for Fisheries & Aquatic Sciences, Fisheries & Oceans Canada
A stage-and river-structured model prediction for establishment probability of bighead and silver carps in the Great Lakes

11:15 a.m. **DEBBIE BURNISTON, J. Waltho, P. Klawunn,** and **C. Marvin,** Environment Canada
Spatial distributions and temporal trends of contaminants in the St. Clair corridor and implications for Lake Erie

11:30 a.m. **D. McGoldrick, SEAN BACKUS, M. Keir, M. Clark,** and **M. Malecki** Environment Canada
Monitoring contaminants in fishes from the Canadian waters of the Great Lakes: 1977 to 2013 - PCBs to PFCs

11:45 a.m. **CRAIG HEBERT, D. Moore, R. Letcher, S. deSolla,** Environment Canada, **T. Dobbie,** Parks Canada Agency, **C. Pekarik**, and **C. Weseloh,** Environment Canada
Status of Waterbirds on Lake Erie

12:00 p.m. **PAUL DRCA,** City of Windsor, and **J.G. Li,** Stantec Consulting Ltd.
Pollution Control in the City of Windsor: Wastewater & CSO Management - 2013 Status and Update

12:15 p.m. **LUNCH**

Theme #4: Documenting Threats/Proposing Solutions
Moderator: Chris Marvin, Environment Canada

1:15 p.m. **SCUDDER MACKEY,** Ohio Department of Natural Resources
Great Lakes water levels and coastal systems - Coastal resiliency and climate change

1:30 p.m. **CHRIS VANDERGOOT,** Ohio Department of Natural Resources
Wind power update for Lake Erie

1:45 p.m. **J. DAVID ALLAN and S.D.P. Smith,** University of Michigan
Summarizing threats to Lake Erie: Multi-stressor mapping to assist decision-making

2:00 p.m. **DOUG PEARSALL, P. Carton de Grammont, C. Cavalieri , C. Chu, P. Doran, L. Elbing, D. Ewert, K. Hall, M. Herbert, M. Khoury, D. Kraus, S. Mysorekar,** The Nature Conservancy**, J. Paskus,** Michigan Natural Features Inventory**,** and **A. Sasson,** The Nature Conservancy

Returning to a healthy lake: An international biodiversity conservation strategy for Lake Erie

2:15 p.m. **L.A. Mason, C.M. RISENG, D.K. Forsyth, B.L. Sparks-Jackson,** University of Michigan**, L. Wang,** International Joint Commission**, E.S. Rutherford,** NOAA-GLERL**, K.E. Werhly,** University of Michigan**, J.E. McKenna,** U.S. Geological Survey**, C. Castiglione,** U.S. Fish and Wildlife Service**, L.B. Johnson,** University of Minnesota**,** and **S.P. Sowa,** The Nature Conservancy

The Great Lakes Aquatic Habitat Framework: Creating a common spatial grid for sharing physical, geochemical, and biological data across the entire great lakes basin

2:30 p.m. **RUSSELL M. STRACH,** Great Lakes Science Center, US Geological Survey

Huron-Erie Corridor Initiative: past successes and future plans of an evolving science partnership

3:00 p.m. **BREAK**

Theme #5: Building Expertise and Collaborations – Opportunities for 2014
Moderator: Jan Ciborowski, University of Windsor

3:30 p.m. **JOHN LAWRENCE and M. Goffin**, Environment Canada

The Amended Canada-United States Great Lakes Water Quality Agreement

3:45 p.m. **ERIC OSANTOWSKI –** Great Lakes National Program Office, US Environmental Protection Agency

Research and the Great Lakes Restoration Initiative; sampling on EPA's research vessel, the Lake Guardian.

4:00 p.m **CHRIS MARVIN –** Environment Canada

COA-related research – federal and provincial activities, plans, and opportunities for collaboration; sampling on Canadian Coast Guard Research Vessel Limnos

4:15 p.m. **ANDREW SCOTT, M.A. Xenopoulos, P.C. Frost,** Trent University, **G.D. Haffner,** University of Windsor, **T. Howell,** Ontario Ministry of the Environment, **M. Koops,** Fisheries and Oceans Canada, **J. Larson,** U.S. Geological Survey, **C. Marvin,** Environment Canada, **M. Twiss,** Clarkson University, and **S. Watson,** Environment Canada

Linking regime shifts to carbon dynamics in Lake Erie

4:30 p.m. **To Be Announced**
CSMI opportunities for collaboration in 201; Other research collaborations, and Great Lakes vessel coordination

5:00 p.m. Discussion and Comments

THURSDAY, OCTOBER 31st

Hypotheses, Research Needs and Planning

8:45 a.m. **JAN CIBOROWSKI**, University of Windsor
Recap and update - LEMN over the next 5-years

9:15 a.m. **JEFFREY REUTTER**, Ohio State University
Charge to the conference: coordinating research

9:30 a.m. **Research needs and Planning in Breakout groups**
Breakout - Research Discussion topics (Tentative)
Understanding causes of eutrophication
Land-based transformations
Nearshore transformations
Offshore nutrient cycling
Lake Erie biodiversity & habitat research needs
Climate change & water level research needs
Anticipating & accommodating effects of invaders
Monitoring & integrating multiple stressors

11:30 a.m. **JEFFREY REUTTER**, Ohio State University
Reporting Out

12:30 p.m. **JAN CIBOROWSKI**, University of Windsor
Final Comments

12:45 p.m. **Adjourn**

1:00 p.m. – 5:00 p.m. **Rooms available for post-conference meetings and planning**

PRESENTATION ABSTRACTS

SUMMARIZING THREATS TO LAKE ERIE: MULTI-STRESSOR MAPPING TO ASSIST DECISION-MAKING

J. David Allan and S.D.P. Smith

School of Natural Resources & Environment, University of Michigan, Ann Arbor, MI, USA

The Laurentian Great Lakes face multiple environmental stressors resulting from human activities that threaten water quality, fisheries, recreation and other human benefits that a healthy ecosystem can provide. GIS mapping tools have the potential to use large, spatially explicit datasets to help identify restoration and conservation priorities, as Allan et al. (2013) illustrated in a basin-wide analysis. However, each Great Lake differs in key ecosystem characteristics, human population pressure, and the suite of environmental stressors that it faces, suggesting that lake-scale analyses may be most useful to managers. In this presentation we assess spatial coincidence of diverse environmental stressors and ecosystem services within Lake Erie in the context of holistic visioning of conservation and restoration planning. While management today is strongly pre-occupied with nutrient management, we highlight the multiplicity of other threats. We hope to enlist partners, including those with complementary data and analyses and those engaged in existing management networks, to use multi-stressor and ecosystem services mapping to craft new ways to identify and prioritize local restoration and conservation opportunities within a lake-wide vision.

THE ROLE OF THE MAUMEE RIVER AS A SOURCE OF PHOSPHORUS SUPPORTING ALGAL GROWTH IN THE WESTERN BASIN OF LAKE ERIE

David B. Baker, L.T. Johnson, and R.P. Richards

National Center for Water Quality Research, Heidelberg University, Tiffin, OH, USA

From 2001-2011, phosphorus loads from the Maumee River, as measured at Waterville, OH accounted 24% of the total phosphorus loads entering Lake Erie from all external sources. Most of the phosphorus entering the Lake from the Maumee River does so during periods of high flow. Flows exceeded 20% of the time accounted for 84% of the total phosphorus load and 74% of the dissolved phosphorus load. Dissolved phosphorus comprised about 27% of that TP while 73% was particulate phosphorus. Analyses of the bioavailability of the Maumee River phosphorus loads indicates that only 27% of the particulate phosphorus was bioavailable, as measured by NaOH extractions, while 96% of the dissolved phosphorus was bioavailable. Consequently, only 46% of the total phosphorus loads measured at Waterville is in forms bioavailable to algae. That bioavailable phosphorus was composed of about 50% dissolved reactive phosphorus, 43% particulate phosphorus and 7% dissolved hydrolysable phosphorus. Studies of storm runoff water as it moves from Waterville through the lower Maumee River and Maumee Bay indicate that most of the particulate phosphorus, including its bioavailable portions, is deposited in the lower river and bay. In addition, this particulate phosphorus settles out of water with high ambient concentrations of dissolved reactive phosphorus and consequently is unlikely to release phosphorus into the water column. Thus only about 26% of the total phosphorus measured at Waterville is in a form and location where it can support algal bloom development. However, the combination of the high volumes of water that move from the Maumee River into Lake Erie during storms, coupled with the high concentrations of dissolved reactive phosphorus, nitrate and silica, create ideal culture media for algal growth that can occupy large areas in the Western Basin. No other source of phosphorus entering the Western Basin has this set of characteristics.

A BRIEF OVERVIEW OF THE INTERNATIONAL JOINT COMMISSION'S LAKE ERIE ECOSYSTEM PRIORITY DRAFT REPORT

Raj Bejankiwar[1], G. Benoy[2], M. Child[1], and D. Dempsey[3]

[1]International Joint Commission- Great Lakes Regional Office, Windsor, ON, Canada
[2]International Joint Commission- Canadian Section Office, Ottawa, ON, Canada
[3]International Joint Commission- The US Section Office, Washington D.C., USA

In 2011, Lake Erie experienced its largest algal bloom in history. In 2012, the International Joint Commission (Commission) established the Lake Erie Ecosystem Priority (LEEP) in response to a growing challenge: lake-wide changes in Lake Erie related to problems of phosphorous enrichment from both rural and urban sources, compounded by the influence of climate change and aquatic invasive species. These changes have resulted in impaired water quality, with impacts on ecosystem health, drinking water supplies, fisheries, recreation and tourism, and property values. The core objective of LEEP is to provide advice to federal, state, provincial and local governments to develop policy and implement management approaches to help restore the health of the lake's ecosystem by reducing nutrient loads and resulting algal blooms. To reach this objective, the Commission established study teams of independent experts to develop a better scientific understanding of the causes and controls of phosphorous loading into Lake Erie. The LEEP work plan addressed *science*, *socio-economic* and *regulatory* themes as part of a comprehensive approach. Each theme was addressed by a series of binational working groups led by various Commission advisory boards and councils or by Commission staff. The draft summary report was available for public review and comment through a series of open houses in the basin and via the IJC website. The Commission is in the process of revising the report and will deliver a final version to the United States and Canadian governments. The Commission believes that current knowledge is sufficient to justify immediate additional effort to reduce external loading of nutrients to Lake Erie. Phosphorous, especially the bioavailable dissolved reactive fraction, is a primary concern. Efforts must deal with both agriculture and urban sources. The highest priority for remedial action should be the Maumee River watershed.

RELATIVE ABUNDANCE OF INVASIVE FISH SPECIES IN THE ONTARIO MINISTRY OF NATURAL RESOURCES LAKE ERIE MANAGEMENT UNIT

Megan Belore, L. Witzel, A. Cook, and B. Locke

Ontario Ministry of Natural Resources, Lake Erie Management Unit, Wheatley, ON
Ontario Ministry of Natural Resources, Lake Erie Management Unit, Port Dover, ON

This presentation discusses the relative abundance of invasive fish species in Ontario Ministry of Natural Resources, Lake Erie Management Unit (LEMU), fish assessment programs and Lake Erie's commercial fishery. Commercial harvest of non-native species consists mainly of Rainbow Smelt, White Perch, and Common Carp. During the past decade, commercial harvest of non-native species comprised an average of 36% of the lakewide harvest. LEMU's annual assessment programs estimate the relative abundance of several species in Lake Erie, including invasive species such as Rainbow Smelt, White Perch, Alewife, and Round Goby. In the western basin young-of-year trawling program, White Perch currently comprise the majority of the catch (76% of the YOY catch from 2003 to 2012). In the lakewide partnership gill net survey, non-native species comprise 21% of the average annual catch between 2003 and 2012, the majority of which is White Perch. In the past decade, the catch of Alewife has declined in this survey from an average of 33.67 fish per gang of net (1989 to 2002) to 1.85 fish per gang of net (2003 to 2012), however 2012 observed a slight resurgence of this species. Round Goby first appeared in the inner Long Point Bay trawl in 1999; it now comprises an average of 69% of the total trawl catch (2003 to 2012). In recent years, LEMU has used new surveillance techniques, such as eDNA, to assist in detecting the presence of emerging threats, including Asian Carp, in Lake Erie and its tributaries.

AN UPDATE ON HARMFUL ALGAL BLOOMS IN WESTERN LAKE ERIE

Thomas Bridgeman and J. Chaffin

University of Toledo, Toledo, OH

Harmful Algal Blooms comprised largely of toxic strains of the cyanobacterium *Microcystis* have become a regular feature of late summer in western Lake Erie. HAB size and duration varies considerably between years, and reached unprecedented proportions in summer 2011. We present updates on HABs for 2012 and 2013 along with an overview of recent projects intended to monitor HABs, determine source populations of HABs, understand links between tributary loading and HAB size, and to track algal nutrient limitation in western Lake Erie.

CHANGES IN LAKE ERIE BENTHOS OVER THE LAST 50 YEARS: HISTORICAL PERSPECTIVES, CURRENT STATUS, AND MAIN DRIVERS

Lyubov E. Burlakova[1], A.Y. Karatayev[1], C. Pennuto[1], and C. Mayer[2]

[1]Great Lakes Center, SUNY Buffalo State, Buffalo, NY, USA.
[2]Department of Environmental Sciences and Lake Erie Center, University of Toledo, Toledo, OH, USA.

During the last 50 years the ecosystem of Lake Erie has experienced major environmental changes, from anthropogenic eutrophication in 1930-1960s, to nutrient and pollution abatement in the 1970s, and then the introduction of exotic dreissenids in the 1980s. We used multivariate statistical techniques to examine long-term changes in the zoobenthic community, comparing contemporary collections (2009, 2011-2012) and historical data (1963-1965, 1978-1979, 1993, and 1998). The Lake Erie benthic community underwent significant changes during each decade examined, showing signs of recovery following ecosystem restoration in the 1970s, but then experiencing major structural and functional changes after dreissenid (*Dreissena polymorpha* and *D. r. bugensis*) introductions. There was a significant temporal trend in community composition changes from 1963 to 2012, and the largest difference was found between pre- and post-dreissenid invasion communities. Currently the lake-wide benthic community is dominated by dreissenids both in density (41%) and total wet biomass (97%), followed by oligochaetes and chironomids. The largest benthic density was found in the central basin, and the greatest biomass in the eastern basin. The number of exotic species found in benthic surveys increased every decade, from 1 in 1963 to 10 in 2009-2012, and the majority of the invaders were molluscs. Whereas the role of benthic invaders in community diversity is still low, their impact has had enormous consequences for the whole ecosystem.

SPATIAL DISTRIBUTIONS AND TEMPORAL TRENDS OF CONTAMINANTS IN THE ST. CLAIR CORRIDOR AND IMPLICATIONS FOR LAKE ERIE

Debbie Burniston, J. Waltho, P. Klawunn, and C. Marvin

Environment Canada, Burlington, ON, Canada

Environment Canada's upstream downstream (u/d) program on the St. Clair River has been monitoring water and suspended sediment at the head and mouth of the St. Clair R. since 1987 and is effective in relating differences in water quality between these two sites to inputs from the Canadian shoreline. Sediment surveys conducted under the Great Lakes Sediment Monitoring program (GLSMP) in the late 1990 showed significant differences in contaminant maps between the upper and lower Great Lakes. While there have been notable measured reductions (up to 90%) in concentrations of mercury, octachlorostyrene, hexachlorobutadiene and hexachlorobenzene in water (dissolved and suspended sediment) near the mouth of the river, localized issues for some of these compounds still exist in areas in the upper reaches of the river. Nonetheless the impact of the reductions is expected to be evident in bottom sediment in the lower Great Lakes. Lake Erie will be the first of the Great Lakes to be surveyed in the next cycle of the GLSMP in 2014.

A STAGE-AND RIVER-STRUCTURED MODEL PREDICITOIN FOR ESTABLISHMENT PROBABILITY OF BIGHEAD AND SILVER CARPS IN THE GREAT LAKES

Kim Cuddington[1], W. Currie[2], and M. Koops[2]

[1]University of Waterloo, Waterloo, ON, Canada
[2]Fisheries and Oceans Canada

We predicted the establishment probability of Bighead and Silver Carps in the Great Lakes using stage-and spatially-structured models parameterized with literature data. Carp may have rather particular requirements for spawning (long rivers with turbulent mixing), but counter-intuitively, the small number of suitable rivers may increase the probability of finding mates. A stage-structured population model parameterized with literature data suggests that positive population growth is the expectation for these species, and that this growth is most sensitive to juvenile survivorship and age at first reproduction. We then combined this stage-structured model with spatial subdivision of spawners and juvenile fish across suitable rivers. We examined various scenarios including advanced age-at-maturity, variable number of spawning rivers, different magnitudes of environmental stochasticity, and various introduction scenarios. The models suggest that even a single event where a few individuals are accidentally introduced into one of the Great Lakes has, under most conditions, a significant probability of establishing a population of Asian carps. The number of adult fish in a single release required for greater than 5% establishment probability in 20 years depended on the exact scenario, but was usually less than 20 (10 males and 10 females).

ON-FIELD OHIO! EVALUATION/REVISION OF THE OHIO PHOSPHORUS RISK INDEX

E.A. (Libby) Dayton[1] and K. King[2]

[1]Ohio State University, Columbus, OH, USA
[2] US Department of Agriculture – Agricultural Research Service

The objective of On-Field Ohio is to evaluate and as necessary revise the Ohio Phosphorus Risk Index (Ohio P Index) by establishing field-scale, edge-of-field (EOF) monitoring facilities around Ohio. Data from these facilities will be used to 1) validate and as necessary revise the Ohio P Risk Index 2) Quantitatively, integrate additional best management practices (BMPs) into the Ohio P Index and 3) An online, web-based, interactive GIS tool (online tool) will be developed and used to actively promote the revised/enhanced P Index. With continuing degradation of surface water in Ohio, a robust functioning Ohio P Index will be an important step to sustain agricultural productivity while protecting surface water quality. The Ohio P Index is used to develop comprehensive nutrient management plans (CNMPs) and manure management plans (MMPs).

A SYNOPSIS OF THE GREAT LAKES NEARSHORE INITIATIVE ATTACHED ALGAE PROGRAM

David Depew and V. Hiriart-Baer

Environment Canada, Burlington, ON, Canada

Recurrent blooms of the filamentous green alga *Cladophora* have been an ongoing issue in eastern Lake Erie since the mid 1990s. Identification of the proximate causative factors responsible for these nuisance blooms are hampered by concurrent changes in point and non-point source P loads and the establishment of dreissenid mussels in much of the littoral zone. The roles of tributaries, lake water nutrients and dreissenid mussels in relation to *Cladophora* blooms have been the focus of significant research effort since the early 2000s, yet a clear delineation of which sources of P are crucial for bloom formation and maintenance remains elusive. As part of Environment Canada's Great Lakes Nearshore Initiative plan for Lake Erie, the attached algae program aims to develop an approach that will allow for the determination of the relative contributions of tributary, lake water and dreissenid P to *Cladophora* blooms. This information will be of critical importance to refining and validating current modeling efforts, and evaluating the likelihood of setting near shore P targets that will achieve measureable reductions in nuisance *Cladophora* blooms. This presentation will provide an overview of the program, some key highlights and approaches, as well as briefly discuss preliminary results from 2012 and 2013 field work.

DEVELOPMENT OF A FINE-SCALE ECOSYSTEM MODEL FOR THE WESTERN BASIN OF LAKE ERIE

Joseph V. Depinto, E. Verhamme, and T. Redder

LimnoTech, Ann Arbor, MI, USA

Over the past several years with funding from a series of projects, LimnoTech has been developing and applying a linked hydrodynamic-sediment transport-nutrient/eutrophication model for the Western Basin of Lake Erie (WLEEM) that can be used to develop a quantitative understanding and prediction of the relationship between nutrient and sediment loadings to the Western Basin and ecological endpoints of concern in the Western Basin. The ecological responses of concern include: turbidity and sedimentation, harmful algal blooms of *Microcystis sp.*, and nuisance growth of the benthic alga, *Lyngbya wollei*. The model was originally calibrated to 2004-5 data for the Western Basin, but we are currently developing an application to 2011 and 2012 as a means of understanding the importance of the Maumee River loads to the generation of *Microcystis* blooms in the Western Basin. The results of the model application to those years will be presented.

WATER QUALITY MONITORING FOR LAKE ERIE STATUS AND TRENDS AND THE GREAT LAKES NUTRIENTS INITIATIVE

Alice Dove and S. Backus

Environment Canada, Water Quality Monitoring and Surveillance Division, Canada Centre for Inland Waters, Burlington, ON, Canada

As part of the Great Lakes Surveillance Program (GLSP), Environment Canada has been conducting water quality monitoring on the Great Lakes for over 40 years. The current spatial distribution of water quality parameters and their temporal changes can be used to indicate their status and trends, respectively. Lake Erie is the most impacted of the Great Lakes with respect to nutrients. Concentrations of total phosphorus frequently exceed Great Lakes Water Quality Agreement targets, particularly in the western and central basins. Despite lower concentrations in the eastern basin, nuisance algae has resurged here as an issue.

Building on this background of Great Lakes water quality information, we have initiated additional nearshore and tributary monitoring as part of the Great Lakes Nutrient Initiative (GLNI). Ultimately, the aim of this work is to assist in the development of binationally agreed-upon, science based, phosphorus load reduction targets. These will require the development of phosphorus objectives for tributaries, the nearshore and the offshore of Lake Erie, which in turn will require a more full understanding of nutrient sources and in-lake dynamics. The water quality monitoring components conducted for GLNI include:

a) Nutrient loads are being measured in priority tributaries to Lake Erie, with improvements over past estimates including a higher frequency of measurement, the inclusion of winter and early-spring measurements, and the inclusion of the more reactive phosphorus fractions, among other parameters.

b) Nearshore water quality is being assessed at selected north-shore eastern and central basin transects, with an aim to improve our understanding of water quality conditions, its variability and correspondence with loads.

c) Nearshore biological indicators (such as invasive mussel and cladophora density, biomass and nutrient concentrations) are being assessed at the same locations to examine their interrelationships with water quality and proximity to tributary discharges.

POLLUTION CONTROL IN THE CITY OF WINDSOR: WASTEWATER & CSO MANAGEMENT
2013 STATUS & UPDATE

Paul Drca[1] and J. G. Li[2]

[1]Public Works Operations, Pollution Control, City of Windsor, ON, Canada
[2]Stantec Consulting Ltd., Windsor, ON, Canada

Prior to 2007, the City of Windsor's Lou Romano Water Reclamation Plant (LRWRP) was the largest and one of the last remaining primary chemical physical wastewater treatment plants in the Great Lakes basin. The plant discharges directly to the Detroit River, one of 43 areas of concern (AOC) identified by the International Joint Commission requiring remedial action with respect specific beneficial use impairments (BUIs). Realizing the need to upgrade the LRWRP to secondary treatment the City commenced with an upgrade and expansion of the LRWRP that included the expansion of primary treatment rated capacity from 163,700 m3/d (36 MIGD) to 272,800 m3/d (60 MIGD) and the construction of a Biological Aerated Filter (BAF) for secondary treatment with a rated capacity of 218,000 m3/d (48 MIGD). In addition, the City has replaced chlorination with UV light for disinfection.

The City of Windsor completed Pollution Control Planning (PCP) studies in the mid 1990s. The PCP study identified combined sewer overflows (CSOs) as one of the major sources of pollution to the Detroit River, thus contributing to the BUIs. To address the issue, the City constructed a high rate CSO Retention Treatment Basin (RTB) Facility to collect and treat CSOs in the riverfront catchment area east of Caron Avenue at a cost of $68 million. Using innovative technology that considerably reduces the construction cost and the footprint of conventional treatment systems, the RTB was designed to meet MOE F-5-5 Guidelines (90% wet weather flow volume capture, 50% TSS & 30% BOD removal rates, TSS < 90 mg/l 50% of the time).

This project along with the $115 million LRWRP upgrade and expansion are major contributing factors to the expected 2018 delisting of the Canadian side of the Detroit River as an AOC.

REACTIVE NITROGEN TRANSFORMATIONS AND LOSSES FROM AGRICULTURAL SOILS

Craig F. Drury, W. D. Reynolds, C. S. Tan, X. Yang, N. B. McLaughlin, and J. Yang

Agriculture & Agri-Food Canada, Harrow, ON and Ottawa, ON

Nitrogen is an essential nutrient that must be supplied to all non-leguminous crops. However, nitrogen can be lost from soils during application (ammonia volatilization), following rain events (nitrate leaching), and under anaerobic conditions (nitrous oxide emissions). Soil, crop and nutrient management practices are being developed to reduce nitrogen losses from soils and thereby increase the amount of nitrogen which is assimilated by crops. This presentation will highlight new management practices which reduce reactive nitrogen losses from soils including: streaming and injecting fertilizer nitrogen; using urease and nitrification inhibitors; and 3) using improved crop rotations and cover crops. Reactive nitrogen losses from agricultural soils can impact the surrounding environment and improved management strategies should be developed, transferred and adopted to reduce environmental losses and thereby improve nutrient use efficiency.

THE ISOTOPIC NICHES OF INVASIVE GOBIIDAE IN THE LAKE ERIE-LAKE HURON CORRIDOR

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The distribution and abundance of the invasive round goby (*Neogobius melanostomus*) since establishment in the Great Lakes is vast, particularly when compared to the invasive tubenose goby (*Proterorhinus semilunaris*). A broad diet can provide potential for plasticity to novel diets, and thus a potential mechanism for successful establishment of aquatic invasive species. We tested the hypothesis that round goby utilise a broader dietary niche than tubenose goby, and that round goby populations at long established invasion sites utilise a more restricted, specialist isotopic niche than at more recent invasion sites. Dietary and spatial niche was inferred from Standard Ellipse Area (SEA) of δ13N and δ13C, with dreissenids' provided baseline for comparisons between systems. Stomach contents and body size was used to support conclusions from isotopic niches. Comparable size round and tubenose goby from the same location had distinct isotopic niches with minimal overlap. Round goby had a wider niche than tubenose goby. The importance of wide niche for broad geographic establishment following invasion is highlighted, with reference to a trade off between generalist and specialist niche for long-term establishment.

STATUS OF WATERBIRDS ON LAKE ERIE

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Waterbirds such as gulls, terns, cormorants, herons, and egrets are integral components of the Lake Erie biotic community. In this presentation we will provide information on population trends in colonial waterbirds from decadal surveys completed through a joint Canada/U.S. effort. Trends in population size differ among species with some increasing, some staying stable, and others declining. Possible factors contributing to these population trends will be discussed.

More detailed annual census data will be presented for Double-crested Cormorants. Cormorant populations on Lake Erie have increased greatly through time and particular attention will be paid to assessing the ecological implications of this increase on unique island habitats in the western basin of the lake. Cormorants breeding on these islands have been shown to detrimentally affect island vegetation. Here, we will contrast the state of island plant communities based upon differing cormorant management strategies. This analysis was possible by linking ground-based nest surveys with long-term whole island assessments of vegetation cover using aerial photography. Early indications are that management actions taken on Middle Island by Parks Canada to reduce numbers of breeding cormorants are benefitting island plant communities while islands with no management are showing ongoing degradation.

The Great Lakes Herring Gull Monitoring Program is one of the oldest annual contaminant monitoring programs in the world. Here we will briefly update ongoing trends in levels of "legacy" pollutants in Lake Erie as well as provide a summary of the research that has been done recently to identify new, "emerging" contaminants.

Finally, future waterbird research needs will be highlighted as will the need for integrated research to address whole ecosystem-scale issues that are affecting waterbirds, e.g. botulism Type E mortality.

SCIENCE AND GOVERNMENT IN ACTION FINDINGS AND RECOMMENDATIONS OF THE OHIO LAKE ERIE PHOSPHORUS TASK FORCE PHASE II

Gail Hesse

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The Ohio Lake Erie Phosphorus Task Force was first convened in 2007 to analyze the relationship between increases in dissolved reactive phosphorus loading from the Ohio portion of the Lake Erie basin and corresponding increases in algal blooms in the western basin of Lake Erie. The Task Force analyzed relative contributions from multiple sources of dissolved reactive phosphorus. The Task Force published a report in 2010 (Ohio Environmental Protection Agency (OEPA), 2010. *Ohio Lake Erie Phosphorus Task Force Final Report*, Columbus, Ohio). Phase II of the Task Force was convened in 2012 to develop target loading reductions and evaluate new and emerging data and information.

Both Phase I and II of the Task Force conducted science-based analyses for the purpose of developing policy recommendations. The Task Force did not conduct any monitoring or modeling but relied on published research and presentations by content experts. The composition of the Task Force includes members from the research community, representatives from the agricultural community and water resources and environmental interests. The mix of public and private sector interests and research scientists fostered deliberation on the status of the science in disparate fields of study and programmatic feasibility and implications. This exchange enabled assumptions to be challenged and allowed for new ideas to come forward while establishing a platform for consensus based recommendations.

STATUS OF LAKE ERIE PHOSPHORUS LOADS AND CONCENTRATIONS

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Under the Great Lakes Water Quality Protocol of 2012, nutrient loading and nutrient concentrations for open and nearshore waters must be re-evaluated for Substance Objectives that are consistent with overall Ecosystem Objectives. One of the primary driving nutrients of interest is phosphorus and is updated here to aid and move forward in satisfying the Protocol requirements. Lake-wide total phosphorus loading has been below or around the target of 11,000 MTA for the last decade including through 2011. Loads to Lake Erie are dominated by monitored tributaries which contribute approximately 70% of the total external load. Largest tributary loads are observed from the Maumee, Detroit and Sandusky Rivers. Historical trends for the Detroit River and Detroit River sewage treatment plant which have shown reductions over time will be discussed. The Maumee River and other Ohio Rivers will be discussed in another presentation during this platform session. Additionally, present in-lake concentrations which exhibit higher levels than in the past will be presented. A preliminary lake-wide mass budget together with future research needs will be provided. This abstract does not necessarily reflect U.S. EPA policy.

THE AMENDED CANADA-UNITED STATES GREAT LAKES WATER QUALITY AGREEMENT

John Lawrence and M. Goffin

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The amended Great Lakes Water Quality Agreement, signed into force September 7, 2012, retains the focus of the earlier Agreement, to restore and protect the water quality of the Great Lakes, but the scope has been expanded to include the full range of issues which threaten the Lakes in the twenty first century. Commitments have been updated; roles and responsibilities have been clarified; and new opportunities have been added for engagement of federal governments, state and provincial governments, tribal governments, First Nations, Métis, municipal governments, watershed management agencies, other local public agencies, and the public. New Annexes have been added to address Aquatic Invasive Species, Habitat and Species and Climate Change Impacts. The general and specific objectives of the Agreement will be described together with the overall structure and mechanism for implementation. Differences between the old and amended Agreements will be highlighted.

PHYSICAL-BIOLOGICAL COUPLING AND THE CHALLENGE OF UNDERSTANDING FISH RECRUITMENT IN THE GREAT LAKES

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Ability to understand and predict fish recruitment is a key goal of fishery management agencies in both freshwater and marine ecosystems. Toward this end, an increasing amount of recruitment-oriented research has focused on the effects of physical processes on early life (e.g., egg, larval, juvenile) growth and survival. The majority of this research, however, has been conducted in marine ecosystems and not their freshwater counterparts, despite both sets of ecosystems having similar physical processes and economically important fishes with life-history characteristics equally vulnerable to physical controls. Herein, we present findings from two Great Lakes Fishery Commission-sponsored workshops that brought marine and freshwater scientists to discuss the value of physical-biological research approaches in Great Lakes fisheries management. In so doing, we provide examples of how physical and biological processes can interact to regulate fish recruitment in these ecosystems, discuss how continued climate change and altered ecosystem productivity might be expected to influence physical forcing of fish recruitment, and identify information needs that can improve our ability to use physical-biological approaches to benefit fishery management objectives.

GREAT LAKES WATER LEVELS AND COASTAL SYSTEMS – COASTAL RESILIENCY AND CLIMATE CHANGE

Scudder D. Mackey

Ohio Department of Natural Resources, Columbus, OH, USA

Increasing surface water temperatures and reduced winter ice cover will result in increased water loss due to evaporation with subsequent reductions in water levels. Recent climate models indicate that these losses may be balanced by increased precipitation in late winter-early spring months. Even though annual Lake Erie water levels may remain slightly below the long-term mean, changes in local precipitation that will result in increased seasonal water level variability. Seasonal changes in storm magnitude, frequency, and direction will result in increased flood frequency and magnitude, changes in coastal wave power and direction, altered littoral sediment transport rates, and reduced nearshore water quality. For example, early spring precipitation events may increase nutrient loadings into the Lake Erie resulting in widespread algal productivity and potentially harmful algal blooms.

Moreover, seasonal changes in water level and flow regimes, thermal structure, and water mass characteristics typically interact with the underlying landscape to create repeatable patterns and connections within and between tributaries, lakes, and shorelines within the basin. These patterns and connections, in part, control the seasonal usage of Great Lakes fish spawning and nursery habitats. High-quality coastal margin habitats (both aquatic and wetland) are created by a unique set of environmental conditions and processes that together meet the life-stage requirements of a species, biological community, or ecological function. These processes play a significant role and ultimately determine the distribution and utilization of essential coastal margin habitats within the Great Lakes system.

Climate-induced changes to physical processes will impact not only the physical characteristics of the shoreline, but create vulnerabilities for coastal habitats, biological communities, and ecosystems that rely on those shorelines. Scenario-based modeling may allow resource managers to explore the impact of different management strategies in response to climate variability.

SEDIMENT-WATER EXCHANGE PROCESSES IN LAKE ERIE

Gerald Matisoff

Case Western Reserve University, Cleveland, OH, USA

Sediment-water exchange processes play a significant role in sediment-oxygen demand (SOD), nutrient cycling, internal loadings, and in recording the historical depositional flux. This presentation summarizes recent progress in all four topics. SOD has been estimated by the EPA using oxygen concentrations during regular monitoring cruises and in work using oxygen microelectrodes, sediment cores, biogeochemical modeling, and benthic macroinvertebrates. Downcore profiles of nutrients may be interpreted as resulting from historical changes in depositional loadings or from post-depositional reactions. Experiments with sediments and water have been conducted to determine the flux of phosphorus released to the water column and the equilibrium or 'saturation concentration' during resuspension.

EFFECTIVENESS OF URBAN BEST MANAGEMENT PLANS TO REDUCE PHOSPHORUS RUNOFF

Shawn P. McElmurry

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Recent algal blooms within Lake Erie have renewed concern over phosphorous (P) loads from non-point sources. Urban runoff is the primary source of water quality impairments in many surface waters, despite comprising only a small fraction (~3%) of land mass. To mitigate the impact of urban runoff, new "green" infrastructure and best management practices (BMPs) are being deployed. Preliminary evidence suggests these systems may not be useful in reducing the amount of P in stormwater runoff. As part of a larger project funded by the International Joint Commission focused on addressing growing concerns over water quality within Lake Erie, a review of urban BMPs used to mitigate P loadings was conducted. The results of this review will be presented and the implications of this work will be discussed.

MONITORING CONTAMINANTS IN FISHES FROM THE CANADIAN WATERS OF THE GREAT LAKES: 1977 TO 2013 - PCBS TO PFCS

Daryl McGoldrick, S. Backus, M. Keir, M. Clark, and M. Malecki

Environment Canada, Burlington, ON, Canada

Canada's Fish Contaminants Monitoring and Surveillance Program (FCMSP) began in 1977 as agreed in the Great Lakes Water Quality Agreement (GLWQA) between Canada and the United States. Under the FSMCP, concentrations of legacy persistent organic pollutants (POPs), such as PCBs and mercury, are measured annually in the tissues of fish from the Canadian waters of the Great Lakes. Coincident with legislated restrictions on the release of these compounds, the concentrations observed in the tissues of fish declined significantly through the 1980s. Despite these declines, the concentration of total PCBs measured in all Lake Trout in 2008, with the exception of some specimens caught in Lake Superior, are still above the environmental target of 0.1 µg/g established in the GLWQA and levels of mercury have ceased to decline and may be increasing in some areas. While legacy POPs are still prevalent and of concern in the Great Lakes ecosystem, there has been increased interest in monitoring other emerged classes of contaminants with the advent of Canada's Chemicals Management Plan. In response, the FCMSP began annual monitoring of contaminants such as polybrominated diphenyl ethers (PBDEs) and perflurooctane sulfonate (PFOS) in lake trout from all 4 Canadian Great Lakes in 2006. In Great Lakes trout, mean concentrations of PBDEs are highest in Lakes Ontario and Superior and lowest in Lake Erie. PFOS concentrations are highest in Lake Trout collected in the Eastern Basin of Lake Erie compared to all other Canadian water bodies monitored by the FCMSP.

RETURNING TO A HEALTHY LAKE: AN INTERNATIONAL BIODIVERSITY CONSERVATION STRATEGY FOR LAKE ERIE

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Employing the Conservation Action Planning framework, we engaged nearly 200 participants from Federal, State, Provincial, and local agencies, conservation organizations, universities and other partners in developing biodiversity conservation strategies for Lake Erie. We assessed the current status of and ranked threats to eight focal conservation targets including the Open Water Benthic and Pelagic Ecosystem, Nearshore Zone, Native Migratory Fish, Connecting Channels, Coastal Wetlands, Islands, Coastal Terrestrial Systems, and Aerial Migrants. Based on an assessment of 110 indicators, most of these conservation targets are currently rated in *Fair* condition, Aerial Migrants being the only exception with a *Good* status rating. This finding is in line with other biodiversity assessments and suggests that biodiversity in Lake Erie is considered to be out of its desirable range of variation but restorable. Biodiversity status varies among the four reporting units in the lake, as expected. Threat status also varies around the lake, with five threats warranting attention lakewide: agricultural non-point source pollutants; invasive species (aquatic and terrestrial); housing and urban development and shoreline alterations; urban non-point and point source pollutants; and climate change. Dams and barriers were not so highly ranked but were recognized by participants as a sixth important issue to address. To address these threats, we developed five strategies, each of which included one or more strategic actions and objectives and incorporated climate change considerations. We also described the ways in which conservation strategies can benefit people by protection and restoring important ecosystem services.

NUTRIENT LOADING AND LAKE ERIE: RECENT LEARNINGS

R. Peter Richards

National Center for Water Quality Research, Heidelberg University, Tiffin, OH, USA

Because of intense interest in algal blooms in Lake Erie in the recent past, this talk will focus on the Western Basin. The Maumee River dominates tributary inputs of nutrients to the basin, though the majority of the water is delivered by the Detroit River.

Long term trends in flow-weighted mean concentrations the Maumee River include a gradual increase in discharge, a gradual decrease in total phosphorus, a U-shaped trend in dissolved reactive phosphorus but with a flattening in the trend in the last seven years, an inverted U-shaped trend in nitrate nitrogen, and a more pronounced inverted U-shaped trend in the nitrate/DRP ratio, which has always exceeded the Redfield Ratio, suggesting phosphorus limitation in the Maumee discharge into the Western Basin.

Total phosphorus loading to Lake Erie from all sources has declined from a high of about 28,000 tonnes in 1968, falling below the target load of 11,000 tonnes for the first time in 1981, and remaining below the target in most years since then. The lake responded with improved water quality in the late 1980's and early 1990's. Paradoxically, recent years have seen renewed signs of increasing eutrophication: increased harmful algal blooms (HABs) and intensified hypoxia in the Central Basin. Management of the Western Basin will need to account for increased supply of DRP and bioavailable phosphorus even as tributary total phosphorus declines.

Research is also focusing on specific source areas and seasons for phosphorus loading as these relate to the severity of HABs. Current best predictive models, based on observations for 2002-2011, utilize discharge or phosphorus loads from the Maumee River for the period March-June. These models fit the extremely large HAB of 2011 and predicted the small HAB of 2012. The prediction for 2013 was for a modest bloom, but the bloom appears to have been larger than predicted, indicating a possible need for refinement of the models. July 2013 was a month of large discharges and P loadings, suggesting that July loadings need to be incorporated into these models as well. This talk will offer a preliminary test of that hypothesis.

THE GREAT LAKES AQUATIC HABITAT FRAMEWORK: CREATING A COMMON SPATIAL GRID FOR SHARING PHYSICAL, GEOCHEMICAL, AND BIOLOGICAL DATA ACROSS THE ENTIRE GREAT LAKES BASIN

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Assessment and classification of Great Lakes aquatic habitats to address restoration, forecasting and management needs requires a hierarchical spatial database of physical, biological and chemical components stretching from watersheds to offshore lake zones. In the Great Lakes Aquatic Habitat Framework project (GLAHF), we are working with resource management agencies and universities to develop a spatial database and classification system that integrates key habitat components in Ontario and US waters of the Great Lakes basin. We have cross-walked bi-national datasets, compiled point sampling data, and calculated new variables. We have delineated watersheds across the entire basin using a consistent watershed definition to standardize the summary of landscape influences on the nearshore. To create more complete point sampling datasets, we compiled water chemistry measurements from various sources by common strata and depths, and summarized biological data with consistent metrics. We processed raw and modeled data to create calculated variables such as spring warming rate or upwelling zones from daily surface temperature. We are leveraging unique GLAHF datasets and many other data to create a basin-wide aquatic habitat classification focused on the near shore environment. In future, we will make public the classification and supporting datasets via geoportal.

LINKING REGIME SHIFTS TO CARBON DYNAMICS IN LAKE ERIE

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"Death watch", "poster child for pollution problems", "deadly intruders", "dead zone", "dead", "danger of collapse", "ailing", "sick", "stinky scum", "fouling" and "poison harvest" are all terms that have been used recently to describe Lake Erie. The lake's current ecological state behind this unfortunate characterization is threatening a multi-billion dollar fishing and tourism industry. Today the Great Lakes, are a dramatically different ecosystem than they were a hundred years ago. This new ecological state (regime) of the Great Lakes needs to be better understood, and soon, since these lakes provide our society with a panoply of ecosystem services including drinking water for the City of Toronto, recreational and commercial fishing, tourism, and transportation of goods, while enhancing regional biodiversity and wetlands. Our project ultimately aims to link aquatic ecosystem services to the current state (regime) of Lake Erie, one of the Great Lakes. Specifically, we will examine the current foodweb structure of different areas in the lake and its connections to key processes that control the lake's carbon balance (carbon = energy). Our results will provide us with an opportunity to test if carbon/energy flux is sufficient to support the world's largest commercial fisheries historically supported by Lake Erie.

INFORMING STRATEGIC CONSERVATION OF STREAMS IN AGRICULTURAL LANDSCAPES OF THE GREAT LAKES: AN OVERVIEW OF THE GREAT LAKES AND WESTERN LAKE ERIE BASIN CONSERVATION EFFECTS ASSESSMENT PROJECTS (CEAP)

Scott Sowa[1], D. Pearsall[1], M.E. Herbert[1], M. Fales[1], A. Sasson[2], A. Froehlic[1], G. Annis[1], C. Vollmer-Sanders[3], B. Stanley[2], K. Hall[1], P. Doran[1], S. Ludsin[4], C. Keitzer[4], J. Reutter[5], A.P. Nejadhashemi[6], L. Wang[7], J. Arnold[8], M. White[8], R. Srinivasan[9], L. Norfleet[8], M. Johnson[8], and C. Rewa[10]

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Strategic conservation involves getting the right conservation practices to the right places in the *right amount* to achieve a r*ealistic* set of desired ecological and socioeconomic conditions. In an adaptive management framework strategic conservation should be guided by related sets of performance indicators and goals from inputs to actions, to outputs and ultimately desired outcomes. Unfortunately, conservation efforts are often guided by resource input (e.g., funding) and conservation action goals (e.g., acres of practices), with little or no understanding of what ecological or socioeconomic benefits will result from those inputs or actions. Ideally, these input and action goals should be established based on *what is needed* to achieve a realistic set of desired ecological and socioeconomic conditions, which then poses the questions of "How much conservation is enough?" and "How much will it cost?" to achieve those conditions? This outcome driven approach requires both an understanding of the relations between ecological indicators and the ability to forecast the cumulative benefits and costs of various conservation scenarios, which are both addressed the Great Lakes and Western Lake Erie Basin (WLEB) Conservation Effects Assessment Projects (CEAP). In these projects we developed a unique approach of using the outputs from a fine resolution Soil and Water Assessment Tool (SWAT) model to identify thresholds and ceilings for fish community metrics associated with several water quality and flow variables. The predictive capabilities of SWAT allowed us to then forecast the likely cumulative benefits and costs of potential future conservation practice scenarios, which are now being used by various partners to establish realistic goals and strategies to achieve them. This presentation will provide an overview of the Great Lakes CEAP effort and the major enhancements that have been incorporated into the current WLEB CEAP.

HURON-ERIE CORRIDOR INITIATIVE: PAST SUCCESSES AND FUTURE PLANS OF AN EVOLVING SCIENCE PARTNERSHIP

Russell M. Strach

US Geological Survey, Ann Arbor, MI, USA

The Huron-Erie Corridor Initiative (HECI) is an international, multi-collaborative partnership focused on generating the scientific information and tools necessary for deliberate and strategic restoration of native aquatic species and their habitats within the St. Clair River, Lake St. Clair, and Detroit River. Since its formation in 2004, the partnership has spearheaded numerous fish habit restoration projects, many of which focused on augmenting spawning habitat for native migratory fish such as lake sturgeon (*Acipenser fulvescens*) and lake whitefish (*Coregonus clupeaformis*). Re-organized under a new governance structure in 2013, the HECI now is developing a holistic science framework for habitat restoration based on Conservation Action Plan (CAP) viability analyses, which involve the use of quantifiable indicators to identify the habitats most in need of restoration and to evaluate the success/effectiveness of remediation efforts. The purpose of this presentation is to review results from past fish habitat restoration projects and discuss development of the CAP-based science framework within the context of partnership evolution.

STATUS OF THE LAKE ERIE FISH COMMUNITY 2013

Chris Vandergoot

Sandusky Fisheries Research Unit, Ohio Department of Natural Resources, Sandusky, OH, USA

The Lake Erie fish community continues to exhibit the dynamic fluctuations in abundance and composition characteristic of this productive system. The current walleye population continues to exhibit considerable annual variation with respect to recruitment and abundance; however, recent trends in these metrics have resulted in population levels that are among the lowest. Similar population trends apply to yellow perch in the western basin although the eastern basin population appears to be increasing in abundance. In recent years, the smallmouth bass population has appeared to remain static although largemouth bass are becoming more prevalent in the fishery. Stocked lake trout continue to serve as the apex predator in the eastern basin, with little evidence of natural reproduction evident. With respect to the forage fish community, spiny-rayed fish continue to comprise the majority of the biomass, particularly in the western basin and recent declines in the abundance of round goby have been observed lakewide. Although the fish community in the nearshore areas of the eastern basin reflects that of the western and central basins, rainbow smelt continue to serve as the primary forage species in the pelagic waters of Lake Erie.

WIND POWER UPDATE FOR LAKE ERIE

Chris Vandergoot

Sandusky Fisheries Research Unit, Ohio Department of Natural Resources, Sandusky, OH, USA

The demonstration wind turbine project initially scheduled to occur in 2010, but subsequently delayed, has been re-initiated in Lake Erie near Cleveland, Ohio. Because the impacts (i.e., biological and limnological) associated with constructing and operating off-shore wind power facilities are unknown, the Ohio Department of Natural Resources has developed biotic and abiotic monitoring criteria for proposed off-shore wind energy projects in Ohio waters of Lake Erie. These sampling criteria take into account where the proposed study site is located in relation to fish spawning habitat, nursery grounds, migration corridors, and commercial and recreational use. Essentially, where impacts are expected by be minimal, less rigorous and stringent sampling is required. I will provide a summary of the proposed project and the issues surrounding the implementation of this project from a fisheries and aquatic resources perspective.

POSTER ABSTRACTS

A COMPARISON OF FISH INDICES OF BIOLOGICAL CONDITION AT GREAT LAKES COASTAL MARGINS

Jeff Buckley and Jan J.H. Ciborowski

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Indicators of biological condition (including indices of biological integrity (IBIs) and multivariate models) quantify the relationship between species assemblages within a habitat and the environmental condition of that habitat. IBIs and similar measures can be used as tools by managers to assess biological responses to anthropogenic disturbance affecting a site. Several biological indicators of fish condition have been developed independently of one another. Using overnight fyke net catch data collected at approximately 175 coastal margin sites across the Great Lakes we compared the fish community indicator measures developed by Uzarski *et al.* (2005), Seilheimer and Chow-Fraser (2006) and Bhagat *et al.* (2012). We determined which indicator most accurately and consistently summarized the levels of agricultural and development-related human disturbance at in the watershed draining into each coastal margin location. Additionally, we used data sampled from benchmark sites over multiple years, to determine which set of interannual measurements most consistently reflected the level of human disturbance.

SHALLOW WATER BATHYMETRY AND SAV DISTRIBUTION IN PENETANG BAY, LAKE HURON, ON: DEMONSTRATION OF A REMOTELY OPERATED VESSEL FOR ENVIRONMENTAL RESEARCH (ROVER)

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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 (HR) bathymetric data and assess submerged aquatic vegetation (SAV) distribution and biomass. Penetang Bay is a former Area of Concern (AOC) with a complex shoreline, organic substrates, and dense macrophyte beds. ROVER uses real-time differential GPS, a recording depth sounder, and shallow-water scanning sonar to collect real-time georeferenced bathymetric and epibenthic information. Transects were were taken 200 m (perpendicular to shore) from sites around the bay to capture changes in submerged plant distribution from offshore to nearshore sites. Petite ponar grabs were taken to assess substrate and where possible 1x1 m quadrats were sampled for vegetation cover and identification. Data collected in 2011 was supplemented with sidescan sonar data, while 2012 data was supplemented with georeferenced underwater video. ROVER data were recorded digitally and are being processed currently. ROVER operated in water depths unsuitable for most watercraft, and collected bathymetric data even where SAV densities were high. Comparison of the 200 kHz and downscan data (455 kHz) allowed us to map both mineral substrate depth and the upper surface of SAV. Data on SAV distribution, volume and density provide a way to map the distribution of aquatic habitats important to fish and invertebrates.

MANAGING AQUATIC INVASIVE SPECIES IN THE WORLDS ECOSYSTEMS, LAURENTIAN GREAT LAKES, LAKE ERIE, AND THE HURON-ERIE CORRIDOR THROUGH ENVIRONMENTAL DNA (EDNA)

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Aquatic invasive species (AIS) pose the most significant threat to biodiversity after habitat loss. Establishment and spread of AIS can occur well before control measures can be implemented. Better technology is needed for detection, prevention of establishment, surveillance, and to control AIS. Environmental DNA (eNDA) is such an emerging technology. Advantages include: tracking AIS presence without visual confirmation; high resolution in detection limits; quantification of AIS even at low abundances; facilitation of rapid responses to invasion fronts; and low cost. We seek to develop eDNA markers and methods for up to forty of the worlds' worst aquatic AIS which pose a high risk for new introductions into Canadian aquatic ecosystems, and likewise for AIS already in or with high potential for expansion into the Great Lakes, their basins, Lake Erie, and the Huron–Erie (HEC) corridor. We will isolate target AIS single nucleotide polymorphic eDNA markers from the COI gene sequence or at higher resolutions using GenBank and other databases or developed in-house. We will analyze ballast-water and water samples for AIS from coastal ports, in the Great Lakes and their basins, Lake Erie, and the HEC using eDNA markers. We will ground truth positive samples, use positive controls, perform aquaria-based experiments, and provide technology to constituents. Sampling will be located where transference and establishment of AIS has already occurred or has a high chance of occurring. False positives for presence/absence can occur due to residual DNA of dead organisms, ingested organisms, or fecal matter. Thus, we will compare positive results with and develop novel RNA-based methods insensitive to false positives. Research efforts will provide tools, reduce uncertainty, and advance knowledge to better manage AIS in the Great Lakes and beyond.

ASSESSMENT OF NATIVE FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE) IN COASTAL LAKE ERIE, LAKE ST. CLAIR, AND CONNECTING CHANNELS, 25 YEARS AFTER THE DREISSENID INVASION

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The invasions of Ponto-Caspian dreissenid mussels (zebra mussels and quagga mussels) have caused massive change to the Great Lakes ecosystem. Among their more prominent and well documents effects was on 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 extensive surveys of known and potential unionid refugia from dreissenid mussels. Over the summers of 2011 and 2012, we visited 46 discrete locations with replicate samples at each for a total of 139 sites in bays, coastal wetlands, and drowned river mouths on the U.S. side of Lake Erie and Lake St. Clair. Using an identical sampling regime at each site, a timed survey within a 0.5 ha area was searched for 2 person-hours with SCUBA, snorkeling, wading, and/or raking. We recorded species presence, abundance and lengths, water depth, soft substrate depth and type, and several water chemistry variables. Twenty-three 23 species and 1923 live unionids were documented from these lakes. While species assemblages have shown major shifts and several rare species have probably been extirpated based on data available prior to the dreissenid invasion, these findings are especially encouraging that mussels survived, particularly given that surveys shortly after the dreissenid invasion pointed toward total extirpation of the unionid fauna. Our continuing research will prioritize areas for continued management and monitoring.

LIST OF EXHIBITORS

Environment Canada

Heidelberg University NCWQR

Hoskin Scientific

International Joint Commission

The Nature Conservancy

Ontario Ministry of Agriculture and Food

University of Toledo Lake Erie Center

U.S. Fish and Wildlife Service

The Lake Erie Millennium Network – Member Organizations

The Lake Erie Millennium Network is a series of events dealing with Lake Erie environmental issues. The objectives are threefold:

- to summarize the status of Lake Erie;
- to collectively document the research and management needs of users and agencies; and
- to develop a framework for a binational research network to ensure coordinated collection and dissemination of data to address the research and management needs

Binational meetings are held every two years. The goals of the meetings are:

1. to exchange information;
2. to generate plans for studying/implementing solutions; and
3. to build on our initiative to implement a binational research strategy to ensure coordinated collection and dissemination of data to address the continuing research and management needs.

Conveners: The conveners are research institutions whose members actively interact and collaborate with the broader Lake Erie community of researchers, managers, and public groups. They will ultimately become the 4 nodes of the binational research network. The parent organization of each convener is also a sponsor of the Millennium Network. The Conveners are:

- the University of Windsor
- Large Lakes Research Station, US Environmental Protection Agency, Grosse Ile
- National Water Research Institute, Environment Canada
- Ohio Sea Grant – F.T. Stone Laboratory, Ohio State University

Sponsors: Funding for activities is solicited from organizations who have a responsibility or mandate related to the status of Lake Erie. Agencies who have elected to formally participate and contribute financial support are acknowledged as sponsors. The participation of sponsors' representatives at workshops and meetings is fundamental to identifying management and research issue that guide the direction of the Millennium Network. Past and current sponsors Include:

Campbell Scientific
DTE Energy
Essex Region Conservation Authority
Great Lakes Commission
Great Lakes Fishery Commission
Great Lakes Science Center – USGS
Hoskin Scientific Limited
International Joint Commission
Lake Erie Lakewide Management Plan
(Environment Canada & US EPA-GLNPO)
Lake Erie Protection Fund
Michigan Sea Grant
Municipality of the City of Windsor
New York Sea Grant
Ohio Sea Grant
Ontario Ministry of the Environment
Ontario Ministry of Agriculture, Food and Rural Affairs
Ontario Ministry of Natural Resources
Pennsylvania Sea Grant

Collaborators: Collaborating agencies are organizations that are active participants in the planning, information transfer, or research aspects of the Millennium Network. Collaborators provide in-kind and/or technical support that furthers the goals of the Network. Past and current Collaborators include:

Citizens Environment Alliance of Southwestern Ontario
Cornell University Biological Field Station
Detroit River Cleanup Committee
Detroit River International Wildlife Refuge
Ducks Unlimited Canada
Essex County Stewardship Network
Great Lakes Environmental Research Laboratory - NOAA
Great Lakes Lab. For Fisheries and Aquatic Science - DFO
Great Lakes Program – SUNY Buffalo
Great Lakes Research Consortium
Greater Detroit American Heritage River Initiative
Ohio Department of Natural Resources
Ohio Environmental Protection Agency
Ontario Commercial Fisheries' Association
Water Environment Federation

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