Lake Erie Millennium Network
Binational Research and Monitoring for the Millennium http://www.LEMN.org

THE SIXTH BIENNIAL CONFERENCE OF THE LAKE ERIE MILLENNIUM NETWORK

Linking Research and Management Needs

27 - 29 April 2010
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

CONFERENCE ORGANIZING COMMITTEE

LAKE ERIE MILLENNIUM NETWORK

Jessica Cuthbert	Convener, Lake Erie Millennium Network, University of Windsor
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

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

President - Dr. Alan Wildeman
Vice-President Academic – Dr. Leo Groarke
Vice- President Research - Dr. Ranjana Bird
Great Lakes Institute for Environmental Research – Dr. Douglas Haffner, Acting Executive Director
Faculty of Science - Dr. Marlys Koschinsky, Dean

CONFERENCE PROGRAM

THE SIXTH BIENNIAL CONFERENCE OF THE
LAKE ERIE MILLENNIUM NETWORK
Linking Research and Management Needs

Ambassador Auditorium, CAW Student Centre
University of Windsor
27 – 29 April 2010

MONDAY APRIL 26

5:00 – 6:00 p.m. **Poster set-up** – CAW Student Centre, Commons Area

5:30 – 7:00 p.m. **WELCOMING SOCIAL-** CAW Student Centre, Commons Area
Registration and Informal mixer

TUESDAY APRIL 27

8:00 a.m. **Poster set-up** – CAW Student Centre, Commons Area

8:30 a.m. **Welcoming Remarks and Introduction**
Dr. Alan Wildeman – President of the University
Dr. Marlys Koschinsky – Dean, Faculty of Science
Dr. Doug Haffner – Acting Executive Director, Great Lakes Institute for Environmental Research

Theme #1 – Nutrient Transport and Transformations
Jeff Reutter, F.T. Stone Lab & Ohio State University, Moderator

8:45 **ELIZABETH (LIBBY) DAYTON,** Ohio State University
Phosphorus chemistry and sequestration in soil.

9:00 **CRAIG F. DRURY**, **W.D. Reynolds**, **C.S. Tan**, **X.M. Yang**, **J.Y. Yang**, **T.Q. Zhang**, and **T.W. Welacky**, Agriculture & Agri-Food Canada, Harrow, ON
Impacts of soil and crop management practices on water partitioning and nutrient losses from agricultural soils.

9:15 **DAVID BAKER**, **J. Kramer**, **P. Richards**, **R. Confesor**, **A. Roerdink**, and **K. Krieger**, Heidelberg University
Characteristics of nutrient and sediment delivery to Lake Erie from Ohio tributaries.

TUESDAY APRIL 27

Theme #1 – Nutrient Transport and Transformations (Cont'd)

Jeff Reutter, F.T. Stone Lab & Ohio State University, Moderator

9:30 **SANDRA COOKE,** Grand River Conservation Authority, and **KAREN MAASKANT,** Upper Thames River Conservation Authority

Delivery of nutrients to Lake Erie: The Grand and Thames rivers (Canada).

9:45 **RAJ BEJANKIWAR,** Essex Region Conservation Authority

Nutrients in the Essex region watershed and its nearshore waters.

10:00 **DEBBIE BURNISTON,** Environment Canada, **R. McCrea**, Environment Canada, **P. Klawunn**, Environment Canada, **R. Ellison**, U.S. E.P.A. Great Lakes National Program Office, **A. Thompson**, Environment Canada, **J. Bruxer**, Environment Canada

Detroit River phosphorus loading determination.

10:15 **BREAK**

10:45 **DOUGLAS D. KANE**, Defiance College, **J.D. Conroy**, Ohio State University, Ohio Department of Natural Resources, **D.L. Bade**, Kent State University, **W.J. Edwards**, Niagara University, **D.A. Culver**, Ohio State University, **J.D. Chaffin**, Lake Erie Center, University of Toledo, **K. Wambo**, University of Toledo, **C.L. Gruden**, University of Toledo, and **T.B. Bridgeman**, Lake Erie Center, University of Toledo

Monitoring, mechanisms, and macronutrients: Microcystis *in the Maumee and Sandusky systems* **.**

11:00 **THOMAS B. BRIDGEMAN**, University of Toledo, **J.D. Conroy**, Ohio State University, **C.L. Gruden**, University of Toledo, **D.D. Kane**, Defiance College, **J.W. Kramer**, Heidelberg University, **C.M. Mayer**, University of Toledo, **G.W. Winston**, Heidelberg University

Lake Erie Algal Source Tracking 2009 (LEAST).

11:15 **TODD HOWELL**, Ontario Ministry of the Environment

Patterns in nutrients over Dreissena-Cladophora *impacted shoreline*

11:30 **JOHN R. KELLY**, U.S. E.P.A. Mid-Continent Ecology Division, **P.M Yurista**, U.S. E.P.A. Mid-Continent Ecology Division, **J.V. Scharold**, U.S. E.P.A. Mid-Continent Ecology Division, **A.M. Cotter**, U.S. E.P.A. Mid-Continent Ecology Division, and **M.A. Starry**, SRA International

Detecting land-based signals in the nearshore zone of Lake Erie during summer 2009.

11:45 **Discussion and Comments**

12:00 **LUNCH**

TUESDAY APRIL 27

Theme #2 – Trophic Status of Lake Erie

Russ Kreis, U.S. E.P.A. Large Lakes Research Lab, Moderator

1:15 **ALEXANDER KARATAYEV**, **L. Burlakova**, **C. Pennuto**, and **C. Basiliko**, Great Lakes Center, Buffalo State College

Dominance of exotic invertebrates changes the Lake Erie benthic community.

1:30 **D. Dolan,** University of Wisconsin-Green Bay, **P. Richards**, Heidelberg University, and **RUSS KREIS**, U.S. E.P.A.

Nutrient load estimates for Lake Erie 2005.

1:45 **PAUL BERTRAM**, U.S. E.P.A. Great Lakes National Program Office

Lake Erie central basin dissolved oxygen trends and recent conditions.

2:00 **SUE WATSON**, **M. Looker, K. McIvor, J. Struger,** and **V. Richardson**, Environment Canada

Lake Erie: algae, nutrients and deficiency

2:15 **STEVEN W. WILHELM**, University of Tennessee, **ROBERT M.L. McKAY**, Bowling Green State University, **M.R. Twiss**, Clarkson University, **G.S. Bullerjahn**, Bowling Green State University, **R.A. Bourbonniere**, Environment Canada, **C.H. Marvin**, Environment Canada, **H.J. Carrick**, Pennsylvania State University, **R.E.H. Smith**, University of Waterloo, **N. D'Souza**, Bowling Green State University, **B.F. Beall,** Bowling Green State University, **M.A. Saxton**, University of Tennessee, **D.E. Smith**, Clarkson University, and **J. Harrison**, University of Waterloo

Biology on ice: Life in a very cold Lake Erie.

2:30 **BREAK**

3:00 **ROBERT T. HEATH, C. Clevinger**, and **D. Bade**, Kent State University

Increasing importance of nitrogen dynamics in the Lake Erie ecosystem.

3:15 **GERALD MATISOFF**, Case Western Reserve University

Oxygen dynamics in Lake Erie.

3:30 **J.D. Conroy**, Ohio State University, Ohio Department of Natural Resources, **S.A. Ludsin**, Ohio State University, **K. Kayle**, Ohio Department of Natural Resources, **J.T. Tyson,** Ohio Department of Natural Resources, **R.L. Knight**, Ohio Department of Natural Resources, and **DAVID A. CULVER**, Ohio State University

Fish community structure in Lake Erie: Continued rehabilitation or a return to degradation?

TUESDAY APRIL 27

Theme #3 – Understanding and Managing the Processes

Russ Kreis, U.S. E.P.A. Large Lakes Research Lab, Moderator

3:45 **PAMELA JOOSSE**, Ontario Ministry of Agriculture, Food and Rural Affairs, **K. Reid**, Ontario Ministry of Agriculture, Food and Rural Affairs, and **R. Campbell**, Ontario Agri Business Association

The 2009 Great Lakes Phosphorus Forum.

4:00 **JOSEPH F. KOONCE**, Case Western Reserve University, **C.S. Findlay**, University of Ottawa, **J.E. Gannon**, International Joint Commission, **N.K.S. Barker**, University of Windsor, **M. Kang**, University of Windsor, and **J.J.H. Ciborowski,** University of Windsor

Weight of evidence for causes of re-eutrophication of the Great Lakes.

4:15 **JOSEPH V. DEPINTO**, **T.R. Redder**, **E.M. Verhamme**, and **L. Weintraub**, Limno-Tech

Recent modeling in the Maumee watershed and the western basin of Lake Erie.

4:30 **Sandra George**, and **MARIE-CLAIRE DOYLE**, Environment Canada

Lake Erie Binational Nutrient Management Strategy.

4:45 **Discussion and Comments**

5:00 – 7:00 **Adjourn to SOCIAL AND POSTER VIEWING**

Location: CAW Student Centre, Commons Area

WEDNESDAY APRIL 28

Theme #4 – Biological and Chemical Contaminants - Legacy and Emerging Issues

Chris Marvin, Environment Canada, Moderator

9:00 **J. Struger**, **DEBBIE BURNISTON**, **E. Sverko**, **S. Cagampan**, **J. Grabuski**, **C. Marvin**, **J. Kraft**, **J. Waltho**, **A. Dove**, and **L. Heslip**, Environment Canada
Pesticide concentrations in the Lake Erie watershed and Great Lakes basin.

9:15 **ROBERT McKAY**, **I. Ilikchyan**, **G.S. Bullerjahn**, Bowling Green State University
Phosphonates: Their occurrence and utilization by cyanobacteria in L. Erie.

9:30 **J. DAVID ALLAN**, **H. Han**, and **N.S. Bosch**, University of Michigan
Spatial and temporal variation in phosphorus budgets for 24 Lake Erie and Lake Michigan watersheds.

9:45 **DEBBIE BURNISTON**, Environment Canada
Pharmaceuticals and personal care products.

10:00 **BREAK**

10:30 **CHRIS MARVIN**, Environment Canada
Organic contaminants in Lake Erie offshore waters.

10:45 **ALICIA PEREZ-FUENTETAJA**, SUNY-Buffalo State College, **M. Clapsadl**, SUNY-Buffalo State College, **T. Lee**, SUNY-Fredonia
Type E Botulism in the Great Lakes: A widespread concern.

11:00 **SATYENDRA BHAVSAR**, Ontario Ministry of the Environment
Contaminant trends in Lake Erie fish and possible impact of invasive species.

11:15 **LYNDA D. CORKUM**, University of Windsor
Status of invasive fishes in Lake Erie: Trends and threats.

11:30 **JEFF TYSON**, Ohio Department of Natural Resources
The state of the Lake Erie fish community, 2010.

11:45 **Discussion and Comments**

12:00 **LUNCH**

Theme #5 – New and Continuing Research

Jan Ciborowski, University of Windsor, Moderator

1:15 **CHRISTOPHER M. PENNUTO**, Buffalo State College, **A. Pérez-Fuentetaja**, Buffalo State College **A. Karatayev**' Buffalo State College, **L. Burlakova**, Buffalo State College, **G. Matisoff**, Case Western Reserve University, **D. Bade**, Kent State University, **J. Conroy**, Ohio State University, **E.A. Marschall**, Ohio State University and **J. Kramer**, Heidelberg University
Nitrogen phosphorus, and isotopes from the nearshore/offshore Lake Erie nutrient study (NOLENS).

1:30 **SCUDDER MACKEY,** University of Windsor and Habitat Solutions
Potential for changes to lake level and implications for shoreline position & nearshore condition resulting from climate change

WEDNESDAY APRIL 28
Theme #5 – New and Continuing Research (Cont'd)

1:45 **M.A. Zarull**, Environment Canada, **JOHN H. HARTIG**, U.S. Fish and Wildlife Service, **A. Cook**, U.S. Fish and Wildlife Service
Soft shoreline engineering: We build it, have they come?

2:00 **EDWARD F. ROSEMAN**, USGS Great Lakes Science Center, **J. Boase**, USFWS Alpena Fish and Wildlife Conservation Office, **D. Bennion**, USGS Great Lakes Science Center, **R. Drouin**, Ontario Ministry of Natural Resources, **J. Francis**, Michigan Dept. of Natural Resources and Environment, **D. Hondorp**, USGS Great Lakes Science Center, **G. Kennedy**, USGS Great Lakes Science Center, **B. Manny**, USGS Great Lakes Science Center, **S. McNaught**, Michigan Dept. of Natural Resources and Environment, **K. Newman**, USGS Great Lakes Science Center, **J. Read**, Michigan Sea Grant**, R. Strach**, USGS Great Lakes Science Center, and **G. Townes**, Michigan Dept. of Natural Resources and Environment
Developing fish habitat enhancement strategies for the Huron-Erie corridor under the Great Lakes Restoration Initiative

2:15 **JOHN GANNON**, International Joint Commission
Towards an Ecology-Economy "Win-Win" for Offshore Wind Power in the Great Lakes.

2:30 **Discussion and Comments**

2:45 **BREAK**

Theme #6 – Building Expertise and Cooperation to Address New Developments and Emerging Issues
Jan Ciborowski, University of Windsor, Moderator

3:15 **GAIL HESSE**, Ohio Environmental Protection Agency
Overview and findings of the Ohio Lake Erie Phosphorus Task Force.

3:30 **JOHN LAWRENCE**, Environment Canada
Canada-United States Great Lakes Water Quality Agreement renewal: An update.

3:45 **VIOLETA RICHARDSON**, Environment Canada
Cooperative science and monitoring initiative: Where are we now?

4:00 **PAUL BERTRAM**, U.S. E.P.A. Great Lakes National Program Office
Research and the Great Lakes Restoration Initiative; sampling on EPA's research vessel, the Lake Guardian.

4:15 **CHRIS MARVIN**, Environment Canada
COA-related research – federal and provincial activities, plans, and opportunities for collaboration; sampling on Canadian Coast Guard Research Vessel Limnos.

4:30 **MARIE COLTON**, NOAA Great Lakes Environmental Research Laboratory
Research at the Great Lakes Environmental Research Lab – NOAA and CILER.

4:45 **Discussion and Comments**

5:00 – 7:00 **Adjourn to SOCIAL AND POSTER VIEWING**
Location: CAW Student Centre, Commons Area

THURSDAY APRIL 29

Current status and future directions for the Lake Erie Millennium Network

9:00 **JEFF REUTTER,** Ohio State University and Ohio Sea Grant
The Great Lakes Regional Research Information Network (GLRRIN) and the Lake Erie Millennium Collaboration

9:15 **JAN CIBOROWSKI,** University of Windsor and **RUSS KREIS**, U.S. E.P.A. Large Lakes Research Lab
Lake Erie Millennium Network – The next 5-year plan

Lake Erie Research Synthesis: Defining and Linking Research and Management Needs

9:30 **JOSEPH DePINTO**, Limno-Tech
Charge to the conference: coordinating research & management

9:40 **Discussion of Research/Management needs and Planning in Breakout groups**
Chris Marvin, moderator

9:40 - 11:00 Breakout discussions by group

Provisional Topics	Leader	Room Section
Causes & management of Eutrophication		
- *critical tests & data needs;*		
- *land-based sources & transport*	Jeff Reutter	**A**
Eutrophication effects & feedbacks		
- *nutrient cycling into and though the food web*		
Nearshore issues:	Joe DePinto	
Lakewide issues:	Russ Kreis	**B**
Offshore cycling of materials		
- *contaminants*	Chris Marvin	**C**
- *nutrients*		
Status and changes through space & time		
- *biodiversity and habitat alteration,*	Scudder Mackey	
- *protection, restoration, assessment*	Jan Ciborowski	**D**

11:00-12:30 **Reporting out and opportunities** (working lunch at noon)
Jeff Reutter and Chris Marvin, moderators

12:30 Closing Comments

12:45 Adjourn

PRESENTATION ABSTRACTS

SPATIAL AND TEMPORAL VARIATION IN PHOSPHORUS BUDGETS FOR 24 LAKE ERIE AND LAKE MICHIGAN WATERSHEDS

J. David Allan, H. Han, and N.S. Bosch

School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI

We estimated net anthropogenic phosphorus inputs (NAPI) to 18 Lake Michigan (LM) and 6 Lake Erie (LE) watersheds for 1974, 1978, 1982, 1987, and 1992. NAPI quantifies all anthropogenic inputs of P (fertilizer use, atmospheric deposition, and detergents) as well as trade of P in food and feed, which can be a net input or output. Fertilizer was the dominant input overall, varying by three orders of magnitude among the 24 watersheds, but detergent was the largest input in the most urbanized watershed. NAPI increased in relation to area of disturbed land (R^2=0.90) and decreased with forested and wetland area (R^2= 0.90). Export of P by rivers varied with NAPI, especially for the 18 watersheds of LM (R^2=0.93), whereas the relationship was more variable among the six LE watersheds (R^2=0.59). On average, rivers of the LE watersheds exported about 10% of NAPI, whereas LM watersheds exported 5% of estimated NAPI. A comparison of our results with others as well as nitrogen (N) budgets suggests that fractional export of P may vary regionally, as has been reported for N, and the proportion of P inputs exported by rivers appears lower than comparable findings with N.

CHARACTERISTICS OF NUTRIENT AND SEDIMENT DELIVERY TO LAKE ERIE FROM OHIO TRIBUTARIES

David Baker, J. Kramer, P. Richards, R. Confesor, A. Roerdink, and K. Krieger

Heidelberg University, Tiffin, Ohio

Most of the nutrients and sediments entering Lake Erie from Ohio tributaries originate from the agricultural watersheds of Northwestern Ohio. Average annual loads in metric tons from the Maumee and Sandusky Rivers for 2001-2008 water years at their tributary monitoring stations are, respectively: suspended sediments (SS), 954,600 and 223,300; total phosphorus (TP), 2,385 and 564; dissolved reactive phosphorus (DRP), 554 and 124; and nitrate-nitrogen (NO_3-N, 31,800 and 6,730. The corresponding average annual unit area export rates, in kg/ha, for the Maumee and Sandusky Rivers are: SS, 520 and 676; TP, 1.28 and 1.50; DRP, 0.304 and 0.339; and NO_3, 17.3 and 18.5. Loads are almost exclusively delivered as pulses during storm runoff events. For example, for the Maumee River, the 20% of the time with the highest flows (>237 m^3/s) during the 2001-2008 water years accounted for 89% of the SS load, 82% of the TP load, 75% of the DRP load, and 71% of the NO_3 load. The 50% of the time with the lowest stream flows (<71 m^3/s) exported only 2% of the SS, 4% of the TP, 5% of the DRP and 6% of the nitrate. These storm pulses include a combination of both high discharge rates and high concentrations. In contrast, point source discharges of DRP, as reflected in the Cuyahoga River loading, enter the lake or rivers at steady rates characterized by relatively low flows but relatively high concentrations. As such, point source inputs may be more subject to nearshore processing and uptake than nonpoint source loads.

Annual variations in landscape source factors result in seasonal differences of loading characteristics among various pollutants. Highest flow weighted concentrations SS and particulate phosphorus (PP) occur in March and June, while the highest NO_3 concentrations occur in May and June and the highest DRP concentrations October and November.

Long-term trends at these tributary loading stations show decreasing trends in SS and PP associated with the adoption of conservation tillage programs and other BMPs aimed at reducing sediment loads. After sharp declines in DRP loading through the mid-1990s, DRP loads have increased dramatically (2.5 to 4 fold) since 1995. Causes for these increases appear to include phosphorus stratification is area soils, increases in late-summer and fall broadcasting of fertilizers and the interaction of these factors with increasing December and January rainfall events and stream discharges. Nitrate loading has remained relatively constant in the Maumee River but has slowly increased in the Sandusky River.

NUTRIENTS IN THE ESSEX REGION WATERSHED AND ITS NEARSHORE WATERS

Raj Bejankiwar

Essex Region Conservation Authority, Essex, Ontario

The Essex Region Watershed consists of a peninsula in the extreme southwestern corner of the Province of Ontario, bounded on three sides by the waters of the Great Lakes system; namely, Lake St. Clair, the Detroit River and Lake Erie. The watershed is dominated by agricultural land use due to the Region's excellent farmland and growing conditions. The surface water quality data collected through the Provincial Water Quality Monitoring Network (PWQMN) and the Four Pilot Watershed Monitoring Program were analyzed to assess current and long-term trends. Concentrations for nitrate-N, total phosphorus (TP) and other chemical parameters were monitored from 1964 through 2008 for 13 subwatersheds in the Essex Region Watershed, on an intermittent basis. TP and nitrate concentrations in the nearshore waters were also examined during 2008-2009. TP concentrations were found to be exceeding the Provincial Water Quality Objective (PWQO) of 30 $\mu g.L^{-1}$ in 100% of samples collected in all the subwatersheds during the study period. Some of the subwatersheds such as the Sturgeon Creek watershed, and the Muddy Creek watershed showed dangerously high levels of TP reaching up to 7000 $\mu g.L^{-1}$. There was a statistically significant decreasing trend for TP concentration in 10 subwatersheds during 1964 to 1989, while TP concentrations remain consistently increasing from 2001 to 2008. Nitrate-N concentrations in these subwatersheds showed a very similar pattern in terms of exceedances, while no significant trend was observed for nitrate-N in any of the studied subwatershed. There were no statistical differences in the 10 year-mean TP concentrations among the subwatersheds, except that the 10 year-mean TP concentrations for the Sturgeon Creek and Muddy Creek watersheds were significantly higher than those of remaining subwatersheds. The majority of subwatersheds had significantly higher nitrate-N and TP in spring and late summer. The Pilot watersheds Study data showed higher levels of nutrients and *E.coli* in the samples collected during wet weather events compared to regular weather samples. Similar results were observed for nutrients and *E.coli* in nearshore water samples. Annual mean TP concentrations were statistically different among the nearshore samples collected for Lake St. Clair, the Detroit River and Lake Erie. A strong correlation was observed between total suspended solids and TP for five subwatersheds which are predominantly agricultural, while other subwatersheds showed statistically weak correlation between these two parameters.

LAKE ERIE CENTRAL BASIN DISSOLVED OXYGEN TRENDS AND RECENT CONDITIONS

Paul Bertram

U.S. Environmental Protection Agency, Great Lakes National Program Office, Chicago, IL

During the years 1970 – 1989, the annual calculated oxygen depletion rates were variable, but the overall average declined. The lowest rates were observed for the 1988 and 1989 summer seasons. During 1990 – 2008, however, the average adjusted oxygen depletion rate remained nearly steady. The calculated depletion rate for 2001 was encouraging, being the lowest in this time series and consistent with the long term trend. The depletion rates for 2002 – 2008, however, were again near the average from the years 1990 – 2008, and they were not consistent with the long term trend observed from 1970 – 1989. Although the calculated oxygen depletion rate for 2001 was the lowest since 1970, 90% of the monitored area of the Central Basin experienced anoxic waters in late summer or early fall. The same areal extent of anoxia was observed each year during the period 2007-2009. The summary conclusion is: not much has changed.

CONTAMINANT TRENDS IN LAKE ERIE FISH AND POSSIBLE IMPACT OF INVASIVE SPECIES

Satyendra P. Bhavsar

Ontario Ministry of the Environment, Toronto, Ontario

Temporal trends of PCB and mercury in Lake Erie fish were examined using long-term monitoring data of Ontario Ministry of the Environment and Environment Canada (mercury only). PCB concentrations in lake trout and walleye appear to be stable over the last three decades; however, weak increasing trends have been observed since the late-1908s to early-1990s. Mercury concentrations declined steadily during the 1970s and 1980s; however appear to be increasing slowly since 1990. The recent increasing mercury trend was present even when the western, central and eastern basins of Lake Erie were considered separately. Although current mercury levels are relatively low in Lake Erie fish, increasing concentration trends are of concern. For PCB, both current elevated fish levels and increasing concentration trends are of concern. Time points for the change from declining/stable to increasing concentration trends of both PCB and mercury coincide well with the invasion of dreissenid mussels and round goby in Lake Erie. This indicates that changes in the Lake Erie food web structure are possibly contributing to the increasing PCB and mercury levels in fish.

LAKE ERIE ALGAL SOURCE TRACKING 2009 (LEAST)

Thomas B. Bridgeman[1], J.D. Conroy[2]. C.L. Gruden[3], D.D. Kane[4], J.W. Kramer[5], C.M. Mayer[1], G.W. Winston[5]

1. Department of Environmental Sciences, The University of Toledo, Toledo, Ohio
2. Department of Evolution, Ecology, and Organismal Biology, the Ohio State University, Columbus, Ohio
3. Department of Civil Engineering, The University of Toledo, Toledo, Ohio
4. Division of Natural Sciences and Mathematics, Defiance College, Defiance, Ohio
5. National Center for Water Quality Research, Heidelberg University, Tiffin, Ohio

Blooms of the cyanobacterium *Microcystis aeruginosa* are a recurring problem in western Lake Erie thought to be linked to tributary inputs. The objectives of the LEAST project were to: 1) Determine the relative contribution of the Maumee River system and lake sediments as a source of algal biomass leading to *Microcystis* blooms in western Lake Erie. 2) Map the distribution, growth, and biomass of benthic and planktonic algae and to measure their phosphorus content in order to determine the potential effects of nearshore algae on the export of bioavailable phosphorus to offshore regions. Synchronized Maumee River and Lake Erie surveys were conducted on three dates: pre-bloom (June), early-bloom (August), and mid-bloom (September) including water column samples, lake sediments, and lake benthic algae (*Lyngbya wollei*). Results indicated no single source of *Microcystis* "seed". *Microcystis* was present in both the river water and lake sediments on the pre-bloom sampling date. *Microcystis* concentration in the river and lake was greatest during the August sampling event with *Microcystis* the dominant phytoplankton species from early August through September. Partitioning of phosphorus between dissolved reactive, dissolved organic, small particulate, and large particulate forms indicated that on an areal basis, most phosphorus in western Lake Erie waters exists in dissolved or small particulate (< 112 um) form rather than in larger particulate form (zooplankton, *Microcystis* colonies, colonial planktonic and benthic algae).

DETROIT RIVER PHOSPHORUS LOADING DETERMINATION

Debbie Burniston[1], R. McCrea[2], P. Klawunn[1], R. Ellison [3], A. Thompson[4], J. Bruxer[4]

1. Environment Canada, Water Quality Monitoring and Surveillance Office Center for Inland Waters, Burlington, Ontario
2. Environment Canada-Retired
3. United States Environmental Protection Agency-Great Lakes National Program Office, Grosse Ile, Michigan
4. Environment Canada, Boundary Waters Issues Unit, Canada Center for Inland Waters, Burlington, Ontario

In response to requests from the Lake Erie LaMP, Environment Canada undertook a nutrient study in the lower Detroit River. The primary goal of the Detroit River phosphorus loading application study was to estimate phosphorus loads to Lake Erie. During the period of August to November, 2007, ISCO programmable water samplers were run at two locations on the Lower Detroit River to collect water samples automatically every two hours, 24-hours a day, in order to provide a better estimate of phosphorus loads to Lake Erie. Sub samples from each ISCO sample collected on a common day were combined to comprise a 24-hour (daily) composite sample. These samples were subsequently analyzed to determine total phosphorus (TP) concentrations. Grab samples were also taken periodically at these and several other locations along the Detroit River. The grab samples were analyzed for TP and total soluble reactive phosphorus (SRP). It was intended that relationships would first be developed between the measured TP concentrations from grab samples taken at the ISCO station(s) and grab samples taken at other locations. Using these relationships, the 24-hour (daily) composite data generated from the ISCO samplers could then be related to the grab sample locations to estimate near-continuous phosphorus loading concentrations. An existing two-dimensional hydrodynamic model of the St. Clair-Detroit River system was modified specifically for this study. It was used to estimate flow distributions across each channel and at each sampling location, so that the total loading of phosphorus entering Lake Erie over the study period could be estimated.

PESTICIDE CONCENTRATIONS IN THE LAKE ERIE WATERSHED AND GREAT LAKES BASIN

J. Struger, Debbie Burniston, E. Sverko, S. Cagampan, J. Grabuski, C. Marvin, J. Kraft , J. Waltho, A. Dove and L. Heslip.

Water Science and Technology Directorate, Environment Canada, Burlington, Ontario

Pesticides are heavily used in agricultural production and in urban areas of southern Ontario. Since 2002 WQM&S has been monitoring a number of surface water sites for a range of pesticides. This program is part of a national initiative (Pesticide Science Fund (PSF)) by EC. It has evolved from sampling a standard suite of currently used pesticides such as neutral and acid herbicides, and organophosphorous insecticides to now include sulfonyl urea herbicides, carbamate pesticides, glyphosate and pyrethroid insecticides. This has allowed for the development of a surface water pesticide database with over 900 samples collected from over 70 locations in southern Ontario representing pesticide inputs from corn and soybean growing areas, fruit growing areas and areas influenced by urban activities. In addition pesticide data is collected from the open waters of the Great Lakes on a rotational basis since 1994 by Alice Dove.

PHARMACEUTICALS AND PERSONAL CARE PRODUCTS

Debbie Burniston

Water Science and Technology Directorate, Environment Canada, Burlington, Ontario

Abstract TBA

NOAA/CILER GREAT LAKES ENVIRONMENTAL RESEARCH LAB

Marie Colton

NOAA Great Lakes Environmental Research Laboratory

Abstract TBA

FISH COMMUNITY STRUCTURE IN LAKE ERIE: CONTINUED REHABILITATION OR A RETURN TO DEGRADATION?

J.D. Conroy[1,2], S.A. Ludsin[1], K.Kayle[2], J.T. Tyson[2], R.L. Knight[2], and David A. Culver[1]

1. Dept. of Evolution, Ecology, and Organismal Biology, the Ohio State University, Columbus, Ohio
2. Division of Wildlife, Ohio Department of Natural Resources, Columbus, Ohio

The Great Lakes Fishery Commission's Lake Erie Committee Forage Task Group collects data on sportfish abundance and phosphorus, chlorophyll, zooplankton, and forage fish from 20 stations around Lake Erie and Lake St. Clair. Sampling is being performed collaboratively by state (OH, PA, NY, and MI) and provincial (Ontario) departmental personnel. In this talk we use the collected fish and lower trophic level data to analyze whether Lake Erie has contined to improve in water quality since 1996. The forage fish community has come to be dominated by benthivorous fish that have a lower food value to walleye than do planktivorous taxa (e.g., shiners, smelt, alewives, etc.)and high phosphate loadings have stimulated harmful algal blooms without a concomitant increase in zooplankton prey for forage fish.

DELIVERY OF NUTRIENTS TO LAKE ERIE: THE GRAND AND THAMES RIVERS (CANADA)

Sandra Cooke[1], and Karen Maaskant[2]

1. Grand River Conservation Authority, Cambridge, Ontario
2. Upper Thames River Conservation Authority, London, Ontario

Historical studies completed under the research-resource management consortium of the Pollution from Land Use Activities Group (PLUARG) (1972-1979; Canada) clearly demonstrated the importance of watersheds in the delivery of nutrients to the Great Lakes. Although it is commonly accepted that watersheds can contribute a significant portion of a lake's nutrients in any given year, the current datasets in Ontario to accurately quantify this contribution are inadequate. Monitoring efforts have sharply declined across southern Ontario to levels that do not even characterize the range of variability in nutrient concentrations on an annual basis let alone quantify nutrient loads. For example, late winter and spring monitoring is likely the most important time to characterize or quantify nutrient loads from watersheds yet very little data exist for this time period. Further, this time period may or may not be extremely important in the delivery of bioavailable phosphorus to the lake. This presentation summarizes data from the Ontario Ministry of the Environment's Provincial Water Quality Monitoring Network for the Grand and Thames Rivers both spatially and temporally to identify broad trends in the transport and delivery of nutrients to Lake Erie. Although it must be acknowledged that additional monitoring data would provide more confidence in the broad trends, the weight of evidence approach allows watershed managers to focus management activities using well established programs such as the Rural Water Quality Program to reduce the delivery of nutrients to streams, rivers and subsequently Lake Erie. Given limited funding for such programs, nutrient loads or budgets for watersheds, are required now, more than ever to identify nutrient contributing areas so that best land management practices can be effectively focused to reduce these contributions.

STATUS OF INVASIVE FISHES IN LAKE ERIE: TRENDS AND THREATS

Lynda D. Corkum

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Are the same life history traits responsible for invasion success and extinction risk? There are 34 non-native species (19 established species and 15 others that have been reported) and 102 native fishes in Lake Erie. Non-native species have been present throughout the century in the commercial fishery, but increased substantially after the completion of the St Lawrence Seaway in 1959. From 1900 to 1950, piscivores and a planktivore comprised most of the native commercial landings, whereas non-native fishes (omnivores) were low in abundance. Since 1950, non-native fishes (mainly planktivores, but also omnivores and herbivores) dominated the commercial catch. Of the 102 native fishes, 28 are species at risk (SAR).

Species that are globally abundant and non-native (particularly those that are invasive) are thought to have life history traits that are opposite from those that are at risk. I tested this hypothesis by examining life history traits and habits of fishes (average length, maximum length, maximum life span, length of spawning period, water temperature at spawning, parental care and diet) for a random subset of 1) invasive species (commercially-harvested fishes and others), 2) SAR, and 3) native species that are not at risk in Lake Erie. I used a factor analysis of these seven life history variables for these species to examine the extent of overlap (if any) among the species groups. Using one-way analysis of variance, I tested if there were significant differences in mean values of life history traits among the three species groups using their factor scores (i.e., coordinates of each species in factor space). The expectation was that invasive species would be larger, have a longer maximum life, wider variation in spawning temperature, exhibit parental care and have a broader diet than SAR or native species and that these traits would be reversed in SAR.

Results did not support the hypothesis. Thus, size of species and their life history traits (slow vs. fast) are not associated with invasion success. Perhaps other traits (behavioural aggressiveness) or threats (degree of human disturbance) better predict invasion success. The most common threats to native species are habitat alteration, invasive species, species interactions, and harvest.

PHOSPHORUS CHEMISTRY AND SEQUESTRATION IN SOIL

Elizabeth (Libby) Dayton

Ohio State University, Columbus, Ohio

This talk will review soil chemical processes important to P sequestration and solubility/mobility/runoff/leaching. Soil testing of labile P, with a distinction between crop production and environmental soil testing, will be discussed. Also a brief overview of Ohio assessment tools to predict risk of P transport (runoff/leaching) will be given.

RECENT MODELING IN THE MAUMEE WATERSHED AND THE WESTERN BASIN OF LAKE ERIE

Joseph V. DePinto, T.R. Redder, E.M. Verhamme, and L. Weintraub

LimnoTech, Ann Arbor, Michigan

Through its participation in the Western Lake Erie Basin Partnership and its responsibilities for regional sediment management in the region, the U.S. Army Corps of Engineers (USACE) Buffalo District has been planning and working within the Maumee watershed to reduce the loading of solids and nutrients to the Maumee River and the western basin of Lake Erie. In support of research and management activities in this system, LimnoTech is in the process of developing and applying two models: 1) an AnnAGNPS model of sediment and nutrient loading from the Blanchard River sub-basin of the Maumee Watershed; and 2) a fine-scale, 3-dimensional linked hydrodynamic – sediment transport – water quality model (LMRM) of the lower Maumee River (beginning at Waterville) through the entire western basin of Lake Erie. The Blanchard Watershed model is intended to identify the primary source areas and pathways of sediment and nutrient loading and to compute export from the watershed in response to management actions. The LMRM is intended to quantify the relationship between sediment and nutrient loading from the Maumee Watershed and other sources to the western basin and aquatic ecosystem endpoints of concern in the lower river and western basin, including sedimentation in Toledo Harbor and the navigational channel and harmful algal blooms (Microcystis, Lyngbya). This presentation will focus on the current status of the model development, show some preliminary results from model runs, and discuss how these models can be used to support management decisions for this system.

NUTRIENT LOAD ESTIMATES FOR LAKE ERIE 2005

D. Dolan[1], P. Richards[2], and Russ Kreis[3]

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2. National Center for Water Quality Research, Heidelberg University, Tiffin, Ohio
3. U.S. E.P.A., ORD, NHEERL, MED, Grosse Ile, Michigan

Evaluation of phosphorus loads to Lake Erie is in progress for multiple uses in the Lake Erie ECOFORE Program. Emphasis is being placed on phosphorus loadings in 1976, 2005, and 2007 for model calibration and other purposes. This presentation focuses on an overview of temporal and spatially explicit phosphorus loading information for 2005; limited preliminary results of nitrate and total suspended solids loads are also presented. Further total Lake loading updates for several parameters are planned in the future through 2007 and beyond. Total phosphorus loads for the Millennium have sparingly exceeded the Great Lakes Water Quality Agreement Target of 11,000 MTA. The Maumee and Detroit Rivers continue to contribute the greatest relative loads of phosphorus to Lake Erie. Generally, non-point phosphorus loads are the greatest contributor, followed by municipal and atmospheric inputs, respectively. Preliminary comparisons indicated that Detroit River WWTP phosphorus load has decreased over time. Maumee River phosphorus loads have generally increased overtime and the Maumee also contributes relatively large loads of total suspended solids and nitrate. Further examination of loading data for all parameters will be conducted in the future and will be used for mathematical modeling and for reconciling the evolving impacts being observed in Lake Erie.

IMPACTS OF SOIL AND CROP MANAGEMENT PRACTICES ON WATER PARTITIONING AND NUTRIENT LOSSES FROM AGRICULTURAL SOILS

Craig F. Drury, W.D. Reynolds, C.S. Tan, X.M. Yang, J.Y. Yang, T.Q. Zhang and T.W. Welacky

Agriculture & Agri-Food Canada, Harrow, Ontario

In humid climates, soil and crop management practices including conservation tillage, cover or catch crops, water table management systems and buffer strips are recommended as beneficial management practices to improve soil and water quality without compromising crop productivity. In many situations, they have achieved their intended objective. For example, conservation tillage systems increase the amount of surface residue and thereby provide a physical barrier which slows water movement and reduces surface runoff and soil erosion. However, there can be unintended consequences of conservation tillage such as an increase in the amount of water and nutrients available for leaching through soil. The increased water flow through soils under conservation tillage is partially intercepted by the network of tile drains under most clay and clay loam soils in Eastern Canada which could increase nutrient entry into ditches, streams or lakes. Cover crops are a common management option for capturing surplus fertilizer nitrogen remaining in the soil after harvest as well as transpiring excess soil water during the fall and spring when the cover crops are actively growing. However, cover crops also reduce surface runoff and thereby enhance water infiltration into the soil which may reduce their effectiveness from a water quality perspective. This presentation will focus on the benefits and risks associated with several soil and crop management practices and discuss how a holistic approach is required to maintain crop productivity while reducing environmental impacts.

TOWARDS AN ECOLOGY-ECONOMY "WIN-WIN" FOR OFFSHORE WIND POWER IN THE GREAT LAKES

John E. Gannon

Great Lakes Regional Office, International Joint Commission, Windsor, Ontario

The interest in renewable energy, particularly wind power, has raised concerns about how such developments in the waters of the Great Lakes can be accomplished while protecting natural resources. Birds and bats use Great Lakes coastal areas for migratory and stop-over sites and many birds such as bald eagles and waterfowl use coastal areas and islands for nesting and rearing young. Wind power projects have been documented to kill birds and bats.

Wind towers placed in Great Lakes waters will require some lakebed disturbance for anchorage and transmission lines. There are concerns how such developments may affect lakebed habitat, especially rocky substrates, that is important fish spawning, nursery and feeding grounds. While a few wind towers likely will have minimal impacts on natural resources, the cumulative impacts of large-scale wind farms are largely unknown. Under such circumstances, the precautionary approach should be invoked and research accelerated to identify and map areas that should be protected from any significant disturbance due to sensitivity of their biological, physical, archaeological or other values and designated for legal protection. In this manner, areas can be identified and mapped where habitats can most tolerate disturbance from wind tower construction and placement.

Guidance on research needs and policy is available in documents including, Dempsey et al. (2006),*Conserving Great Lakes Aquatic Habitat from Lakebed Alteration Proposals*, the GLFC Lake Erie Committee's 2009 *Position Statement on Offshore Wind Power*, and the Great Lakes Wind Collaborative's 2009 *Offshore Siting Principles and Guidelines for Wind Development on the Great Lakes*.

Wherever offshore wind farms are proposed, extensive pre- and post-construction monitoring should be conducted to learn about any unanticipated or cumulative environmental impacts and adjust and modify future project criteria and permits accordingly in an adaptive management mode. The Michigan Great Lakes Wind Council's proposed criteria for offshore wind energy offers an ecology-economy "win-win" worthy of consideration Great Lakes wide. Wind towers cannot be located within 3 miles (5 km) of the coastline to protect the most biologically active and productive zone for migratory birds and bats and habitat for fish and other aquatic biota. In addition, the Council proposes extending an offshore viewshed buffer zone to 6 miles (10 km) beyond which wind towers cannot be easily seen, thereby not interfering with the beauty of the shoreline.

LAKE ERIE BINATIONAL NUTRIENT MANAGEMENT STRATEGY

Sandra George, and Marie-Claire Doyle

Environment Canada, Burlington, Ontario

Lake Erie water quality has taken a turn for the worse. Despite billions of dollars of public expenditure to reduce phosphorus loadings to the Lake, evidence of phosphorus-driven eutrophication is again before us.

Algal blooms which threatened the Lake Erie ecosystem in the 1960s and 1970s have returned. *Cladophora* (algae) growth has once again become a problem in nearshore zones and in areas with hard bottom substrate; botulism outbreaks are believed to be linked to a combination of interrelationships between *Cladophora*, *Dreissenids* and round gobies; and models developed to predict the lake response to various inputs are no longer accurate.

The algal blooms that began their return to the western basin in the mid 1990s are composed primarily of the blue-green alga *Microcystis aeruginosa.* This species is capable of producing high concentrations of the toxin *microcystin* which can impact drinking water supplies, recreational use, and the aquatic community. At the mouth of the Maumee River, benthic mat-forming blue-green algae float to the surface and wash ashore after storms and the fouled shorelines can have harmful impacts on people and the ecosystem. There are disturbing trends of increasing loads of soluble reactive phosphorus in the Maumee River and Sandusky River and similar loads may be present in other tributaries, but monitoring data is limited for these areas.

Water is the keystone resource that all life is dependent upon. Impacts associated with unsustainable nutrient loading include unstable fish and wildlife population and degraded habitats, beach contamination and closures, declines in property values, declines in tourism, and added costs to municipalities, industry and people for the provision of safe drinking water.

The efforts to reduce phosphorus loads in the 1970s and 1980s were successful and led to a healthier Lake Erie, until problems resurfaced in the mid 1990s. We are now again faced with the challenge to "fix" the lake. We faced this challenge before, and succeeded; and with the same commitment to working together and coordinated actions, we can again succeed.

The Lake Erie Binational Nutrient Management Strategy is a coordinated and strategic response from Canada and the United States that outlines nutrient management actions to reduce eutrophication in Lake Erie. It represents the consensus of Lake Erie resource managers on priority actions and it is essential that every agency and stakeholder adopt the actions that are outlined to restore Lake Erie once again. The strategy provides quantitative targets and identifies nutrient management, restoration, research and monitoring priorities and actions that need to be considered and adopted by everyone (government agencies, non-government organizations and all people) in the watershed.

This approach to make phosphorus reduction a priority and to engage and promote the actions of a wide range of people and agencies will result in a significant reduction of nutrient concentrations and ensure a healthy Lake Erie for everyone to enjoy.

INCREASING IMPORTANCE OF NITROGEN DYNAMICS IN THE LAKE ERIE ECOSYSTEM

Robert T. Heath, C. Clevinger, and D. Bade

Department of Biological Sciences and the Water Resources Research Institute, Kent State University, Kent, Ohio

The Lake Erie Paradigm has provided a successful management strategy over the past 35 years: control excessive growth of P-limited phytoplankton communities by preventing external loading of biologically available P; internal loading of P from anoxic sediments is controlled by limiting the occurrence of anoxia. Increasing evidence collected in our laboratory and others over the past ten years indicates that the premises on which the Lake Erie management paradigm is based no longer holds. Using a wealth of bioassay, chemical and biochemical indicators (Schelske-style nutrient amendment bioassays, SRP concentration, radiometric assay of phosphate uptake rate and turnover time, alkaline phosphatase specific activity, phytoplankton phosphorus-debt, phosphorus deficiency index, C:P, N:P, and C:N ratios) we and others conclude that phytoplankton in the Central Basin of Lake Erie are N-and-P co-limited. Here we present data from summer 2008 that indicate this co-limitation; similar data taken from the Central Basin in 1996 show that phytoplankton communities were P-limited at that time. We show that nitrification, an oxygen-consumptive dissimilatory microbial process that oxidizes one mole ammonium to one mole nitrate whilst consuming two moles of O_2, exacerbates natural processes that lead to large regions of hypoxia and anoxia ("Dead Zones") in the hypolimnion of the Central Basin. Hypoxia and anoxia in turn support denitrification and anammox, two microbial processes that reduce nitrite ultimately to N_2, which leaves lake by exchange with the air. That is, a major consequence of Dead Zones is that they inevitably lead to loss of available N, conceivably leading to N-limitation of phytoplankton. Lake Erie research needs to focus on the causes, controls and consequences of phytoplankton communities that are N-and-P co-limited. Management of Lake Erie ecosystem processes needs to broaden beyond looking only at loadings and consider also those processes that result in nutrient "leavings" to the air. Management strategies also need to consider N-dynamics as integral to understanding the limits of management capabilities.

OVERVIEW AND FINDINGS OF THE OHIO LAKE ERIE PHOSPHORUS TASK FORCE

Gail Hesse

Ohio Environmental Protection Agency, Columbus, Ohio

Ohio EPA convened the Ohio Lake Erie Phosphorus Task Force in 2007 to review and evaluate the increasing Dissolved Reactive Phosphorus loading trends and the connection to the deteriorating conditions in Lake Erie. The long term tributary loading program conducted by Heidelberg University provides the information that the DRP loads and concentrations are increasing. The Task Force was charged to identify and evaluate potential point and nonpoint sources and related activities that might be contributing to the increasing trends in DRP. The Task Force included a wide range of participants and presentations by invited experts in a variety of disciplines. The presentation will provide an overview of the findings of the Task Force along with recommendations for future management actions for Ohio. Examination of pollutant loading data for the Lake's major U.S. tributaries suggests that the problem stems not from any increase in the total amount of phosphorus entering the Lake, but instead from changes in the forms of phosphorus entering the lake from its large agricultural watersheds. The Maumee and Sandusky Rivers have the highest DRP loads under high flow conditions, suggesting that nonpoint sources are the most important in these watersheds. The final report of the Task Force is expected to be released within the next couple of weeks.

PATTERNS IN NUTRIENTS OVER *DREISSENA-CLADOPHORA* IMPACTED SHORELINE

Todd Howell

Environmental Monitoring and Reporting Branch, Ontario Ministry of the Environment, Etobicoke, Ontario

Strong variability in nutrients and other indicators of water quality such as chloride and suspended solids occurs at the shoreline and over mixing areas as runoff from the adjacent land dilutes with the lake at tributary mouths. The gradients are often steep and range widely in spatial extent. In the case of larger tributaries, the affected areas may periodically extend over several kilometers. In contrast, affected area associated with small discharge volumes may be difficult to detect beyond the immediate shoreline. Typically there are pronounced differences over time in the spatial extent and the orientation of mixing areas reflecting variability in volume and quality of tributary discharge and lake circulation. Periodic physical disturbance of the shoreline and shallow lakebed by wave action further contributes to heterogeneity in conditions as particulate material becomes entrained in the water column. In many areas of the Great Lakes the lakebed along the shoreline is heavily colonized by dreissenid mussels and seasonally overgrown with lawns of *Cladophora* and periphyton. The biological activity and physical construction of the *Dreissena* and *Cladophora* layer over the lakebed present additional complex dimensions to spatial, short-term and seasonal variability in nearshore water quality. In this presentation patterns in phosphorus levels and other potential diagnostic water quality features will be compared among selected reaches of shoreline in eastern Lake Erie and Lake Ontario. The shoreline reaches share the feature of a lakebed overgrown with *Dreissena* and *Cladophora* but vary in the extent of land-based influences on the nearshore. It is likely that the strong variability in water quality observed over the nearshore affects the productivity and function of the *Dreissena* and *Cladophora* association. However, point-in-time spatial patterns in water quality provided only limited insight on the question of how the *Dreissena* and *Cladophora* association may be may be affecting short-term and spatial variability in water quality in the nearshore.

THE 2009 GREAT LAKES PHOSPHORUS FORUM

Pamela Joosse[1], K. Reid[1], and R. Campbell[2]

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The Ontario Agri Business Association along with industry, academic and government stakeholders received funding from the Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem to organize a Great Lakes Phosphorus Forum that took place on July 28-31, 2009 in Windsor, Ontario. Representatives from the fields of agronomy, nutrient management, soil science and water quality were gathered together to share relevant information and to discuss non-point source phosphorus issues and losses from agricultural land in the Great Lakes Basin.

The conference was held in conjunction with the annual meeting of SERA-17, an information exchange group supported by the United States Department of Agriculture whose mission is to develop and promote innovative solutions to minimize phosphorus losses from agriculture.

One of the main objectives of the Forum was to bring aquatic and terrestrial researchers together in one room to better understand the phosphorus related issues of each group. The Technical Steering Committee developed a backgrounder document that identified five key topic areas covering the full life-cycle of phosphorus in the environment from land application to the impact on the aquatic environment. This backgrounder provided an overview of current understanding on each subject area and a list of questions that the speakers were asked to incorporate into their presentations. The presentations and a synthesis of discussion around the questions in the background document are available at www.sera17.ext.vt.edu/Meetings/greatlakepforum. A special issue of the Canadian Journal of Soil Science is being prepared that will highlight some of the key presentations and posters from the Forum, and will be a useful resource for those who attended this Forum as well as those who were not able to participate.

MONITORING, MECHANISMS, AND MACRONUTRIENTS: MICROCYSTIS IN THE MAUMEE AND SANDUSKY SYSTEMS

Douglas D. Kane[1], J.D. Conroy[2,3], D.L. Bade[4], W.J. Edwards[5], D.A. Culver[6], J.D. Chaffin[7], K. Wambo[8], C.L. Gruden[8], and T.B. Bridgeman[7]

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5. Department of Biology, Niagara University, Lewiston, New York
6. Limnology Laboratory, Department of Evolution, Ecology, and Organismal Biology, The Ohio State University, Columbus, Ohio
7. Department of Environmental Sciences and Lake Erie Center, University of Toledo, Oregon, Ohio
8. Department of Civil Engineering, University of Toledo, Toledo, Ohio

During 2009 we conducted two complimentary strategies for assessing both the phytoplankton and nutrient conditions of the Maumee and Sandusky Rivers, Bays, and nearby regions of Lake Erie. *Microcystis* was abundant during summer in the lake, consistent with previous observations. But to our surprise, we also found *Microcystis* in spring and at low-order tributaries in these systems and throughout the sampling period. Nutrient uptake experiments and physical transport models and genetic analyses may assist in determining the extent to which *Microcystis* growth in the upper reaches of these systems affects blooms in Lake Erie.

DOMINANCE OF EXOTIC INVERTEBRATES CHANGE THE LAKE ERIE BENTHIC COMMUNITY

Alexander Karatayev, L. Burlakova, C. Pennuto, and C. Basiliko

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To estimate the role of exotic species in the benthic community of Lake Erie, we collected samples from all lake basins in the summer of 2009, and compared these data to a 1979 survey (Dermott 1994). In 1979, 3 exotic species (Gastropoda: *Bithynia tentaculata*, and Oligochaeta: *Branchiura sowerbyi*, *Potamothrix vejdovskyi*) constituted < 1% of the total benthic density, 2% of the biomass. The 1979 community was dominated by oligochaetes, fingernail clams, and the amphipod *Diporea*. Eight exotic species were found in 2009, including molluscs *Dreissena r. bugensis*, *D. polymorpha, Sphaerium corneum, Cipangopaludina chinensis, Potamopyrgus antipodarum, Valvata piscinalis*, the oligochaete *B. sowerbyi*, amphipod *Echinogammarus ischnus*, and numerous shells of *B. tentaculata*. Exotics were disproportionally abundant among molluscs, and were absent from the most diverse group of native invertebrates -insects. Benthic invaders now constitute 40% of total benthic density, and over 95% of the total wet mass. Benthic community structure and dominance has changed significantly since 1979, and the community is currently dominated by exotic species.

DETECTING LAND-BASED SIGNALS IN THE NEARSHORE ZONE OF LAKE ERIE DURING SUMMER 2009

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We conducted two styles of nearshore surveys in Lake Erie during August to mid-September 2009. The first used a spatially-balanced probability survey (SBS) design to establish discrete stations within a GIS-defined target population—the nearshore zone extending approximately 5 km from the shoreline. This survey was an exploratory precursor to the upcoming (2010) US National Coastal Condition Assessment, during which these sites will be re-sampled. The second sampling style used vessel-towed *in situ* sensors (for water quality and plankton), oscillated from near surface to near bottom while circumnavigating much of the lake (US and Canada) in the nearshore zone at ~15 m (10 m in the western Basin). The two survey styles complement each other — creating a comprehensive, semi-synoptic picture of late summer nearshore conditions and allowing examination of nearshore patterns to relate to watershed-based stressors. This short presentation will focus on some results of the SBS survey. We estimated mean total phosphorus (TP) in the US nearshore zone to be 34.6 μg/L (95% CI = ± 26%). Greater than 67% of the US nearshore area had TP concentrations in excess of 10 μg/L, >50% of the area exceeded 15 μg/L, and ~45% of the area exceeded 20 μg/L; these concentrations are water quality management threshold goals for Lake Erie's offshore (east and west basins) and nearshore regions, respectively. We examined spatial variability of nutrients as a function of watershed characteristics by mapping the 45 US sites in relation to adjacent landscape stressors (PCA-based metrics based on many individual parameters from the GLEI collaboration [Danz et al. 2007]). Multivariate regression modeling including landscape disturbance metrics as independent variables yielded strong empirical predictive models. For example, TP concentrations were predicted [N = 45, R^2 = 0.74, model ANOVA with df =3,41 showing significance at $p<0.00001$] as a function of three independent variables: (a) water column depth, (b) an agricultural landscape metric (non-point source), and (c) a point source landscape metric. The surveys and models provide strong insights about nearshore condition and response to landscape stressors across scales that range from localized to lake-wide and these comprehensive nearshore assessments suggest linkage to potential basin-wide management actions. *This abstract does not necessarily reflect U.S. EPA policy.*

WEIGHT OF EVIDENCE FOR CAUSES OF RE-EUTROPHICATION OF THE GREAT LAKES

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In the 2007-2009 Priority Cycle, the International Joint Commission charged a Eutrophication Work Group to provide advice and recommendations to the Parties to the Great Lakes Water Quality Agreement on the weight of evidence on cause-effect relationships to explain the recent re-eutrophication of Lake Erie and the other Great Lakes. Through a series of workshops with technical experts, the workgroup employed a fuzzy cognitive mapping approach to develop a consensus understanding of the causal structure for these problems and applied a weight-of-evidence approach to evaluate the potential effectiveness of various management interventions. This presentation summarizes the progress made in past IJC Priority Cycle and subsequent analysis.

Symptoms of the re-eutrophication that were identified at the workshop included excessive growths of *Cladophora* in many nearshore areas, bluegreen algae blooms, outbreaks of botulism events, increased frequency of beach closings, and appearance of a dead-zone in central Lake Erie. The most frequently cited potential drivers of the phenomenon included climate change (and flooding associated with more intense and altered timing of storms), soluble reactive phosphorus entering the lake, total phosphorus from point sources, lower lake levels, and agricultural activities. In-lake attributes that were frequently identified included dreissenid biomass, *Cladophora* biomass, and nearshore concentrations of soluble reactive phosphorus.

A key finding from this work is that the complex causal structure that emerged from technical experts has insufficient weight-of-evidence to justify preference for any particular management intervention. Further, the characteristics of the evidence for various causal pathways suggest that much better understanding of spatial processes in the nearshore will be required before a strong scientifically-based case can be made for undertaking specific management actions to solve the problem.

CANADA-UNITED STATES GREAT LAKES WATER QUALITY AGREEMENT RENEWAL: AN UPDATE

John Lawrence

Water Science & Technology Directorate, Environment Canada, Burlington, ON

Following a detailed review of the Canada – United States Great Lakes Water Quality Agreement in 2006/2007 which involved considerable public and stakeholder engagement, the Governments of the two countries announced in June 2009 their intention to renegotiate the Agreement. A detailed multi-level negotiating process has been developed and a time line established to have the negotiations completed by the end of 2010. The process involved the establishment of 10 parallel Issue Teams on both sides of the border but some of these Issues may be combined to reduce the overall number. Each team will develop a national position which will then be shared with their opposite number and a common, binationally acceptable position negotiated. At each stage of the process, the national and binational positions will benefit from input from government and stakeholder advisory panels as well as broader public engagement. The binational positions will form the recommendations for amendment of the Agreement.

At this time, negotiations are on schedule. Draft Canadian and United States national positions are undergoing final review and binational negotiations will be starting shortly. The presentation will discuss the subject areas of the Issue Teams and provide a general overview of the negotiations to date.

CLIMATE CHANGE, WATER LEVELS, ADAPTATION, AND THE LAKE ERIE ECOSYSTEM

Scudder D. Mackey

University of Windsor, Windsor, ON, and Habitat Solutions NA, Beach Park, IL

Future changes in climate and increased climate variability will have a significant impact on Lake Erie water level regimes. Anticipated impacts include changes in the seasonal and interannual magnitude, frequency, timing, duration, and rate of change of Lake Erie water levels. Multiple scenarios (but not all) predict somewhat lower Great Lakes water levels, with long-term declines on the order of 1 meter within the next 50 to 70 years. In low slope, shallow water areas, the position of the shoreline may shift lakeward by more than 1 km in some areas of the Western Basin. Existing wetland complexes may become hydraulically isolated from the main Lake and new wetlands may form on the exposed lakebed. In shallow embayments and river mouths (such as Sandusky Bay, East Harbor, Sheldon Marsh), there will be an increase in both submergent and emergent aquatic vegetation as lake levels decline.

Potential changes in the seasonal timing of threshold temperatures and spring flood events may alter fish spawning activity in Lake Erie tributaries, and lower water levels may periodically expose the crests of the Western Basin Reefs during extreme low-water events. The Lake will stratify earlier, and hypoxia events in the Central Basin will become more frequent and last longer due to higher surface water temperatures, increased productivity, and a thinner hypolimnion.

Recreational boating access will become more limited, and increased dredging will occur (with associated environmental impacts) in order to maintain navigation and commerce at many Lake Erie ports, harbors, and marinas. These potential impacts coupled with the already significant impacts to the food web, fisheries, and wetland plant communities due to the introduction of invasive species, must be incorporated into future adaptive natural resource management and research strategies. Moreover, there is a pressing need for research to identify critical thresholds or "tipping points" that will result in significant (i.e., unacceptable) detrimental changes to the Lake Erie ecosystem and associated socio-economic impacts. This new research must also include recommendations for long-term environmental monitoring to identify when conditions in Lake Erie are approaching critical thresholds or "tipping points", and also explore potential adaptive solutions to minimize socio-economic and environmental impacts resulting from climate change.

ORGANIC CONTAMINANTS IN LAKE ERIE OFFSHORE WATERS

Chris Marvin

Environment Canada, Burlington, Ontario

Abstract TBA

OXYGEN DYNAMICS IN LAKE ERIE

Gerald Matisoff

Case Western Reserve University, Cleveland, Ohio

This presentation will examine key findings from selected recent studies of oxygen dynamics in Lake Erie. Current work by the speaker and his student (Small) includes biogeochemical modeling to calculate the sediment-oxygen demand (SOD). Model results indicate that macrobenthos increase the SOD by about a factor of 2 over controls for the range of expected bioirrigation rates. Laboratory studies of bioirrigation by mayflies and chironomids were conducted by Edwards, Soster, Matisoff and Schloesser (2009) who found that these organisms periodically irrigate their burrows to flush low oxygen water out of their burrows and thereby increase the sediment-oxygen demand. They report that mayflies increase the SOD by 0.3-2.5 times that of the control at natural population densities and account for 22-71% of the SOD. Conroy, Boegman, Zhang, Edwards and Culver (ms) combined weekly measurements of DO and temperature in the Sandusky Basin with winds peed and tributary discharge in a 2-D hydrodynamic model. They found that with more storms the hypolimnion was warmer, thermal stratification occurred later and autumnal turnover occurred earlier, and that hypolimnetic oxygen demand (HOD) rates increased 12%.

PHOSPHONATES: THEIR OCCURRENCE AND UTILIZATION BY CYANOBACTERIA IN LAKE ERIE

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Phosphonates are organic phosphorus compounds that contain a C-P bond instead of a phosphomonoester bond. Typically viewed as a refractory, less bioavailable form of phosphorus, it has been recently shown that many cyanobacteria can utilize naturally occurring phosphonates as P sources. The herbicide glyphosate (Roundup) is a synthetic phosphonate, and our studies indicate that picocyanobacteria endemic to the Great Lakes can utilize glyphosate as a sole source of P. This raises the possibility that loadings of glyphosate enter the food web as a chemically distinct form of P not accounted for by the Great Lakes Water Quality Agreement. Specifically, PCR data and growth assays reveal that all strains of pelagic Synechococcus spp. tested have the genetic potential to assimilate phosphonates, and most strains can utilize glyphosate. Furthermore, glyphosate is routinely detected by ELISA in samples collected from major tributaries of Lake Erie and in nearshore locations of the lake. Detection coincides with the springtime application of glyphosate. The potential for glyphosate loadings to contribute to eutrophication and to community shifts in the endemic microbial consortium will be discussed.

NITROGEN, PHOSPHORUS, AND ISOTOPES FROM THE NEARSHORE/OFFSHORE LAKE ERIE NUTRIENT STUDY (NOLENS).

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Although the nutrient abatement strategies implemented in the Lake Erie watershed have reduced nutrient inputs to target levels (i.e., ~10,000 tons/yr), not all of the anticipated responses have been realized. The central basin hypoxia event (the 'dead-zone'), extensive *Cladophora* growth in the eastern basin, and repeated outbreaks of nuisance algal blooms in the western basin have all occurred since the reduction in nutrient inputs. We measured nutrient concentrations (N & P) and stable isotope values (δC and δN) in multiple biotic compartments, the water column, and sediments, at multiple depths, and from locations in the eastern and central basins of Lake Erie to provide a snapshot of nutrient pools and to begin assessing nutrient movement among the major pools. The size of nutrient pools in biota varied spatially, and was driven by the density of *Dreissena* mussels. Sediment nutrient levels were highest in the offshore central basin, but not statistically different from other sediment locations. Water column nutrients showed a distinct west-to-east and nearshore/offshore reduction, but location had a significant effect on the seasonal patterns in NS/OS nutrient changes. Phytoplankton values (chlorophyll *a* and cell counts) followed the nutrient patterns (highest in the west, lowest in the east). Nutrient limitation was observed only in the central basin and only in September samples. Stable isotope values suggest a spatial change in water column food chain length both across basins and from NS to OS. West-central basin plankton communities appear to have longer food chains (i.e. largest size fraction has highest δN) relative to eastern basin communities with lower δN values for largest size fraction. A NS to OS increase in δN was also observed at most stations, suggesting food chain length increases offshore. We are still amassing sediment data and continuing to estimate pool sizes and movements.

TYPE E BOTULISM IN THE GREAT LAKES: A WIDESPREAD CONCERN

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Type E botulism outbreaks are becoming a regular seasonal event in most Great Lakes. Characterized by large mortalities of migrating birds in the Spring and Fall, these epizootics also kill numerous local birds and fish that feed in the lakes during the warmer months. This is a disease transmittable through trophic interactions from the bottom-up, therefore, the composition of the sediments and the benthic organisms that inhabit them play a crucial role. Temperature drives many of the processes that take place in sediments, and increasing lake water temperatures may be linked to the spread of type E botulism epizootics in the Great Lakes. Under warm conditions, decomposition and anoxia in sediments provide adequate substrate for *Clostridium botulinum* type E. Modification of the lake substrate by dreissenid mussels may have played a pivotal role in the expansion of habitat for these bacteria by creating pockets of decomposing feces and pseudofeces and sheltering the sediment from exchange with the sediment-water interface. We found that 22% of the mussel tissue sampled contains DNA from *C. botulinum* type E spores, compared with 40% in feces/pseudofeces and 10% in sediments. However, chironomid larvae and oligochetes had much higher levels of spore DNA than the dreissenids. For a type E botulism outbreak to start, food web links need to be present to transmit the spores, cells or toxin to the next trophic level. However, there are some general limnological conditions that preclude the activity of *C. botulinum* in sediments and the potential for an outbreak. These conditions include warm temperatures near sediments (close to 20^{o}C), and a decrease in dissolved oxygen, pH and redox potential. Weather conditions vary from year to year in the Great Lakes region, and the extent and intensity of the epizootics tend to follow these changes.

COOPERATIVE SCIENCE AND MONITORING INITIATIVE: WHERE ARE WE NOW?

Violeta Richardson

Environment Canada, Burlington, Ontario

Abstract TBA

DEVELOPING FISH HABITAT ENHANCEMENT STRATEGIES FOR THE HURON-ERIE CORRIDOR UNDER THE GREAT LAKES RESTORATION INITIATIVE

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Learning from two previous habitat construction projects, Huron-Erie Corridor (HEC) Initiative partners have developed adaptive scientific strategies and techniques to address loss of fish spawning habitat in the HEC (St. Clair and Detroit Rivers and Lake St. Clair). Project goals include restoration of native species spawning and nursery habitats in order to enhance population sustainability, diversity, ecosystem function, and connectivity. Project team members have identified key uncertainties related to the loss of aquatic habitat in the HEC and its immediate watershed. Based on these uncertainties, hypotheses and strategies were developed for prioritizing research and management actions in the HEC that will lead to habitat restoration and address beneficial use impairments.

THE STATE OF THE LAKE ERIE FISH COMMUNITY, 2010

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The Lake Erie fish community continues to undergo changes associated with environmental condition changes. Overall, coolwater species (percid) abundance is similar to levels seen in the late-1980s, however, species composition (yellow perch vs. walleye) has changed. Walleye abundance is declining and walleye are experiencing highly variable recruitment. Yellow perch abundance appears to be more stable, with an apparent shift in yellow perch population productivity from the west basin to the central basin. Managers have established (or are in the process of establishing) Management Plans for both walleye and yellow perch that include predefined harvest strategies and rehabilitation plans. Coolwater species, including lake trout, whitefish, and burbot are showing variable trends. Prey fish abundance appears to be relatively stable in Lake Erie, however, shifts in species composition are evident. Likely trends in ecosystem condition are having a significant impact on overall fish community composition and productivity, with increasing phosphorus and HABs negatively affecting the western basin and potentially causing shifts in species distributions. Exotic species (algae, invertebrates, and fish) continue to have unintended consequences on the fish communities in all basins of Lake Erie.

LAKE ERIE: ALGAE, NUTRIENTS AND DEFICIENCY

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Abstract TBA

BIOLOGY ON ICE: LIFE IN A VERY COLD LAKE ERIE

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The WAMBaM (Winter Assessment of Microbial Biomass and Metabolism) research team has recently completed its fourth season examining limnological parameters in Lake Erie during the winter season (January through April). During winter months this lake supports a moderate to high phytoplankton biomass (2-12 μg Chla L^{-1}) dominated by the microplankton size-fraction, which generally accounts for > 80% of chl biomass. We previously demonstrated microplankton to be dominated by centric diatoms of the species *Aulacoseira* spp. Dissolved nutrient concentrations remained elevated throughout the lake and sub-Redfield N:P molar ratios of seston combined with microcosm incubation assays suggest a P-sufficient phytoplankton assemblage. Whereas the winter assemblage achieved moderate to high rates (2-4 g C g Chl a^{-1} h^{-1}) of total light-saturated primary production, variable chl biomass and light attenuation coefficients, which ranged from 0.5-1 m^{-1}, resulted in widely ranging estimates of areal production from ~100-1500 mg C m^{-2} d^{-1}. These rates of primary production appeared decoupled from microbial activity as bacterial carbon production rates remained low (~ 1% of summertime rates) throughout our observations. When taken in light of estimates of export production derived from sediment traps throughout the lake, the winter diatom bloom suggests a potential role promoting the formation of hypoxia in Lake Erie's central basin.

SOFT SHORELINE ENGINEERING: WE BUILT IT, HAVE THEY COME?

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Historically, many urban river/lakefront shorelines were stabilized and hardened to protect developments from flooding and erosion, or to accommodate commercial navigation or industry (i.e., hard shoreline engineering). Today, there is growing interest in developing shorelines using ecological principles and practices that reduce erosion and achieve the stabilization and safety of shorelines, while enhancing habitat, improving aesthetics, and even saving money (soft shoreline engineering). In 2008–2009, a survey of 36 soft shoreline engineering projects in the Detroit River-western Lake Erie watershed was conducted. In total, $16.5 million was spent on these projects. Of the 36 projects implemented, only six (17%) had any quantitative assessment of post-project ecological effectiveness. The monitoring performed at these six projects with quantitative assessment of ecological effectiveness was undertaken for only one or two years. Experience has shown that there is a need to perform long-term monitoring to fully document ecological results. Clearly, opportunistic monitoring is better than nothing, but greater emphasis must be placed on strategic monitoring based proper assessment, quantitative target setting, and rigorous post-project assessment of effectiveness undertaken as part of an adaptive management strategy. Such post-project monitoring should remain in place for some time as recovery may be slow and adjustments to management actions may be necessary, in the spirit of adaptive management. It would be prudent to treat habitat modification projects as experiments that promote learning, where hypotheses are developed and tested using scientific rigor. The remaining 30 projects lacked monitoring or only a qualitative assessment through visual inspection. Key lessons include: involve habitat experts up front in waterfront planning; establish multiple objectives; ensure multidisciplinary project support; start with demonstration projects and attract partners; involve citizen scientists, volunteers, university students, and/or researchers in monitoring, and obtain commitments for post-project monitoring of effectiveness up front in project planning; measure benefits and communicate successes; and promote education and outreach, including public events that showcase results and communicate benefits.

POSTER ABSTRACTS

TEMPORAL AND SPATIAL PATTERNS OF GENETIC CONNECTIVITY AND DIVERGENCE AMONG LAKE ERIE WALLEYE (*SANDER VITREUS*) SPAWNING GROUPS

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Genetic connectivity and divergence patterns among walleye spawning groups are investigated for temporal and spatial stability from five years spanning 1995-2008 for three river and reef Lake Erie sites. Results are compared with those from a previous study by our laboratory that tested variation among 501 spawning walleye from 11 Lake Erie river and reef sites. That study discerned significant genetic divergence among some Lake Erie spawning groups, and a pattern of connectivity among walleye spawning in 2003 from the Maumee and Sandusky Rivers and Van Buren Bay reef. This new study tests whether a congruent pattern of genetic diversity and connectivity characterize the spawning groups at these sites in 1995, 1998, 2007, and 2008; using the same 9 microsatellite loci and a total of 770 walleye (including 361 previously analyzed in 2003). We also test for congruency among cohorts and between the sexes at given sites, for which the data were available. Relationships were tested using pairwise F_{ST} analogs and contingency tests, AMOVA partitioning, genetic distance trees, and Bayesian assignment tests. Results reveal temporal genetic consistency among walleye groups spawning at given sites, with some differences detected in the Sandusky River for year 2007. Genetic diversity values appear consistent, and no significant differences are detected between the sexes or among year cohort groups within given spawning locations. The relationship among the three sites shows varying patterns of genetic divergence versus connectivity among years. These results indicate that a single year "snapshot" of walleye spawning groups may not adequately characterize their genetic connectivity and divergence patterns, illustrating the importance of understanding temporal stock structure to assist fisheries management.

ASSESSMENT OF MICROCYSTIS NUTRIENT STATUS

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In western Lake Erie, Microcystis biovolume is often greatest in waters that transition from Maumee Bay to offshore. Turbidity and soluble nutrients (nitrogen, N; phosphorus, P) are very high in the transition zone (TZ). Abundant Microcystis biovolume in the TZ suggests that the conditions in these waters support healthier Microcystis with a greater growth rate relative to the open lake. To test this hypothesis, during the 2008 bloom, Microcystis was collected from western Lake Erie for measurements of total protein and cellular nutrient content, as an indicator of growth rate potential and nutrient status. The greatest total protein content occurred in the TZ and indicates Microcystis cellular health is greatest in these waters. N content of Microcystis remained high over the summer, despite very low dissolved nitrate concentrations and low total N-to-total P ratio in the bloom in the lake. Ammonium level in the lake was constant during the summer, and likely provided the N source for Microcystis. Cellular P content was variable over the summer and suggested that Microcystis was moderately P limited, but not extremely deficient. Iron and magnesium quota co-varied with P quota, suggesting a possible co-limitation. Nickel content was 6x greater than typical and may indicate a possible toxicity effect on Microcystis health. TZ waters provide Microcystis conditions that favor rapid growth and cellular health due to the combination of high nutrients and high turbidity.

WIND-DERIVED SEICHES AS A MEANS FOR DETECTING AND MONITORING THE UNIONID COMMUNITY IN THE WESTERN BASIN OF LAKE ERIE

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Wind-derived seiches may be an effective way of detecting and monitoring the unionid mussel community in the western basin of Lake Erie. Atmospheric fronts, moving SW to NE, repeatedly create seiches of a meter or greater that leave large areas of open lake bottom exposed and enable quick detection of unionid mussels, independent of their abundance and density. In two such events (December 2007 and October 2008), we documented eight species of unionids live, all with multiple year classes, and recorded another four species fresh dead, including Ohio state threatened *Obliquaria reflexa* and state species of concern *Truncila truncata*. We documented unionids during seiches along the entire southern shore of Maumee Bay, and in areas on the northern shore of Sandusky Bay, as well as Crane Creek State Park (OH) and Luna Pier (MI) during non-seiche conditions. Many individuals are colonized by dreissenids, albeit at densities much lower than the complete colonization of non-living unionid hard surfaces at these sites. We suggest that novel approaches are needed for detecting and monitoring these native mussels in turbid conditions.

MAPPING THE SPATIAL RELATIONSHIP OF BURROWING MAYFLIES AND DREISSENID MUSSELS IN WESTERN LAKE ERIE

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Hexagenia (burrowing mayflies) recolonized western Lake Erie in the early 1990's providing an optimistic sign of improved water quality and an important food source for fish. However, *Hexagenia* densities may be affected by *Dreissena* (zebra and quagga mussels) distribution on soft sediment. Preliminary mesocosm experiments show that *Hexagenia* prefer *Dreissena*-covered sediments over bare sediment, but this finding has not been examined under field conditions. In this study we mapped *Hexagenia* and *Dreissena* distributions in western Lake Erie collected from multiple sites for four consecutive years (1999-2002). We found that the highest densities of *Hexagenia* (>600/m^2) are found in areas with low *Dreissena* density (<100/m^2). However, over 60% of the sites with *Dreissena* have at least 100 *Hexagenia*/m^2, suggesting that *Dreissena* do not inhibit *Hexagenia* presence. We also found that *Hexagenia* densities in western Lake Erie show high temporal and spatial variability. *Dreissena* clusters on soft sediments was not a preferred habitat at the spatial scale we examined in western Lake Erie, suggesting that different mechanisms affect *Hexagenia* habitat choice at small (mesocosm) vs. large (basin) spatial scales.

EFFECTS OF CONTAMINANTS ON FEMALE REPRODUCTIVE TRAITS IN THE BROWN BULLHEAD (*Ameiurus nebulosus*)

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Aquatic ecosystems are highly resilient to environmental stressors such as contamination. Fish communities are often able to thrive in environments exposed to contaminants well above concentrations known to elicit toxic effects in acute laboratory experiments. While the notion of aquatic resilience to contaminants has been widely acknowledged, the mechanisms driving this resilience at an individual level remain to be understood. We used brown bullhead (*Ameiurus nebulosus*), a bottom-dwelling species tolerant to contaminant effects, to examine relationships between contaminant exposure and female reproductive traits. In 2009, we collected and compared ripe eggs from female bullhead from two contaminated and two clean habitats in the Detroit river area. We measured egg size, fecundity, total carotenoid concentration, and percent lipid concentration and quantified organic contaminants (e.g. PCBs) for each individual. In order to assess whether responses to contamination are due to acclimation or adaption, we compared reproductive traits between individuals caught in 2009 and those caught in 2008 that had been cleared in a clean and novel habitat for one year. This research will help to predict how individuals will respond to future contamination or habitat restoration and thus will be useful for local conservation efforts.

SPATIAL AND TEMPORAL VARIATION IN BURROWING MAYFLY NYMPHS (EPHEMEROPTERA: *HEXAGENIA LIMBATA* AND *H. RIGIDA*) RECOLONIZING THE WESTERN BASIN OF LAKE ERIE

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Beginning in the early 1990s, burrowing mayfly species recolonized the Western basin of Lake Erie after 30 years of hypoxia at the sediment-water interface. Long-term monitoring of adult mayflies at shoreline areas showed that while Hexagenia rigida were much more abundant than *H. limbata* during the initial recolonization period, they have gradually been replaced by *H. limbat*a. We hypothesized that the temporal shift in dominance from *H. rigida* to *H. limbata* would be confirmed by the distribution and abundance of nymphs, which can be distinguished by unique pigmentation patterns (confirmed through genetic analysis). We also hypothesized that the distributions of both species should reflect historical distributions in Lake Erie, with higher densities occurring in the central part of the Western basin. Nymphs that had been collected using Ponar grabs from 41 sites (5 replicates per site) distributed throughout Western Lake Erie, from 1997 to 2004, were identified. The relative abundances of *H. rigida* and *H. limbata* nymphs exhibited the same temporal sequence as adults. In 1997 and 1998, *H. rigida* nymphs were most abundant, while both species showed equal abundance in 1999. Since then, *H. limbata* have become increasingly dominant: in 2004, *H. limbata* represented 90% of all nymphs collected. The distributions of both species remained widespread throughout the basin. However, after 2000, *H. limbata* occurred at more sites than *H. rigida*. Furthermore, the distributions of both species did not reflect historical distributions. Highest densities occurred near the Western end of the basin, indicating the possibility of the Detroit and Maumee Rivers as sources of *Hexagenia* recolonization.

THE DISTRIBUTION OF *LYNGBYA WOLLEI* IN WESTERN LAKE ERIE

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Lyngbya wollei is a nuisance cyanobacterium which appeared in Maumee Bay and western Lake Erie in 2006. *L. wollei* forms dense benthic and floating mats which can negatively impact aquatic life and recreational water use. While prevalent in the southeastern United States, little is known about the distribution, abundance, and effects of *L. wollei* in western Lake Erie. The objective of this study was to record the temporal and spatial distribution of *L. wollei* in the western basin and examine relationships between *L. wollei* distribution and environmental factors such as light, substrate, and nutrients. Surveys were conducted between June-September 2009 over an area of approximately 210 km2. Benthic samples were georeferenced to create a map of *L. wollei* distribution. In addition to *L. wollei* samples, data were collected on substrate type, water chemistry (pH, alkalinity, dissolved oxygen, and nutrients), light attenuation, temperature, and depth. Dry weight of *L. wollei* was recorded in the laboratory. Results indicate widespread distribution of *L. wollei* in the western basin with the most abundant distribution found between depths of 2-4 m. The average biomass of *L. wollei* found between 2-4 m was 9.4 g dry weight/m^2. *L. wollei* was found in areas receiving low light. More than 70% of *L. wollei* was present at benthic irradiance levels lower than 40 $\mu Em^{-2}s^{-1}$. 25% of *L. wollei* was found with *Dreissena* substrate. *L. wollei* biomass was lowest in early summer (2.77 g dry weight/m^2) and increased over the summer (6.82 g dry weight/m^2). These initial data show that factors such as light and substrate play a role in the distribution and abundance of *L. wollei* in western Lake Erie. Studying the distribution pattern of *L. wollei* is important in determining which areas will be most affected by the presence of *L. wollei*.

VIRAL HEMORRHAGIC SEPTICEMIA (VHS) IMMERSION CHALLENGE FOR JUVENILE MUSKELLUNGE USING STaRT-PCR: A QUANTIFICATION STUDY

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Viral hemorrhagic septicemia (VHS) is a very contagious fin fish disease, of which a unique and especially virulent strain (IVb) broke out in 2005 in the Great Lakes killing several economically prominent freshwater fishes: yellow perch (*Perca flavescens*), muskellunge (*Esox masquinongy*), and freshwater drum (*Aplodinotus grunniens*). Despite efforts to reduce detection time with DNA diagnostics, cell culture - a weeks long laborious process - is the only currently approved method to detect VHS (Fig. 1). This project pairs with the University of Michigan (Drs. Faisal and Kim) to compare current detection diagnostics with our new and improved StaRT-PCR (Standardized Reverse Transcriptase Polymerase Chain Reaction) method via an immersion challenge. Our method uniquely employs internal standards, offering increased accuracy and verification over other RT-PCR methods. Duplicates of 45 juvenile muskellunge were challenged at four doses of VHSv-IVb: control (0pfu/mL), low (100pfu/mL), medium (4,000pfu/mL), and high (100,000 pfu/mL). MSU is conducting cell culture to determine if samples test positive or negative and plaque assay/qRT-PCR (quantitative Reverse Transcriptase Polymerase Chain Reaction) for viral quantification, which we are comparing with our new StaRT-PCR method. In addition, we tested 14 spawning walleye samples from the Maumee River for the Ohio Department of Natural Resources (ODNR) with our newly developed in comparison with results from cell culture the Ohio Department of Agriculture (ODA). Results of positives versus negatives were analogous. Our test is projected to benefit aquaculture, hatchery, and baitfish facilities and Great Lakes fishery managers in accurately detecting the presence or absence of the virus within hours.

HABITAT ASSESSMENT AND RESTORATION IN THE HURON-ERIE CORRIDOR

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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 that allows flexibility 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 including lake sturgeon, walleye, and lake whitefish; 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.

FINE-SCALE POPULATION GENETIC STRUCTURE OF LAKE ERIE YELLOW PERCH: ANY RELATION TO MANAGEMENT UNITS?

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Discerning the genetic basis underlying fine-scale population genetic structure of exploited native species, and its relationship to effective management units is a critical goal for effective conservation. Genetic data are essential for evaluating annual to long-term population fluctuations in response to exploitation and environmental stressors, such as habitat loss, pollution, and invasive species. Lake Erie yellow perch Perca flavescens populations have fluctuated due to unstable recruitment patterns and exploitation, and this is the first fine-scale investigation of their genetic structure using high resolution nuclear microsatellite markers. Fifteen loci are analyzed for 569 spawning individuals from 13 Lake Erie spawning sites, in comparison to outlying populations spawning in Lake St. Clair and Lake Ontario. Additional comparisons are made to test for variation between the sexes and among age/size cohorts. Analyses include pairwise divergence comparisons, hierarchical AMOVA partitioning, Mantel regression, genetic distance trees, Bayesian assignment tests, 3-dimensional factorial correspondence, and Monmonier geographic networks. Results demonstrate fine-scale genetic structure distinguishing spawning groups in Lake Erie, showing a primary split between northern and southern littoral regions, and further division between western and central basin spawning groups versus eastern basin sites. The relationships among spawning groups show little congruence to current management units.

GRADUATE TEACHING FELLOWS IN STEM HIGH SCHOOL EDUCATION: AN ENVIRONMENTAL SCIENCE LEARNING COMMUNITY AT THE LAND-LAKE ECOSYSTEM INTERFACE

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Our GK-12 program, Graduate Teaching Fellows in STEM High School Education: An Environmental Science Learning Community at the Land-Lake Ecosystem Interface partners advanced graduate students at the University of Toledo with high school teachers and their students. The objectives are to: 1) Generate student enthusiasm for science careers by engaging them in hands-on research into environmental problems, 2) Exchange knowledge and pedagogies between graduate fellows and teachers resulting in cutting-edge environmental science content and increased teaching and communication skills, and 3) Develop hands-on solutions to environmental problems along schoolyard stream ecosystems feeding the Great Lakes. Participants gain hands-on experience in the role of urban and agricultural influences on watersheds in the history, social development, and future vitality of the Great Lakes region; disseminated through the project website, science fair projects, presentations, and publications. Our schools encompass an urban-suburban-rural gradient, and projects focus on augmenting an existing Student Watershed Watch program that samples water quality in schoolyard streams. Our fellows mentor science fair projects along this and other themes, with many winning regional and state awards. Our program embraces the public scholarship philosophic concept of merging scientific research with civic responsibility to benefit the public and the community.

TOWARDS THE RESTORATION OF RONDEAU BAY'S ECOSYSTEM: ACTIONS IN THE WATERSHED TO REDUCE SEDIMENT AND NUTRIENT LOADS

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Rondeau Bay's ecosystem is a rare jewel on the Lake Erie shoreline. Its long-term sustainability is threatened by chronic, highly-degraded water and sediment quality conditions. A comprehensive ecological assessment, conducted in 2005/06, led to the development of a ten year restoration plan for the entire watershed by the Ontario Ministry of Natural Resources (OMNR). It involved setting nutrient reduction and habitat restoration targets. Strategic management practice changes are required to achieve these outcomes. Among the most important actions taken in this project was the establishment of several sediment and nutrient reduction ponds built to capture and treat drainage waters from agricultural fields. It was also well recognized that land use activities and conditions in the upland watershed regions impact the sediment and nutrient inputs to each of these near shore ponds. Project activities sponsored by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), in partnership with other agencies, area farmers and rural residents, have made on-the-ground changes through a suite of management practices aimed at soil erosion and nutrient loss reduction in these contributing watershed areas. Deployment of these mitigation measures throughout this landscape was aided by LiDAR-based (Light Detection and Range) digital elevation models (DEM's), a detailed agricultural resource inventory (AgRI) and within-field-scale soil erosion modeling with ArcGeoWEPP. Monitoring of the effectiveness and performance of these project activities will help to shape future strategies for similar Lake Erie coastal watershed agri-environmental responses by OMAFRA and its partners.

ECOLOGICAL BENEFITS OF HABITAT MODIFICATION

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2. US Fish and Wildlife Service, Detroit River International Refuge, Grosse Ile, Michigan
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4. Detroit River Canadian Cleanup, , Essex, Ontario
5. U.S. Environmental Protection Agency, Grosse Ile, Michigan

Despite substantial loss of habitat in the Detroit River and western Lake Erie, the area remains critically important for migratory and resident fish and wildlife. Although much has been done to restore lost habitats and improve existing conditions, the ecological improvements resulting from these projects, as well as the cumulative effects of these changes have yet to be quantified or evaluated against goals or targets of existing plans or programs. This paper discusses some of the key findings from 12 case studies of habitat modification presented in a recently released State of the Strait Conference Report. The report concludes: quantitative goals and objectives should direct the selection and implementation of habitat restoration and enhancement techniques, and should provide the benchmarks for measuring project success; monitoring efforts need to remain in place for some time as recovery may be slow and adjustments to management actions may be necessary as part of an adaptive management strategy; habitat management remains a fragmented responsibility among many agencies and interests, which is often an obstacle to realizing ecological improvements, recovery, and sustainability; and knowledge transfer sessions should be convened on a regular basis.

SUB-SURFACE FLOW CAN BE A SIGNIFICANT PATHWAY FOR SOIL PHOSPHORUS LOSS

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Soil phosphorus (P) loss has been historically believed through pathways of surface runoff and erosion. However, recent studies have increasingly evidenced that sub-surface runoff or title drainage can account for 22 to 98% of the total soil P loss. Partition of soil P loss between tile drainage and surface runoff is a function of tile spacing, but the optimum tile spacing can vary with soil types. Particular P often plays an important role in soil P loss in tile drainage water, followed by the dissolved reactive P. Variation of P loss in tile drainage water, including seasonality, magnitude, and relative importance to total soil P loss, is significant. Factors affecting P form distribution and their concentrations and magnitudes of loss in tile water can include those (soil, weather, crop, management practices) that are eventually related to soil P status (i.e. degree of P saturation, solubility), dispersibility, and hydrological properties (i.e. porosity and size distribution, amount of discharge and flow rate). This review paper will discus the up-to-date research findings by using case studies that have been conducted in large field plots equipped with most advanced auto-sampling and monitoring systems.

LIST OF EXHIBITORS

Campbell Scientific

Citizens Against Lake Erie Wind Turbines

Citizens Environmental Alliance

Detroit River Canadian Cleanup

Fishes of Essex County

Great Lakes Fishery Commission

Great Lakes Institute for Environmental Research

Hoskin Scientific

Lake Erie Management Plan

Ontario Ministry of Agriculture, Food and Rural Affairs

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 conferences are held every two years. The goals of the conferences 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 organizations of each convener is also a sponsor of the Millennium Network. The Conveners are:

- The University of Windsor, Great Lakes Institute for Environmental Research
- 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 issues that guide the direction of the Millennium Network. Current sponsors include:

- Campbell Scientific
- DTE Energy Company
- 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 & 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. The 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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