

A stylized map of the Lake of the Woods basin, showing the lake and its tributaries in blue, set against a light green background representing the land. The text 'Lake of the Woods' is overlaid on the map in a large, black, serif font. Below the map, the text '9th Annual - International Water Quality Forum' is written in a smaller, black, serif font.

Lake of the Woods

9th Annual - International Water Quality Forum

Proceedings Report

March 7 - 8, 2012

Rainy River Community College
International Falls, Minnesota, USA

The information contained in this Proceedings report was compiled by the Lake of the Woods Water Sustainability Foundation, on behalf of the Organizing Committee of the 9th International Lake of the Woods Water Quality Forum, from summaries prepared by the Foundation for the March 7 Working Groups, and from the March 7 & 8 symposium poster and presentation abstracts as supplied by the presenting authors.

The text herein does not reflect the official views of the International Joint Commission

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Todd Sellers
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Executive Summary

The 9th annual International Lake of the Woods Water Quality Forum (the Forum) was held March 7-8th at the Rainy River Community College in International Falls, Minnesota. The Forum is the only professional symposium for researchers and resource managers working on research and management activities related to the Lake of the Woods and Rainy River watershed. The Forum's ecosystem focus encompasses all disciplines relevant to water quality and aquatic ecology in the Lake of the Woods and Rainy River watershed. The name of the Forum is perhaps a misnomer – a legacy of first Forum's focus in 2004 on the water chemistry of the lake.

The Forum is organized and hosted by a partnership of agencies led by the Lake of the Woods Water Sustainability Foundation. One hundred and six researchers, resource managers, and policy makers attended this year's Forum – a record attendance. Forum participants reflect a broad range of interests and engagement in the watershed, including representation from agencies of local governments, soil and water conservations districts, provincial and state governments, federal governments, US Tribes, industry and non-governmental organizations – all with the common connection of working on water or water-related issues in the Lake of the Woods and Rainy River watershed.

This year's forum featured focused working groups on March 7th, geared to developing collaboration and information sharing on specific focal areas of research or management activities. The working groups focused on development of a synthesis of the impacts of climate change on the region, development / scoping of a core monitoring program, and a workshop with the Lake of the Woods Control Board focused on improving water regulation in the basin.

Over its nine years, the Forum has become increasingly a “hub” for other groups working in the basin. Many groups, such as the International Multi-Agency Arrangement Working Group and its Technical Advisory Committee and the IJC's 2000 Rainy River and Namakan Lake Rule Curve Review team, take advantage of the Forum as an opportunity to hold collaborative meetings.

The reception and poster session on the evening of March 7th provided a collegial atmosphere to review the day's work, discuss the research poster presentations and develop professional networks. Lana Pollack, Chair –US Section of the International Joint Commission provided the keynote address, focusing on the recommendations contained in the January 2012 IJC “Report to the Governments of the United States and Canada on Bi-national Water Management of the Lake of the Woods and Rainy River Watershed”. The Kallemeyn Award was presented to Lee Grim in recognition of his outstanding professional achievements and contributions to research and resource management in the Lake of the Woods and Rainy River basin. The Wilson Stewardship Award was launched this year to honour the outstanding achievements of individuals, groups, or projects that have made a significant contribution to environmental stewardship in the Lake of the Woods and Rainy River watershed. Presented at the reception to Gerry Wilson and named in her honour, it will be open for nomination each year.

The Poster Session (March 7) and Symposium Presentations (March 8) featured 20 presentation of research pertaining to Lake of the Woods and Rainy River watershed. In addition, the International Multi-Agency Arrangement presented an update on its activities during 2011 and priorities for 2012. A special session on Climate Change focusing on potential impacts and adaptation measures featured keynote addresses from climate experts Dr. David Pearson and Dr. Mark Seeley. Dr. Pearson focuses on broad scale regional to global-scale impacts and Dr. Seeley presented information about climate trends and impacts in northern Minnesota and the Lake of the Woods watershed area. Other major themes of the research presentations included:

- Watershed monitoring efforts and networks.
- Nutrients, algae and bio-monitoring.
- Hydrology and hydraulic modeling.
- Watershed-scale water quality modeling, particularly related to Minnesota's Phosphorus TMDL study for Lake of the Woods.

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Program At A Glance

MARCH 7

13:00 – 17:00 Registration open

12:00 – 13:00 Lunch

13:00 – 15:00 Meetings of individual collaborative groups

13:00 – 14:00 Climate change synthesis paper working group Specific attendance – contact group lead andrew.paterson@ontario.ca

14:00 – 15:00 Core monitoring program – development and scoping General attendance – please just show up

- Meeting rooms are also available for other groups who wish to meet while at the Forum. Contact Todd Sellers tsellers@lowwsf.com to arrange meeting space.

15:00 Break

15:30 – 17:00 Lake of the Woods Control Board: Balancing the Interests

This session is an important opportunity to participate with the Lake of the Woods Control Board to identify water level and flow issues and make recommendations to help the Board improve water level and flow regulation and Board outreach efforts – please plan to attend and participate!

17:00 Break

18:00 – 21:00 FOUNDATION RECEPTION & POSTER SESSION (AMERICINN)

Guest Speaker – Lana Pollack, Chair – US Section, International Joint Commission

Kallemeyn Award Presentation

Student Poster Award Presentation

The AmericInn is the former Holiday Inn across the street from the Rainy River Community College

POSTER SESSIONS – MARCH 7 (AMERICINN) & MARCH 8 (RAINY R. COLLEGE)

The Foundation Reception on March 7th includes the main poster session (at the AmericInn). Posters will also be set up at the College on the 8th as we've done in the past.

1. Water quality on Lake of the Woods, Northwest Angle. [Kayla J. Bowe, Red Lake Department of Natural Resources, Red Lake Band of Chippewa Indians.](#)
2. Estimating Sediment and Nutrient Loading from Southern Shoreline Erosion in Lake of the Woods. [Matt Ribikawskis¹, Stephanie Johnson¹, Corryn Trask²](#)
¹ Houston Engineering, Inc.; ² Lake of the Woods County Soil and Water Conservation District.
3. Lake of the Woods Control Board – The Board, the basin and current lake conditions. [Rick Cousins, Matt DeWolfe, Lake of the Woods Control Board.](#)
4. Ten year watershed monitoring process of the Minnesota Pollution Control Agency. [Michael J. Kennedy, Minnesota Pollution Control Agency.](#)
5. Availability of northern pike breeding habitat in Rainy Lake and Namakan Reservoir. [Anne Timm and Rod Pierce, USDA Forest Service](#)

MARCH 8

08:15 Welcome and Introductions

08:25 SESSION 1 – UPDATES

1. International Multi-Agency Arrangement (IMA) Report.
2. Fishing for answers: Intensive Watershed Monitoring in the Big Fork Watershed. [Erin Andrews](#). [Minnesota Pollution Control Agency](#).
3. Watershed pollutant load monitoring network: Program overview and water quality results. [Patrick Baskfield](#). [Minnesota Pollution Control Agency](#).

9:20 SESSION 2 – CLIMATE CHANGE: From Impacts To Adaptation

4. Keynote 1 – The wet are getting wetter and the dry are getting drier: a climate reality check. [David Pearson](#), [Laurentian University](#), [Sudbury, Ontario](#).

10:00 Break

5. Keynote 2 – Climate change from Impacts to adaptation. [Mark Seeley](#), [University of Minnesota](#).
6. Climate change effects on coldwater fish in Lake of the Woods. [Peter Jacobson](#)¹, [Tom Heinrich](#)¹, [Tom Mosindy](#)², [Don Pereira](#)¹. ¹Minnesota Department of Natural Resources; ²Ontario Ministry of Natural Resources.

11:30 SESSION 3 – NUTRIENTS, ALGAE & BIO-MONITORING

7. The CABIN program: monitoring the benthic macro-invertebrate community as a bio-indicator for Lake of the Woods. [Tim Pascoe](#), [Tana McDaniel](#), [Jeffrey Hanna](#), [Sue Watson](#). [Environment Canada](#).
8. An assessment of the long-term phenology and impact of *Bythotrephes longimanus* in Island Lake Reservoir, Minnesota, using sediment records.. [Ashley E Beranek](#), [Donn K. Branstrator](#). [University of Minnesota Duluth](#)

12:10 Lunch and Poster Session

9. Reconstructing a historical phosphorus budget for Lake of the Woods. [Edlund, M.B.](#)^{1*}, [Reavie, E.D.](#)², [Schottler, S.](#)¹, [Hogarty, D.](#)³, [Wattrus, N.](#)³, [Baratono, N.](#)⁵, [Paterson, A.M.](#)⁴, [Barotono, N.](#)⁵, [Engstrom, D.E.](#)¹
¹St. Croix Watershed Research Station; ²Center for Water and the Environment, University of Minnesota Duluth; ³Large Lakes Observatory, University of Minnesota Duluth; ⁴Dorset Environmental Science Centre, Ontario Ministry of the Environment; ⁵Minnesota Pollution Control Agency
10. Sediment phosphorus fluxes in the Lake of the Woods. [Bill James](#). [U.S. Army Corps of Engineers](#)
11. Characterization of microcystin congeners in water and sediments from Lake of the Woods. [Arthur Zastepa](#), [Pick, F.](#), [Blais, J.](#) [University of Ottawa](#).
12. Satellite monitoring of Lake of the Woods as a tool for assessing lake-wide trends in algal blooms in relation to physical and climate variables. [Caren Binding](#), [Tracie Greenberg](#), & [Robert Bukata](#). [Environment Canada](#)

14:50 Break

15:20 SESSION 4 – HYDROLOGY & MODELING

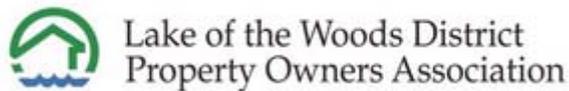
13. Development of a HEC-RAS hydraulic model to describe the movement of water through Namakan Reservoir, Minnesota and Ontario. [Jeffrey Ziegeweid](#)¹, [Brenda Densmore](#)², and [Aaron Thompson](#)³
¹U.S. Geological Survey Minnesota Water Science Center; ²U.S. Geological Survey Nebraska Water Science Center; ³Environment Canada.
14. Estimating the effect of water-level fluctuations on the reproductive success of common loons. [Steve Gutreuter](#)¹, [Steve Windels](#)² and [Ryan Maki](#)². ¹USGS, La Crosse, WI; ²U.S. National Park Service, Voyageurs National Park, International Falls, MN
15. Incorporating change assessment in watershed-scale water-quality modeling applications. [Megan Burke](#). [RESPEC](#).
16. Watershed-scale hydrology and water-quality modeling in Rainy River tributary basins subject to regular timber harvest. [Cindie McCutcheon](#). [RESPEC](#).

16:40 – 17:00 CLOSING REMARKS – LANA POLLACK, CHAIR US-SECTION INTERNATIONAL JOINT COMMISSION

Forum Sponsors – 2012

The organizing committee would like to thank our 2012 sponsor's for assisting with the 9th Annual International Lake of the Woods Water Quality Forum. This event would not be possible without the assistance of the following groups:

- Lake of the Woods Water Sustainability Foundation
- International Joint Commission
- Minnesota Pollution Control Agency
- Manitoba Water Stewardship
- North American Lake Management Society
- Lake of the Woods District Property Owners Association
- Environment Canada
- Rainy River Community College
- St. Cloud State University
- Dorset Environmental Science Centre (OMOE)



Organizing Committee – 2012

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Working Group Meetings – March 7

Climate Change Synthesis Working Group

Given the evidence of climate change occurring in the Lake of the Woods and Rainy River basin area, a working group was held at the 2012 forum to discuss current research as well as the interest in putting together a synthesis paper on the topic. This group of approximately 20 scientists discussed the compelling evidence that the transition zone in which Lake of the Woods is located, is showing early warning signals that climate change is having a fairly significant impact on the number of ice free days, average winter temperatures, ice thickness, amount of precipitation, number and severity of storm events and stream flow. It was discussed that annual temperatures in Kenora have increased by approx. 1.2 degrees in the last 106 years, the highest increase being in the last few decades. Similar signals have been seen in Minnesota with an overall increase of 1-2 degrees per century and this increase more apparent since around 1980. In addition, it has been found that the signals in this region are more obvious in late winter/early spring – over the last 106 years, February temperatures in Kenora have increased by around 5 degrees. These physical changes are affecting the biology of the system by providing more favorable conditions for blue-green algae growth, altering extents of habitat limits because of temperature changes and may be linked to the decline in cisco in Minnesota lakes during the same time period of more advance warming (since the 1970/80s).

There was agreement that developing a peer-reviewed synthesis paper to pull together the research that has been done on this topic in this region would be of benefit. In addition to the work being done by the scientists attending this work group session, the synthesis will also include input from foresters, soil and wildlife scientists. It was agreed that such a paper would serve as a handy citation for researchers who continue to investigate climate change and would also be a useful reference document when applying for funding.

Core Monitoring Working Group

Following on one of the recommendations made in the 2012 IJC report to governments regarding bi-national management of the Lake of the Woods and Rainy River basin, a working group session was held at the 2012 forum to discuss the need and components of a potential core monitoring program for the basin.

“Core monitoring” was defined as a set of common sites that are monitored over the long term by several agencies, First Nations and/or Tribes, working collectively and that must be designed around compelling scientific and management questions. This concept has been supported by the International Multi-Agency Working Group (IMA-WG) and Technical Advisory Committee (IMA-TAC) who prepared a preliminary scoping document for review by the group. The document outlined the need for a core monitoring program in this basin, proposed goals and objectives, the need to determine existing programs, gaps, spatial extent and GIS requirements and the challenges in developing such a program.



The group discussion indicated general agreement that this type of monitoring program is needed in the basin in order to formulate management actions and measure their effectiveness. Suggestions made included the consideration of a communications plan and funding scheme, the inclusion of biota monitoring, partnering with the IJC on this initiative and the need to determine key scientific questions that will drive this monitoring program, at least initially. Feedback on the document was requested within one month's time in order to allow the IMA-TAC to present its recommendations to the IMA-WG for further guidance.

Lake of the Woods Control Board – “Balancing the Interests” Session

As part of their ongoing efforts to enhance outreach around water level regulation, the Lake of the Woods Control Board (LWCB) hosted a working session at the 2012 forum called “Balancing the Interests”. The session was very well attended by forum participants and allowed the LWCB to provide an overview of their mandate, their area of jurisdiction and the variety of stakeholders they consider when making regulation decisions.

Rick Cousins presented on behalf of the LWCB and outlined its area of jurisdiction, objectives, mission, the variety of stakeholders they deal with and the many interests they try to balance. Rick noted that:

- LWCB maintains a website that is reviewed and changed daily with data updates.
- LWCB monitors/maintains 5 gauges on LOW, gathers water level, flow, temperature and precipitation data from many more sites across Winnipeg River drainage basin.
- Commented on IJC recommendations to governments – in support of recommendations but only if resources are provided to do them



The discussions that ensued following the presentation focused on improvements the LWCB is pursuing regarding forecasting technology, suggestions for continued and improved outreach and education, technical questions regarding how the system is regulated and how it responds to natural events in the basin, additions that have been made to the LWCB website to enhance its use for the public and some of the challenges being faced by the LWCB. Specific questions raised and discussion comments during the meeting were as follows:

- **Regulation improvement question, re: modeling and reservoir management?** – Comments were that the Board is hoping to eventually do this for whole basin and that basin-wide hydrology would certainly help. The Board is looking to use a hydrologic model for flow forecasting that has been set up by others for the basin, and using the output from that for a reservoir management model being developed by the Board.
- **How often do the levels get reviewed?** – levels are reviewed every day and can go 2 months without making a change; in high flow conditions, daily changes can be made.
- **How responsive are LOW levels to changes at Norman Dam?** – quite slow...in order to change the lake level by a few inches, change has to be dramatic and over a fairly long period of time.
- **Datum issue and difference in gauges between U.S. and Cdn. Datum?** – research has been done to resolve this, but it wasn't successful.
- **How are impacts on Winnipeg River past the point of jurisdiction of LWCB considered?** – the Board does consider downstream impacts, but are managing the two systems and it is difficult to make everyone happy. The Board tries to consider interests

downstream on the Winnipeg River, but if limits are reached on LOW and Lac Seul, the lakes under jurisdiction take priority.

- **Does the regulation respond well to impacts of heavy precipitation upstream in the basin and its impact downstream?** – managing this well; would benefit by having a good forecasting system, including precipitation forecasts but this requires good modeling and will take time to develop.
- **Post-glacial rebound and its relation to the difference in datums?** – Rick doesn't know how related these are, but difference in measurement between US and Canadian gauges not likely to be largely due to rebound since the differences have been observed for a long time; Kenora is rising 4" per century faster than Warroad and this effects impacts from water levels.
- **What are climate change issues facing water level and flow regulation?** – climate change suggested as a major issue based on bigger convective storms, increased variability, increased evaporation...this makes it tough to make lake level decisions. Long-term climate changes don't affect board operations as much as increased variability within seasons being experienced now.
- **Dams in basin are old – would improving infrastructure also improve response and is it more economically feasible?** – Rick feels enhanced technology probably wouldn't enhance their response capabilities and would be expensive.
- **When were most of the dams put in?** 1892 to 1927 and have been well maintained.
- **Does NOAA provide info on snow and soil moisture?** Yes it is available, but LWCB can't currently utilize that data; snow in the basin affects the freshet but spring rainfall has the biggest impact on summer lake levels; satellite snow surveys are also available to LWCB.
- **How much money is required to get forecasting model?** – \$90,000 over next two years is an estimate (This is a very low cost for this type of work and is only this low due to plans to use a model that has already been set up for the system.)
- **After 2001-2002 high water, there was pressure to make changes to regulation – was anything done?** – after 2001 the LWCB made a commitment to try to hold summer levels 4-6" below summer median peak level to encourage beach replenishment and avoid always high levels; maintain that commitment today. Some interests are more concerned with low water, such as the Board heard last summer at a public meeting in Warroad, where navigation concerns under low conditions were raised.
- **Would partnering with water quality scientists be helpful re looking at intra-lake flows?** – Rick agreed this could be useful.
- **How long is temp data record?** – for some stations, it goes back to turn of the century. Most is public agency data, some Board data.
- **What about precipitation monitoring?** It was noted, that there is not a good rain gauge network for a basin this size. Also, Rick encouraged people living in the watershed to call LWCB with any issues, reports of precipitation events, etc.
- **Has there been a recent recruiting program for volunteer monitoring?** No, but that's a good idea; consider contacting schools to get science classes involved (e.g. Red River Basin Riverwatch program). It was noted that the biggest holes in rain gauge network in watershed is on Canadian side.
- **What is current approach to try to protect fishery and spawning?** – biggest tool LWCB has is the agency biologists in the basin – speak weekly to them during spring flow; want to try to set the flow in April and keep it static for 6 weeks and this way, flow on Winnipeg R won't change that much; delay any reductions until spawn is done on the

river. Also, it was reported that H2O Power have agreed to no peaking during the spawning season May 15 – July 15 window – no longer voluntary – it will be done on the Canadian side.

- **Outreach – how can this be improved?** LWCB doesn't get to the U.S. as often as Kenora – suggestion made that LWCB try to get a seat on the IMA-WG. Also, Feedback form is now available on the LWCB website in order to garner more feedback from people at this forum specifically.
- **Is there an email list of those who would like regular updates?** No but the Board may be ready to do this if there is enough interest. It was suggested that use of webinars be considered. Also, the Board would like to enhance the participation of groups at their in-person meetings by netmeeting.
- **How often does LWCB put something into local publications?** – not very often; they have great success at the LOWDPOA Cottage Show and advertise yearly in Area News magazine, speak to local newspapers – suggestion made to talk to local radio stations after a big storm. Todd Sellers remarked that LWCB communication with public is better than any other similar organization in the basin, but cautioned to be careful saying that having better forecasting will solve everything

Overall, the session was a success in that it provided good information to a wide audience, some of whom were unaware of how the LWCB works, and it provided creative ideas for the LWCB to pursue in their efforts to improve regulation and the balancing of that regulation for the many interests in the basin.

Foundation Reception and Poster Session

The Lake of the Woods Water Sustainability Foundation hosted the reception and poster session on the evening of March 7. The reception provided a collegial atmosphere for Forum attendees to carry on discussion of the day's work, and foster professional networking and collaboration.

Guest Speaker – Lana Pollack, IJC Chair US-Section

Lana Pollack US-Section Chair of the International Joint Commission was the Foundation's guest speaker at the reception. During her address, Commissioner Pollack reviewed the key recommendations for bi-national water management of the Lake of the Woods and Rainy River watershed, contained in the Commission report submitted to the Governments of the United States and Canada on January 27, 2012. Commissioner Pollack also spoke to next steps required for implementation of these recommendations and the importance of civic engagement in ensuring that governments act on the recommendations.



Lana Pollack, IJC Chair US-Section

Kallemeyn Award

Lee Grim was the recipient of the 2012 Kallemeyn Award, presented at the 9th International Lake of the Woods Water Quality Forum, held March 7-8 in International Falls.

The Kallemeyn Award is presented annually by the Lake of the Woods Water Sustainability Foundation, to recognize the outstanding professional achievement in scientific research or resource management in the Lake of the Woods and Rainy River Basin. This peer-recognition award is named in honor of its first recipient, Larry Kallemeyn, USGS Voyaguers National Park (retired), who throughout his career, made significant contributions to scientific understanding, resource management and collaborative and cooperative approaches in the watershed.

The selection committee for the Kallemeyn Award consists of researchers and resource managers from both Canada and the United States. It was their unanimous recommendation that Lee's well rounded contributions and strengths as an educator, researcher and steward of the ecosystem epitomized the values represented by the award.

Larry Kallemeyn was on hand to personally present the award to Lee Grim on behalf of the Lake of the Woods Water Sustainability Foundation. In presenting the award, Larry cited many of Lee's contributions including his ability to talk with and connect with all people – scientists, members of the public and first nations and tribal peoples and find common ground. In addition Larry cited Lee's numerous other achievements including his:



Larry Kallemeyn (l) presents the Kallemeyn Award to Lee Grim (r). This year's award plaque was accompanied by a carving of a burbot, carved and donated by Bev Clark, recipient of the Kallemeyn Award in 2009.

- Work as a resource biologist for 39 years in Voyageurs National Park and in particular Lee's work to establish long-term monitoring and research programs for bald eagles, ospreys, and great blue herons.
- Influence as a biology instructor who imparted an enthusiasm for the natural world on generations of students and local residents, many of whom were inspired to pursue careers in natural science or resource management.
- Volunteer service on the International Joint Commission's (IJC) International Rainy Lake Board of Control and the IJC's International Lake of the Woods and Rainy River Watershed Task Force, where his efforts to obtain information, gain consensus, and engage the community in decision making has contributed greatly to the success of the Rainy Board and development of a watershed governance model for the future.

Lee joins the ranks of previous recipients of the Kallemeyn Award, including:

- 2011 - Tom Mosindy, Ontario Ministry of Natural Resources
- 2010 - Nolan Baratono, Minnesota Pollution Control Agency
- 2009 - Bev Clark, Hutchinson Environmental Services
- 2008 - Larry Kallemeyn, USGS Voyageurs National Park (retired)

Wilson Stewardship Award

The Foundation launched a new award at the reception this year, to honour the outstanding achievements of individuals, groups, or projects that have made a significant contribution to environmental stewardship in the Lake of the Woods and Rainy River watershed through:

- Education, outreach, civic engagement and participation in stewardship initiatives or program development.
- Projects or programs focused on protection, restoration, preservation or reduction of environmental impact and development of sustainable practices.

The award is named in honour of its first recipient, Gerry Wilson, who was on hand at the reception to accept the award consisting of a plaque and original painting donated by Kenora artist Melissa Jean.

Gerry served as Executive Director of the Lake of the Woods District Property Owners Association from 1992 to 2008. During this time, Gerry grew the membership of the association – waterfront property owners – from about 900 to over 4,000 and mobilized the membership to become involved in shoreline protection and water quality protection. Gerry instituted programs for septic re-inspection, water quality sampling and algae monitoring, including organizing a volunteer water quality monitoring program for the Lake of the Woods, Winnipeg River and many small lakes in the region, as part of the Ontario Ministry of Environment's Lake Partner Program.

Gerry was instrumental in developing solid working relationships between property owners and key organizations including Ontario Hydro, Ministry of Natural Resources, Ministry of Environment, Lake of the Woods Control Board, the local Chamber of Commerce and the municipalities that surround the lake. In addition, she began the annual tree seedling program



Gerry Wilson (at right) recipient of the first Wilson Stewardship Award, named in her honour, poses with Lee Grim, recipient of the Kallemeyn Award (at left).

that has seen over 500,000 trees planted in the Lake of the Woods region since its inception. When algae started to become more of an issue on Lake of the Woods, Gerry enlisted the help of algal taxonomist, Hedy Kling, to take samples and report back on the status of algae toxicity. She played a key role in the organization of the first Lake of the Woods Water Quality Forum in 2004 and was also involved in bringing the International Joint Commission to Lake of the Woods in 2004 for the initial fact finding tour.

As publisher and editor of the Lake of the Woods Area News Magazine since 1992, Gerry continues to make a major contribution to educating and engaging property owners in stewardship and protection of the Lake of the Woods and surrounding lakes and rivers in the region.

Poster Session

The poster session was held during the reception again this year, providing an opportunity for attendees to meet with presenters and discuss their results.

Poster displays included:

- Water quality on Lake of the Woods, Northwest Angle – Kayla Bowe, Red Lake Department of Natural Resources, Red Lake Band of Chippewa Indians.
- Refining the Lake of the Woods nutrient budgets: A focus on shoreline erosion and tributary contributions – Stephanie Johnson et al, Houston Engineering
- Lake of the Woods Control Board: The Board, the basin and current lake conditions –Rick Cousins and Matt DeWolfe
- Ten year watershed monitoring process of the Minnesota Pollution Control Agency –Michael J. Kennedy, MPCA
- Availability of northern pike breeding habitat in Rainy Lake and Namakan Reservoir – Anne Timm and Rod Pierce, USDA Forest Service



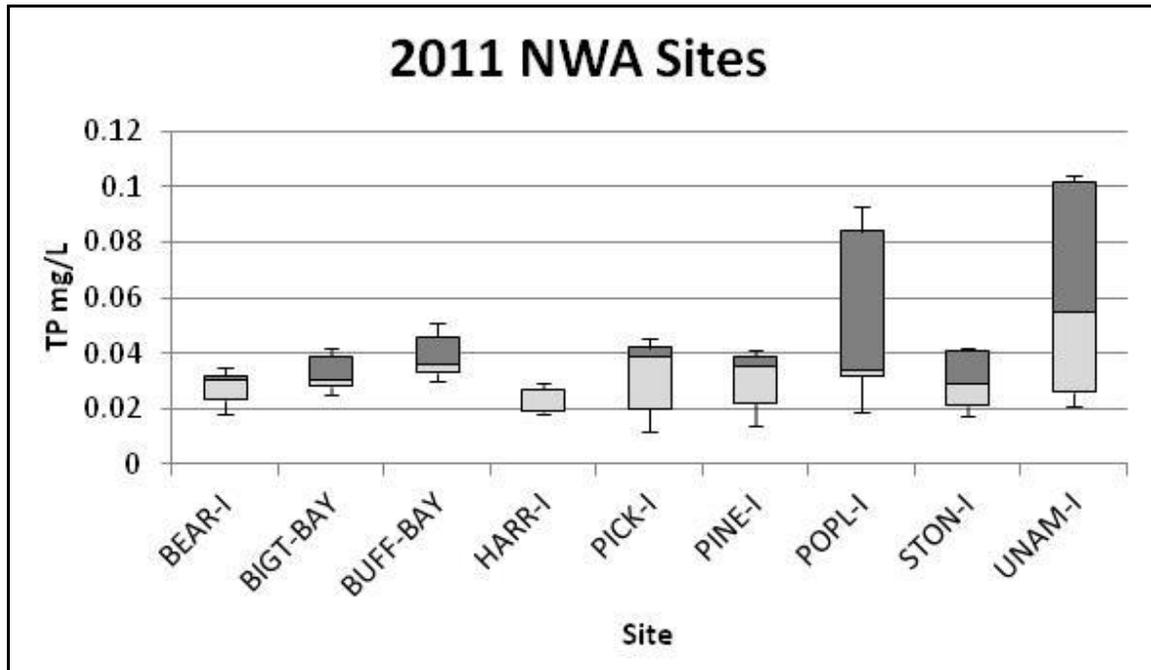
Anne Timm, USDA Forest Service, discusses her research into Availability of northern pike breeding habitat in Rainy Lake and Namakan Reservoir

Poster Abstracts

Water quality on Lake of the Woods, Northwest Angle

Kayla J. Bove

Red Lake Department of Natural Resources, Red Lake Band of Chippewa Indians
15761 High School Dr, Red Lake, MN 56671, 218-679-1607, kbowe@redlakenation.org



Abstract

The Red Lake Department of Natural Resources of the Red Lake Band of Chippewa Indians, a signatory to the International Multi-Agency Working Arrangement for Lake of the Woods, continued water quality monitoring efforts during the 2011 sampling season on Lake of the Woods, Northwest Angle streams. Seven streams and two open water lake sites at the Northwest Angle were sampled. Five sampling events took place beginning in May 2011. Typical physical and chemical water quality parameters were sampled at all sites. The collection of flow data and deployment of depth level loggers occurred at four stream sites. Data show overall high water quality of Lake of the Woods at Northwest Angle sites indicating low nutrient input from these stream sites. Sampling efforts for the 2012 season will include the same parameters but likely at a reduced rate due to the completion of a project-specific grant.

Estimating Sediment and Nutrient Loading from Southern Shoreline Erosion in Lake of the Woods

Matt Ribikawskis¹, Stephanie Johnson¹, Corryn Trask²

¹ Houston Engineering, Inc., 140 – 6901 East Fish Lake Rd, Maple Grove, MN 55369

² Lake of the Woods County Soil and Water Conservation District, P.O. Box 217, 119 1st Avenue NW, Baudette, MN 56623



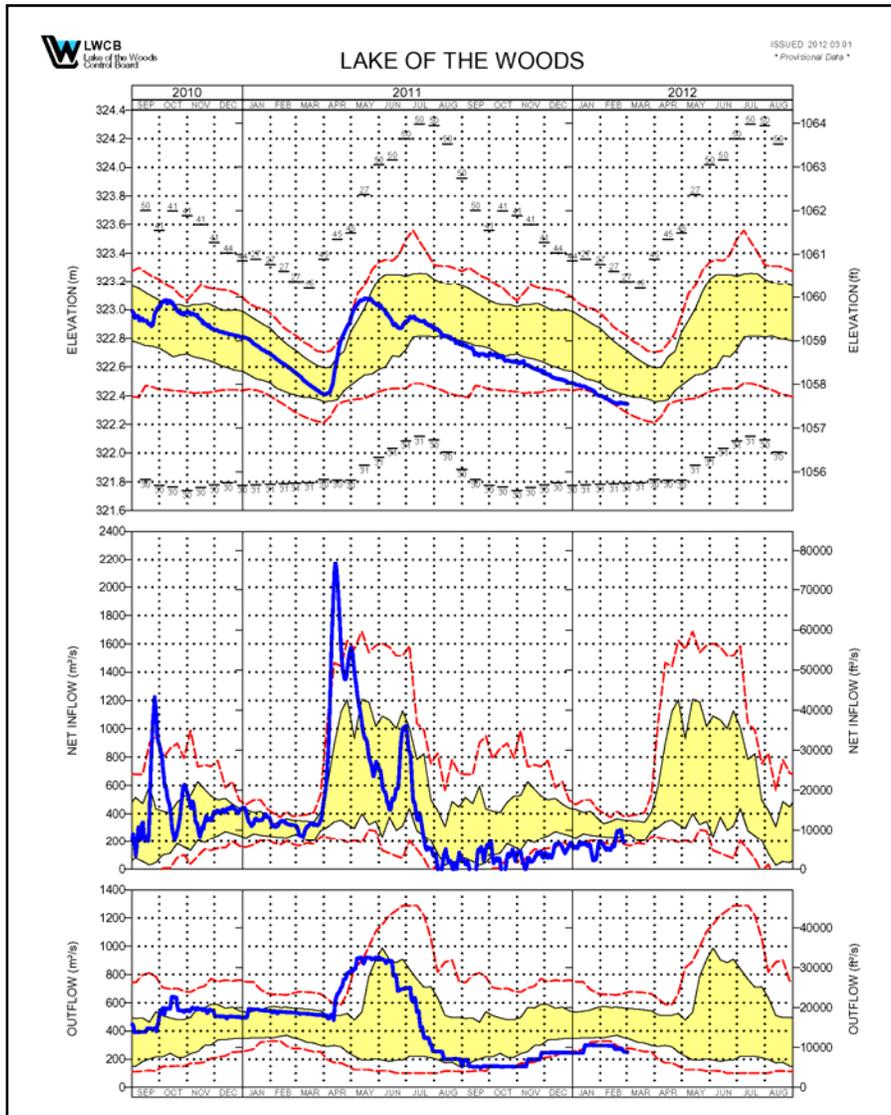
Abstract

The southern shoreline of Lake of the Woods (LOW) is experiencing significant erosion problems. This erosion threatens unique fish and wildlife habitat that provides refuge for a number of federally threatened and endangered species. The eroding sediments are also, likely, a consequential source of nutrient loading to the lake, which is impaired for eutrophication and biological indicators. The goals of this research include: identifying areas of major shoreline erosion between 1940 and 2009; developing a method to classify physical shoreline characteristics that correlate to erosion; and estimating the volume of erosion occurring along the LOW southern shoreline. Initial analyses show that shoreline areas with bank heights of less than five feet and within mucky soils have a relationship with high erosion. Furthermore, portions of the shoreline are dynamic with recession and deposition occurring between the years 1940 and 2009. Future tasks of this project include: estimating the volume of sediment that has eroded into LOW from the southern shoreline; computing annual erosion rates; conducting nutrient sampling and analysis of near-shore soils to estimate nutrient loads due to erosion; and updating nutrient and sediment budgets for the US portion of LOW.

Lake of the Woods Control Board – The Board, the basin and current lake conditions

Rick Cousins and Matt DeWolfe

Lake of the Woods Control Board Secretariat, Ottawa ON K1A 0H3 / 800-661-5922 / www.lwcb.ca



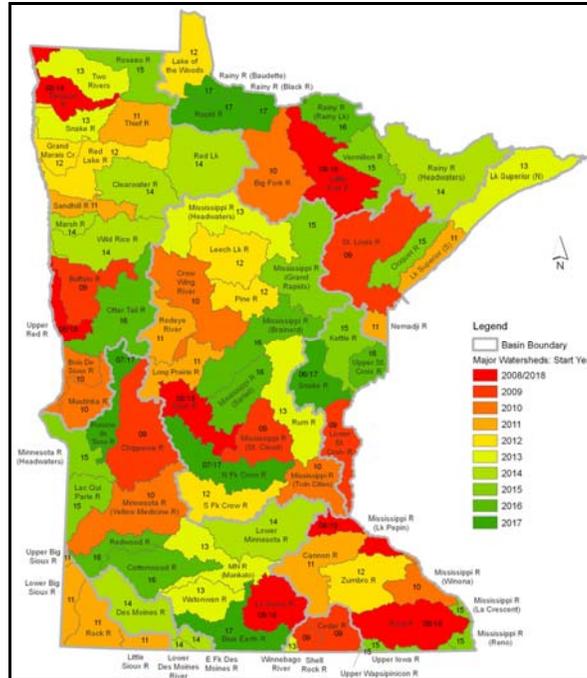
Abstract

In 1912 the International Joint Commission was directed through a reference from Canada and the United States to study management of water levels on the Lake of the Woods. This study eventually led to a United States-Canada treaty in 1925 for the regulation of the lake. In anticipation of the treaty, the Lake of the Woods Control Board (LWCB) was established by Canada in 1919 to regulate the water levels of Lake of the Woods and the flows in the Winnipeg River. The Board's informational display presents the mandate of the LWCB, a brief description of the basin, how the lake is managed and current water level and flow conditions for Lake of the Woods and the Winnipeg River. The Board is assisted in fulfilling its mandate by its full-time Secretariat that monitors conditions in the basin, provides information and analysis, and recommends regulating strategy and specific outflows. It also implements the Board's adopted strategy, conducts studies and maintains communications with basin users.

Ten year watershed monitoring process of the Minnesota Pollution Control Agency

Michael J. Kennedy

Minnesota Pollution Control Agency, Northeast Regional Office, 525 Lake Ave. S., Ste 400, Duluth, MN 55802 mike.kennedy@state.mn.us



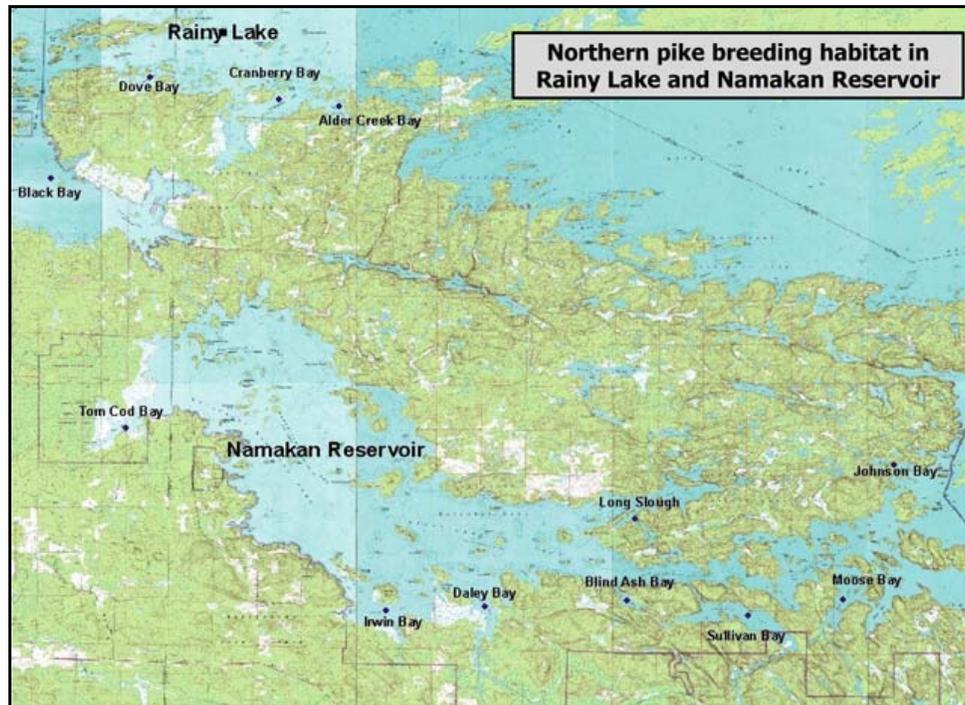
Abstract

Starting in 2008, the MPCA began an aggressive schedule to monitor and assess all waters of the state through its Major Watershed Restoration and Protection Planning. This effort, targeted at the Eight-digit HUC scale, includes 14 major watershed in Northeastern Minnesota. Learn about this new process and the schedule of which watershed will be addressed and when the action starts in your area! The goal of this new systemic approach is to intensively examine these large scale watersheds and develop strategies with local partners to protect high quality waters and develop restoration actions for degraded waters. Special emphasis will be the Rainy River Basin watersheds of Big Fork, Little Fork, and Lake of the Woods.

Availability of northern pike breeding habitat in Rainy Lake and Namakan Reservoir

[Anne Timm](#) and [Rod Pierce](#)

USDA Forest Service, Northern Research Station, 1831 East Highway 169, Grand Rapids, MN 55744



Abstract

The International Rainy Boards 2000 "Rule Curves" should expand the range of elevations covered by emergent aquatic vegetation that would be available as northern pike spawning habitat in Rainy Lake and Namakan Reservoir by providing a summer drawdown and earlier spring water level rise. The main objective of this study is to compare predicted northern pike spawning and nursery habitat, using water level, temperature, and aquatic plant Arc GIS data to field sample data to verify that larval and young-of-the-year (YOY) northern pike are using predicted habitats. This study will expand larval light-trapping, YOY trap-net sampling, and aquatic plant stem density sampling within Rainy Lake and Namakan Reservoir to identify specific characteristics for highly productive breeding habitat. Light-trapping data from Dove Bay, Rainy Lake and Sullivan Bay, Kabetogama Lake, 2011 suggests that high breeding success is associated with mean water levels ≥ 337.4 meters in Dove Bay and ≥ 340.5 meters in Sullivan Bay. Preliminary comparisons of seining, electro-fishing, and trap-netting methods for YOY sampling suggests that trap-netting is the most effective with July, 2011 counts ranging from 4 in Daley Brook Bay, Kabetogama Lake to 36 in Alder Creek Bay, Rainy Lake.

Presentation Abstracts

International Multi-Agency Arrangement – 2011-2012 Update

Todd Sellers

IMA Work Group Member – Lake of the Woods Water Sustainability Foundation, Box 112, Kenora, ON P9N 3X1

Accomplishments 2011
<ul style="list-style-type: none">• P budget thesis – published (J. GL. Res.)• Historical nutrient loading project – underway• Internal P loading tech report – completed• Shoreline erosion / loading study – underway• Common database – nearing completion• Core monitoring scoping – under development• Revised 5 yr work-plan – under review• Intensive watershed assessment (B. Fork; L. Fork)• Forum –10th anniversary coming

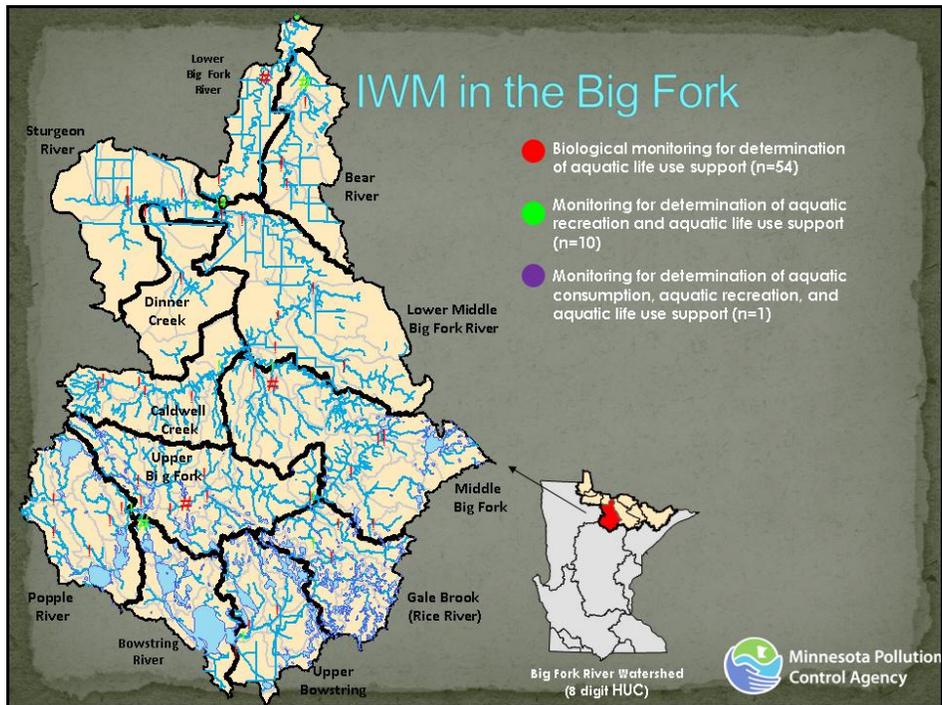
Abstract

The International Multi-Agency Working Arrangement (IMA) is a framework within which partners and stakeholders can actively engage in coordinated activities to help protect and restore water quality in LOW. The purpose of the IMA is to foster trans-jurisdictional coordination and collaboration on science and / or management activities to enhance / restore water quality in the Lake of the Woods Water Watershed (Lake of the Woods and Rainy River Basins). In May 2009, nine organizations signed on as members of the IMA, including: Environment Canada, Lake of the Woods Water Sustainability Foundation, Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, Ontario Ministry of the Environment, Ontario Ministry of Natural Resources, Manitoba Water Stewardship, Red Lake Band of Chippewa Indians, and the United States Environmental Protection Agency. An update on collaborative activities during 2011 and plans for 2012 and beyond is presented. The IMA structure consists of a Work Group, which is a manager-level committee charged with overall IMA development, approval of workplans and projects and seeking funding for collaborative projects. The Technical Advisory Committee (TAC) is a staff level group providing advice to the Work Group. The TAC is working through its ad hoc subcommittees on addressing a communications plan, data gaps, five-year work-planning (currently focused on nutrient work), and development of a core monitoring program scoping draft. Implications are discussed for the IMA of the recent IJC Report to the Governments of the United States and Canada on Bi-national Water Management of the Lake of the Woods and Rainy River Watershed. Major accomplishments to date, and priority next steps for 2012 are presented.

Fishing for answers: Intensive Watershed Monitoring in the Big Fork Watershed

Erin Andrews

Minnesota Pollution Control Agency



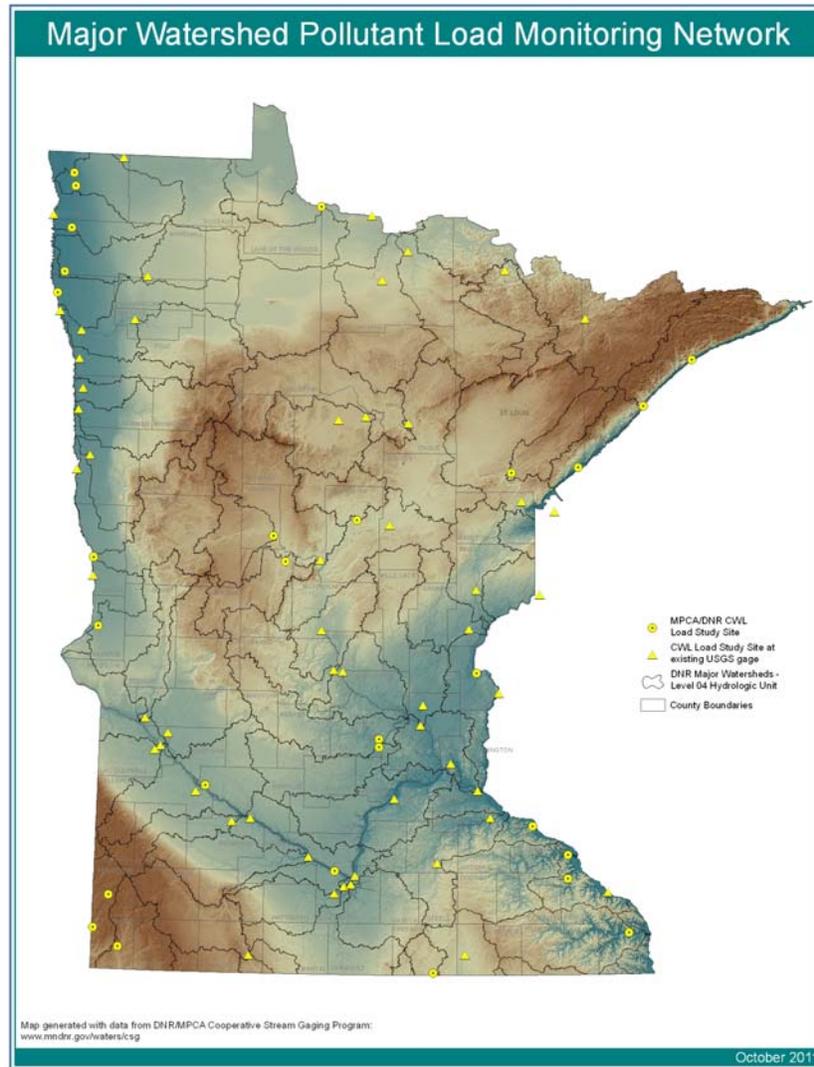
Abstract

In 2010, the Minnesota Pollution Control Agency (MPCA), supported by clean water funds, conducted an intensive survey of the Big Fork River Watershed as part of the state's Intensive Watershed Monitoring Program. The study involved a systematic approach of sampling the outlets of watersheds of varying size, collecting fish, macro invertebrates and water chemistry data to obtain sufficient information required for assessments to determine whether or not water quality standards for aquatic life, recreation and consumption are met. A holistic picture of the IWM process and preliminary assessment results will be presented. In addition, a sneak peak of the agency's plans in 2013 for the Lake of the Woods watershed will be offered along with an update on the Little Fork Watershed.

Watershed pollutant load monitoring network: Program overview and water quality results

Patrick Baskfield

Minnesota Pollution Control Agency, 12 Civic Center Plaza, Suite 2165, Mankato, MN 56001
pat.baskfield@state.mn.us



Abstract

The MPCA administered Watershed Pollutant Load Monitoring Network (WPLMN) was designed to measure and compare regional differences and long-term trends in water quality among Minnesota's major rivers including the Red, Rainy, St. Croix, Minnesota, and Mississippi and the outlets of major tributaries (eight digit hydrologic unit code [HUC] scale) draining to these rivers. The purpose of this presentation is to give an overview of the program's design, and statewide data generated to date.

Keynote 1 – The wet are getting wetter and the dry are getting drier: The challenge of adapting to a changing climate.

David Pearson

Laurentian University, Sudbury, Ontario

Abstract

On Earth Day 2011 the Ontario government released “Climate Ready”, its strategy and 37 actions for adapting to climate change based on recommendations from an expert panel. The province’s Environmental Commissioner has released a critique of the government’s plan, calling for priorities and methods of evaluating the proposed actions. These initiatives have put the province in a strong position relative to other jurisdictions. Several extreme weather events that are likely to be typical of future climate have stimulated action in cities in Ontario. The Peterborough Flood of July 2004 and Toronto’s Finch Avenue storm in August 2005 that cost over \$500 million were salutary, as was the Rainy River flooding in June 2002. These events may well have led to the design of a recent Walmart parking lot in Guelph that uses a collector system to remove oil before storm water is released into the water table from infiltration reservoirs below the surface of the lot. Infiltration avoids overloading culverts while recharging the city’s aquifer. Temperature records indicate winter nights and spring days are warming most in southern and central Ontario. The resulting shorter winters are projected to see no snow left on the ground in March by mid century.



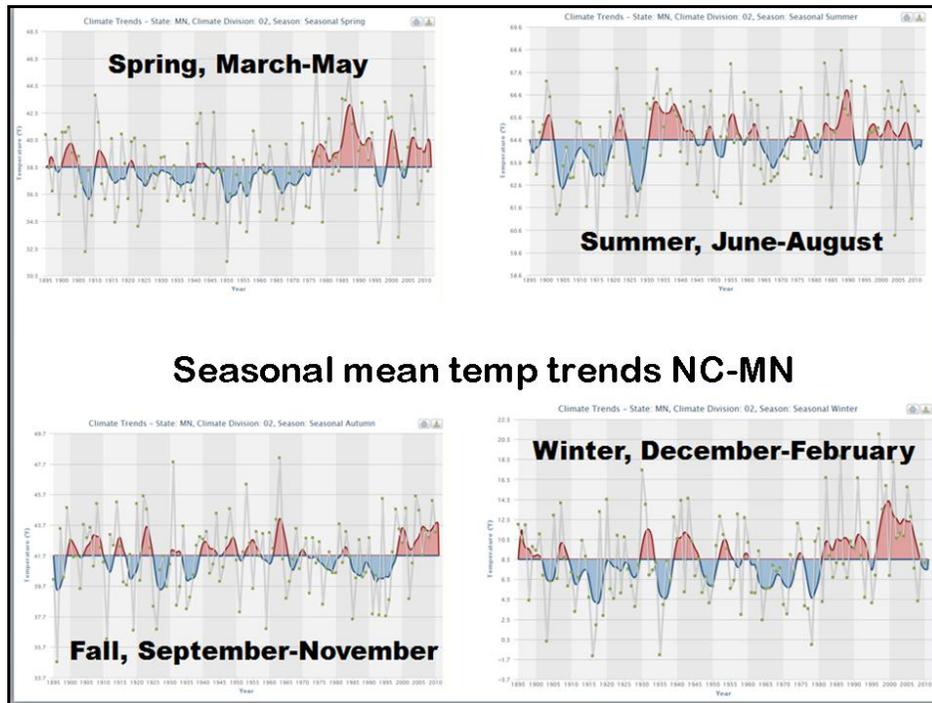
Hudson Bay is losing 7 – 8 days of ice cover per decade. This loss is very significant for regional temperature and precipitation in Far North Ontario because of warming and evaporation from open water. It is possible that change is or will occur at the boundary of the polar cell and the mid-latitude cell, possibly involving the jet stream which has been very fragmented during the last 6 weeks of change. Isolated Far North Ontario communities will be very challenged to adapt to the projected changes in winter temperature and precipitation.

Examples of adaptation seen in Canada include research on hydrophobic nanotechnology coatings on transmission pylons to reduce ice storm damage; polymers in cement to reduce freeze-thaw damage; selected winter wheat seeds with extendable roots able to withstand soil freezing; holding water back on farmland to increase dry season soil moisture; extra height under the confederation bridge to accommodate sea level rise. Vancouver and Halifax will be especially challenged by sea level rise because of regional land subsidence. Computer simulation of adaptation options has been used in discussion of adaptation options in Vancouver. Regional climate adaptation organizations like SaskAdapt have promoted many science-based local adaptation projects dealing with rangeland issues, urban forestry in Edmonton, and water conservation in Regina. In the end, however, it is important to realise that there is a limit to adaptation and that attacking the root cause in the form of greenhouse gas reduction agreements is urgently required.

Keynote 2 – Climate change from impacts to adaptation

Mark Seeley

University of Minnesota Extension Meteorologist and Climatology, Dept of Soil, Water, and Climate



Abstract

Minnesota's climate data certainly illustrates relatively recent and significant environmental change. These changes are not only evident in measurement statistics, but also in the character of our weather and climate episodes. There is widespread agreement among climate scientists that three regional climate attributes are changing: temperatures are warming, most pronounced in the winter season, and in overnight values (minimum); there are more frequent spells of sultry weather produced by tropical-like dewpoints that lead to high Heat Index Values in the summer; and precipitation is becoming more variable, and generally increasing. These climate trends are clearly linked to measurable consequences that are already being observed, and have serious implications. Perspectives on these climate trends and observed consequences in Minnesota are shared in the context of the Rainy River watershed. Without question ignoring or dismissing these changes in climate behavior across the region would be a mistake relative to managing our water resources.



Climate change effects on coldwater fish in Lake of the Woods

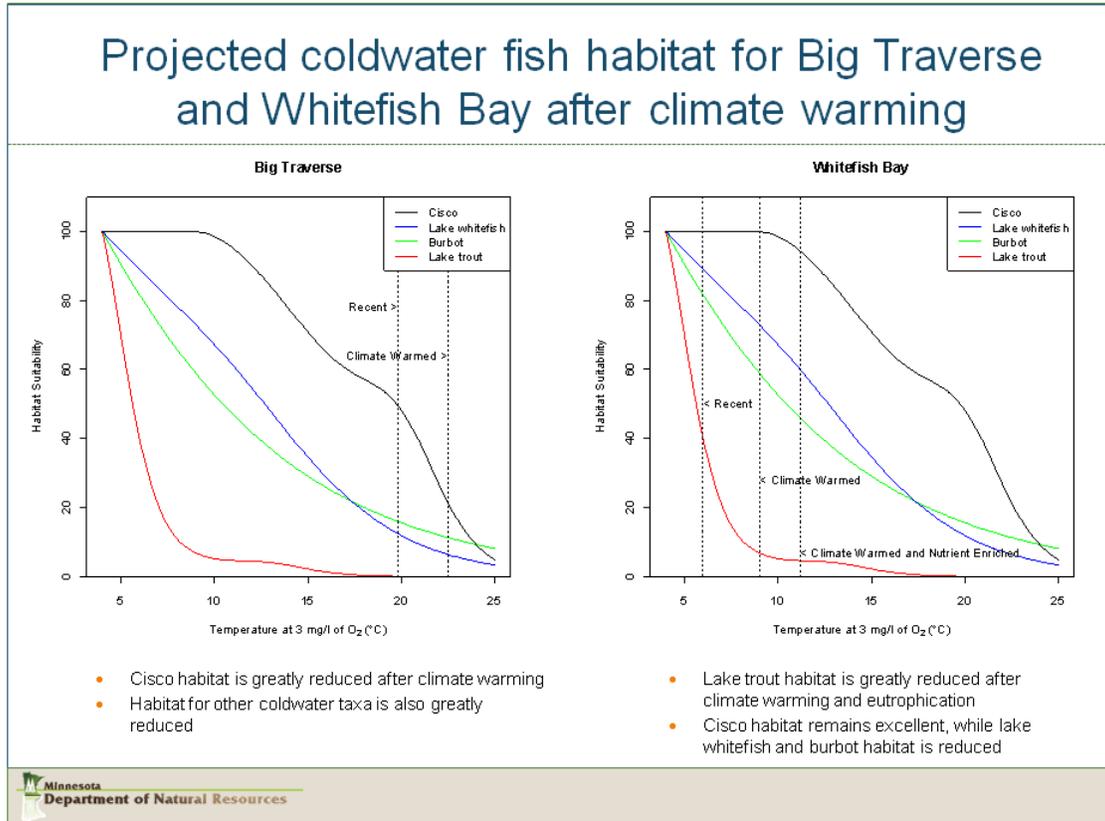
Peter Jacobson¹, Tom Heinrich², Tom Mosindy³, Don Pereira⁴

¹Minnesota DNR, 27841 Forest Lane, Park Rapids, MN 56470;

²Minnesota DNR, Baudette Area Fisheries Office, 204 Main Street East, Baudette, MN 56623;

³Ontario Ministry of Natural Resources, Lake of the Woods Fisheries Assessment Unit, Kenora, ON

⁴Minnesota DNR; Box 20, 500 Lafayette Rd., St Paul, MN 551554020



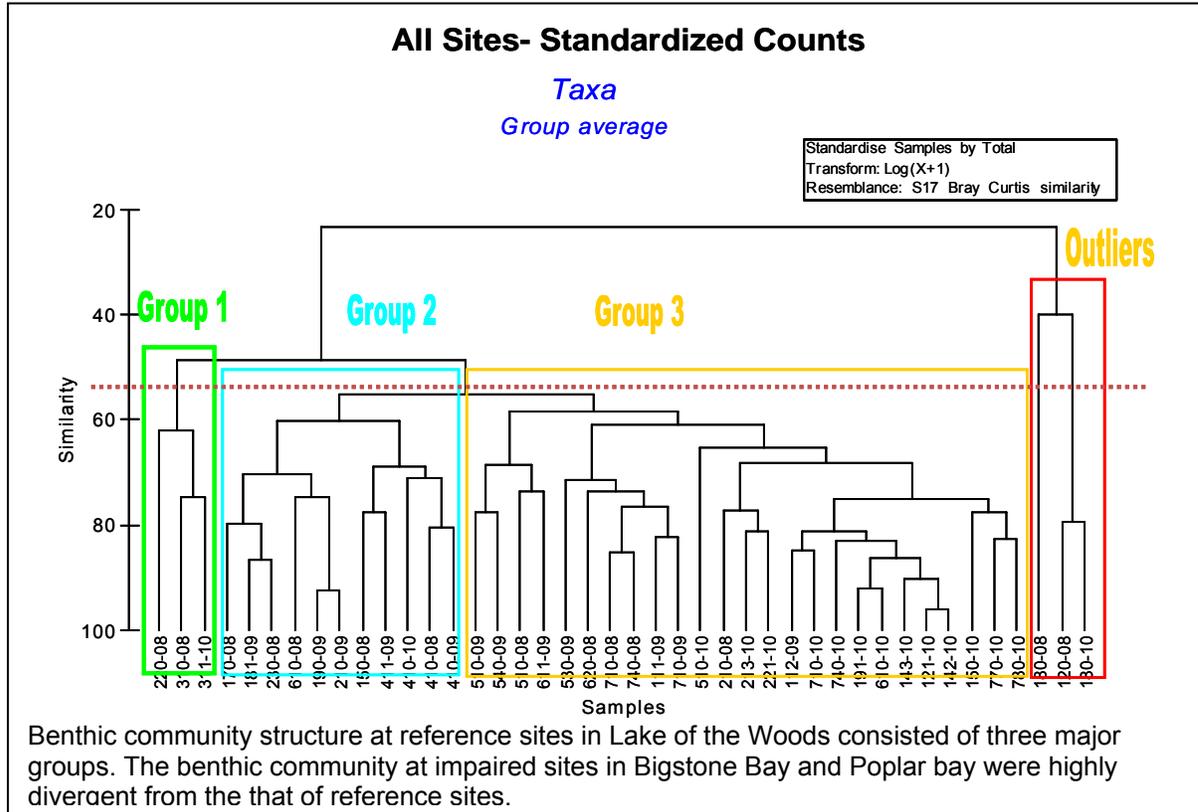
Abstract

Climate change is expected to have a profound impact on coldwater fish in North American lakes. Specific effects for coldwater fish in Lake of the Woods will depend on individual basin morphometry and productivity. We will present the results of modeling coldwater thermal habitat in two distinct basins of Lake of the Woods: Big Traverse and Whitefish Bay. Big Traverse is large, shallow, productive and isothermal, while Whitefish Bay is deep, thermally stratified, and less productive. Future, climate-warmed habitat conditions for cisco *Coregonus artedii*, lake whitefish *Coregonus clupeaformis*, burbot *Lota lota*, and lake trout *Salvelinus namaycush*, will be projected in both basins and possible adaptation strategies will be discussed.

The CABIN program: monitoring the benthic macro-invertebrate community as a bio-indicator for Lake of the Woods.

Tim Pascoe, [Tana McDaniel](#), Sue Watson

Environment Canada, Science and Technology Branch, PO Box 5050, 867 Lakeshore Rd E, Burlington, ON L7R 4A6



Abstract

Environment Canada’s Canadian Biomonitoring Network (CABIN) provides an integrated national approach for collecting, managing, assessing and distributing information on the biological condition and biodiversity of aquatic ecosystems in Canada. Assessment of the benthic macro-invertebrate community of LOW, through CABIN, compliments our physical and chemical water quality monitoring program by providing an effect-based indicator of biological response. The Reference Condition Approach links benthic habitats to biological communities by establishing reference conditions and was used to identify sites within the lake where the benthic community was indicative of stress.

Sediment composition, chemistry, water quality and benthic macro-invertebrate structure were sampled at 31 off-shore stations within major basins of LOW over a three year field program. Offshore benthic habitats varied within the lake, with thermal stratification in deep northern basins resulted in low concentrations of dissolved oxygen. Persistent organic pollutants such as PAHs and PCBs were present at low concentrations in LOW sediments, however, concentrations of nutrients and some metal species (Ni, Cu, Cr, Ni, Mn) exceeded provincial sediment quality guidelines at more than eighty percent of stations. Preliminary analysis of off-shore benthic communities noted a reduction in diversity in deep northern basins where dissolved oxygen was low and concentrations of metals and nutrients in the sediments were elevated. The goal of this program is to develop a baseline CABIN reference model for Lake of the Woods which can be utilized for tracking temporal trends and assessment of condition in the future.

An assessment of the long-term phenology and impact of *Bythotrephes longimanus* in Island Lake Reservoir, Minnesota, using sediment records

Ashley E. Beranek, [Donn K. Branstrator](#)

Department of Biology, University of Minnesota Duluth, Duluth, MN 55812.



Abstract

Bythotrephes longimanus, a predacious zooplankter, has invaded >130 inland lakes in North America, yet few studies have documented the long-term phenology and impact of an invasion. This study used *Bythotrephes* spines and *Daphnia ephippia* in ^{210}Pb -dated sediment cores from four sites in Island Lake Reservoir (Minnesota, United States) to document the establishment and growth of the *Bythotrephes* population and to examine corresponding changes in daphnid species composition and density during a 40-year period spanning the invasion. Based on sediment evidence, *Bythotrephes* invaded the reservoir in 1982, or 8 years prior to what was its first detection in the water column in 1990. If accurate, this makes Island Lake Reservoir the first documented inland lake invaded in North America. Year to year population density of *Bythotrephes* followed a logistic growth model, and generally took about 10 years to reach annual carrying capacity. A notable impact of *Bythotrephes* on the daphnid community occurred within the first few years but did not intensify with increased *Bythotrephes* density over time. Daphnid species composition shifted in the western basin toward *D. mendotae* dominance, but did not shift in the eastern basin. The reservoir maintained a population of its largest-bodied daphnid, *D. pulex*, despite *Bythotrephes* presence. Coincident with *Bythotrephes* invasion, mean daphnid ephippium size decreased both within species and for the whole 3-species daphnid assemblage. This research suggests that lakes could harbor *Bythotrephes* for years before its first detection in the water column, that annual population build-up of *Bythotrephes* may require years before reaching peak annual densities, that the impact of *Bythotrephes* on food webs occurs relatively quickly, and that long-term impacts of *Bythotrephes* in a reservoir may be less severe than in natural lake ecosystems.

Reconstructing a historical phosphorus budget for Lake of the Woods

Edlund, M.B.¹, Reavie, E.D.², Schottler, S.¹, Hougardy, D.³, Wattrus, N.³, Baratono, N.⁵, Paterson, A.M.⁴, Engstrom, D.R.¹

¹St. Croix Watershed Research Station, Science Museum of Minnesota, Marine on St. Croix, MN 55047

²Center for Water and the Environment, Natural Resources Research Institute, University of Minnesota Duluth, 1900 East Camp Street, Ely, MN 55731; ³Large Lakes Observatory & Department of Geological Sciences, 10 University Dr., Duluth MN 55812; ⁴Dorset Environmental Science Centre, Ontario Ministry of the Environment, 1026 Bellwood Acres Road, P.O. Box 39, Dorset, ON, P0A 1E0; ⁵Minnesota Pollution Control Agency, 909 Riverside Drive/International Falls, MN 56649



Abstract

Lake of the Woods (LoW) is known to have elevated levels of the phosphorus (P) in comparison to other lakes within the Precambrian Shield, and is well-known for its extensive cyanobacterial blooms. While both of these characteristics have some historical precedence, monitored inputs of P loads from the Rainy River, the primary source of P to LoW, have decreased in the last 30 years as point source loadings have declined. Yet, comparison of monitored water quality variables between the 1980s and 2000s shows little change in concentrations of most nutrients. Furthermore, paleoecological evidence in Canadian waters of the northern part of the lake record little change in diatom-inferred P values. In contrast, cyanobacterial blooms, especially in the southern basin, are perceived to be more frequent and of greater spatial coverage than in previous decades, suggesting that there may be a strong legacy effect of nutrient availability from sediments. Alternative mechanisms, such as warmer temperatures or a longer ice-free season, may also be fueling blooms. To address this problem, we are studying the historical nutrient dynamics in LoW by constructing a historical P mass balance using whole-basin reconstruction techniques. Historical loading of P to the lake – the record of importance to resource managers – is calculated for each decade by the sum of P historically lost from the outflow and P burial in the sediment. We are mapping the depositional zones of the southern lake basins using seismic-reflection profiling and taking sediment cores from strategic locations in the lake. Cores are dated using radioisotopes (²¹⁰Pb, ¹³⁷Cs, ⁷Be), subfossil diatom communities are studied to reconstruct water column P concentrations, and P is extracted from sediments and measured for each depth increment. The historical burial of P will be estimated for each basin and summed for the entire lake by decade. Phosphorus lost through the outflow of the lake is calculated using historical diatom-inferred P in the water column, based on sediment cores, and multiplied by the historical outflow. Initial seismic work shows that the southern basins of the lake contain about 2 m of LoW sediment overlying up to 12 m of Glacial Lake Agassiz clays but also extensive non-depositional regions where fine-grained sediments are not presently accumulating. Preliminary cores show sediments to be highly inorganic with low linear sedimentation rates and a sediment interface well mixed down to 2 cm, characteristics that have strong bearing on modern and historical nutrient dynamics.

Sediment Phosphorus Fluxes in the Lake of the Woods

William F. James

ERDC Eau Galle Aquatic Ecology Laboratory, W500 Eau Galle Dam Rd, Spring Valley, WI 54751

Abstract

Sediment cores were collected in September, 2011, for determination of sediment textural and chemical characteristics and rates of diffusive and equilibrium phosphorus (P) fluxes from bottom and resuspended sediments in the Lake of the Woods system. Intact sediment cores were collected from stations located in the eastern and western basin of Big Traverse Lake, and in Muskeg and 4-Mile Bay. The upper 10-cm sediment layer at all stations exhibited relatively high moisture content ($> 60\%$) and a particle size distribution dominated silts and clays. Big Traverse Lake sediment had the highest clay content at $\sim 50\%$ versus $< 25\%$ for Muskeg and 4-Mile Bay. Sand content was $< 7\%$ at all stations. Sediment total P concentrations were modest, ranging between 0.64 and 0.76 mg g^{-1} . Biologically-labile P (i.e., the sum of the loosely-bound, iron-bound, and labile organic P fractions; subject to recycling and biological uptake) accounted for ~ 30 to 50% of the total P. Iron-bound P represented ~ 45 to 60% of the biologically-labile P.

Diffusive P fluxes from sediment were relatively high under anaerobic conditions (8.3 to $12.5 \text{ mg m}^{-2} \text{ d}^{-1}$) and coincided with moderately high concentrations of iron-bound P in the sediment. In contrast, aerobic diffusive P fluxes were over 20 times lower. Nevertheless, rates under aerobic conditions ranged between 0.2 and $0.6 \text{ mg m}^{-2} \text{ d}^{-1}$. Sediment total Fe concentrations were high at ~ 15 - 20 mg g^{-1} for Muskeg and 4-Mile Bay and $\sim 30 \text{ mg g}^{-1}$ for Big Traverse Lake. The sediment Fe:P ratio exceeded 25. These patterns suggested that diffusive P flux from sediments in the Lake of the Woods was probably coupled with oxidation-reduction reactions associated with Fe cycling.

Equilibrium P studies indicated that sediments probably act as a sink for phosphate and bind P during resuspension events when aqueous concentrations exceed ~ 0.01 to 0.02 mg L^{-1} as soluble P. The equilibrium P concentration for sediment in the Lake of the Woods system ranged between near zero and only 0.013 mg L^{-1} . The linear adsorption coefficient (k_d) was high (~ 700 to $3,200 \text{ L kg}^{-1}$), suggesting a high buffering capacity for soluble P during P disequilibrium (i.e., deviations from the equilibrium P concentration). Binding sites on sediment particles were also undersaturated with respect to P, as suggested by Langmuir isotherm analysis.

Simulated resuspension experiments indicated that sediment critical shear stress (i.e., force required to initiate sediment resuspension; dynes cm^{-2}) was relatively low (1.3 - $2.3 \text{ dynes cm}^{-2}$), indicating a high potential for resuspension during wind-generated shear stress. Soluble P concentrations in the overlying water column were $\sim 0.020 \text{ mg L}^{-1}$ during simulated resuspension and close to the independently measured equilibrium P concentration.

Preliminary total P budgets for the Lake of the Woods have suggested that tributary P loadings do not account for total P concentration and mass balance, implying that internal P loading sources to the system that may be driving algal productivity. Overall, the present research suggested that diffusive and equilibrium soluble P fluxes from sediments are relatively low, suggesting that a portion of the total P imbalance might be due to additional sources such as resuspended sediment that are not directly available for algal uptake. Future P budgetary and modeling analysis need to consider the *availability* of both tributary loads and internally-derived P sources for algal uptake (i.e., soluble versus total P flux to the water column) in order to better understand and target P sources that are driving algal productivity in the Lake of the Woods.



Characterization of microcystin congeners in water and sediments from Lake of the Woods

[Arthur Zastepa](#), Pick, F., Blais, J.

University of Ottawa



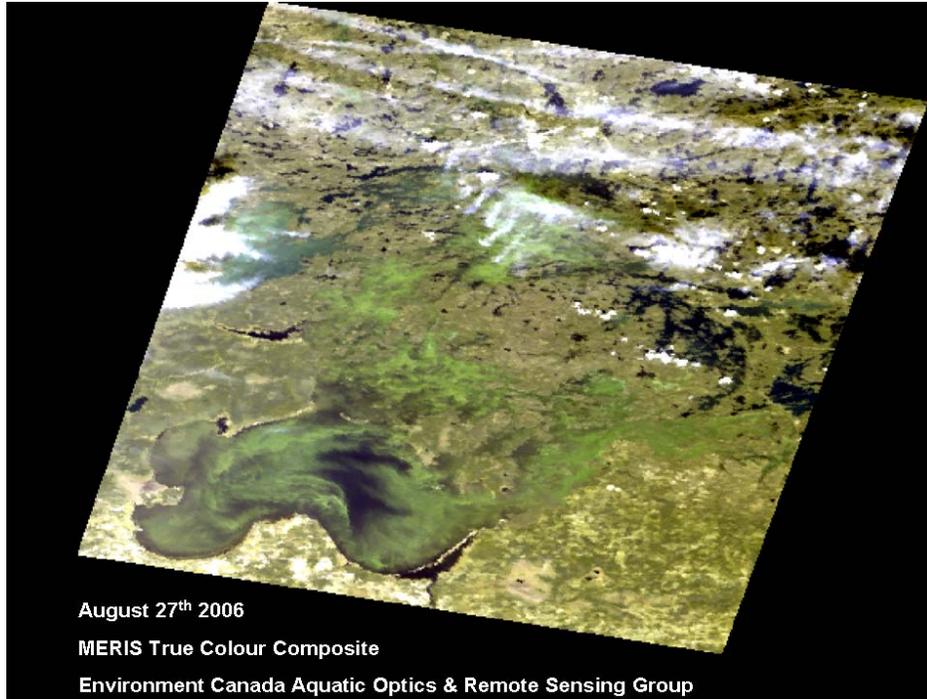
Abstract

Toxic cyanobacterial blooms have received much attention in the last decade due to increased public awareness and a perceived increase in their frequency and severity. Although significant paleolimnological work has been done to reconstruct water quality (DI-TP) and climate history in Lake of the Woods, only recent advances in cyanotoxin detection have afforded the opportunity to put this apparent increase of toxic blooms into a historical context. Lacking long-term monitoring data of cyanotoxin concentrations, we investigated the possibility of using cyanotoxins, potentially preserved in sediment, as a proxy for historical water column concentrations. The most fitting cyanotoxins are a family of hepatotoxins called microcystins because of their common production by toxigenic blooms, persistence under both laboratory and environmental conditions, and ability to adsorb to sediment. Hence, we developed a method to extract and analyze nine microcystin congeners (RR, YR, 7dmLR, LR, WR, LA, LY, LW, and LF) as well as nodularin in sediment matrix using accelerated solvent extraction (ASE) followed by LC/MS/MS quantitation. The method was also validated on sediment spiked with toxigenic cultures to simulate extraction of microcystins from intact cyanobacterial cells deposited into lake sediment. In July 2010, we visited Rat Portage, Bigstone Bay, and Hay Island locations at Lake of the Woods and found water column concentrations of microcystin-LR and -LA in the range of 0.2-1.3 ug/L and 0.1-1.6 ug/L. Detectable levels of microcystin-YR and -7dmLR were also measured at Bigstone Bay and Hay Island. Preliminary measurements at the sediment-water interface (13, 23, and 23 m depth) also found 0.02-1.08 ug/L microcystin-LR at all three sites suggesting presence in surficial sediment. At Hay Island, microcystin-LA was additionally observed at 1.05 ug/L at the sediment-water interface. We will apply the ASE-LC/MS/MS method to selected sediment core samples, focusing initially on surficial and deep sections, to assess the potential to reconstruct a sediment core profile of microcystin congeners based on Pb-210 dating.

Satellite monitoring of Lake of the Woods as a tool for assessing lake-wide trends in algal blooms in relation to physical and climate variables

[Caren Binding](#), [Tracie Greenberg](#), & [Robert Bukata](#)

Environment Canada, Water Science & Technology Directorate, 867 Lakeshore Road, Burlington, ON, L7R 4A6 caren.binding@ec.gc.ca



Abstract

The remote location of Lake of the Woods combined with the hydrologically complex nature of its waters, makes adequate *in situ* monitoring of the lake difficult and costly. Satellite imagery from the European Space Agency's MERIS sensor is shown to be successful in detecting and tracking the evolution of algal blooms on Lake of the Woods. Evidence is presented suggesting that day to day wind-induced mixing of cyanobacteria has a considerable impact on the surface biomass that can be detected by a satellite sensor. Imagery is analysed over the period 2003-2010 in order to address the commonly raised concern that algal blooms on the lake have been increasing in recent years. Trends in bloom characteristics (intensity, timing, and aerial extent) are analysed in relation to local climate variables, offering important new insights to the mechanisms driving algal bloom occurrences on the lake.

Development of a HEC-RAS hydraulic model to describe the movement of water through Namakan Reservoir, Minnesota and Ontario

Jeffrey Ziegeweid¹, Brenda Densmore², and Aaron Thompson³

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Abstract

Namakan Reservoir includes Namakan, Kabetogama, Sand Point, Crane, and Little Vermilion Lakes. Water levels are controlled by privately owned dams but regulated according to rule curves established by the International Joint Commission. Rule curves were developed to satisfy several legally recognized water uses. Water levels are monitored by streamgages on Crane Lake and the outlet of Namakan Lake near Kettle Falls. However, during periods of substantial inflow, water levels at Kettle Falls and Crane Lake may differ by as much as 1.0 ft (0.3 m), and such discrepancies in water levels complicate efforts to satisfy legally-recognized water uses throughout the reservoir. Therefore, better understanding the flow of water through the lakes of Namakan Reservoir could help water managers generate options for water level regulation that would more consistently provide satisfactory conditions for multiple water uses. In this study, we investigate how narrows between the lakes may constrict water movement and create transitory changes in water levels and travel times among lakes. Bathymetry data and velocity transects were collected in Little Vermilion, King Williams, Harrison, and Namakan Narrows during August 2011. Bathymetry data were collected using a multi-beam echosounder, and velocity transects were collected using an acoustic Doppler current profiler (ADCP). Both the echosounder and the ADCP were coupled with a real-time kinematic global positioning system to provide accurate position and elevation data. Pressure transducers used to collect water-level data were deployed in Little Vermilion Lake, Sand Point Lake above Harrison Narrows, and Sand Point Lake below Harrison Narrows from August 2011 to November 2011. Transducers will be re-deployed in spring 2012, and a transducer will be added in Namakan Lake below Namakan Narrows. Bathymetry, velocity, and stage data that are collected by the U.S. Geological Survey will be given to Environment Canada for development of a HEC-RAS hydraulic model that will provide a better understanding of how the narrows affect water levels throughout Namakan Reservoir.

Estimating the effect of water-level fluctuations on the reproductive success of common loons

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Abstract

The ultimate goal of this study is to predict effects of the 2000 Rule Curve on the reproductive success of common loons on Rainy Lake and the Namakan Reservoir Complex. Common loons are iconic summer residents of north temperate and subarctic lakes. Loons nest along lake shorelines, and their nests are vulnerable to flooding during water-level rises. Nesting rafts are commonly used to mitigate adverse effects of water-level fluctuations. However, the effect of water-level fluctuation has not been investigated over a broad spatial scale. We obtained data from the volunteer LoonWatcher (LW) and Minnesota Loon Monitoring (MLMP) Programs, managed by the Minnesota Department of Natural Resources, and used records from lakes of at least 405 ha (1000 acres) from which there were at least three years of recordings of loon nestings and at least six recordings of water-surface elevations during the presumptive 60-day nesting seasons. We also data from Kabetogama, Namakan, Rainy and Sand Point Lakes of Voyageurs National Park (VOYA), yielding a total of 656 lake-years of loon counts. Loon observations from the MLMP included counts of adult loons and fledged chicks, and observations from LW and VOYA also included counts of nesting pairs. The numbers of daily water-level recordings varied from 6-60 among lakes, and were used to estimate the maximum daily rate of water-level rise and its variance for each combination of lake and year. Eagles may be an important predator on loon chicks, and therefore we used data from the Wisconsin Bald Eagle and Osprey Surveys as a regional index of eagle abundance. We are developing hierarchical Bayesian statistical models to estimate the effect of water-level rises on the reproductive success of loons, measured as the numbers of fledged chicks per nesting pair. A multiple imputation model is used to estimate missing pair counts from adult counts. The models include the maxima daily rates of water-level rise and the eagle index as covariates. The models include the measurement errors in the maxima daily rates of water-level rise, and among-lake sources of variation in baseline reproductive success. Preliminary results indicate that, across all lakes, there is approximately an 80% probability that water-level rises adversely affect the reproductive success of common loons. Reproductive success was also influenced by the regional abundance of bald eagles and the day of the year of ice break up.

Incorporating change assessment in watershed-scale water-quality modeling applications

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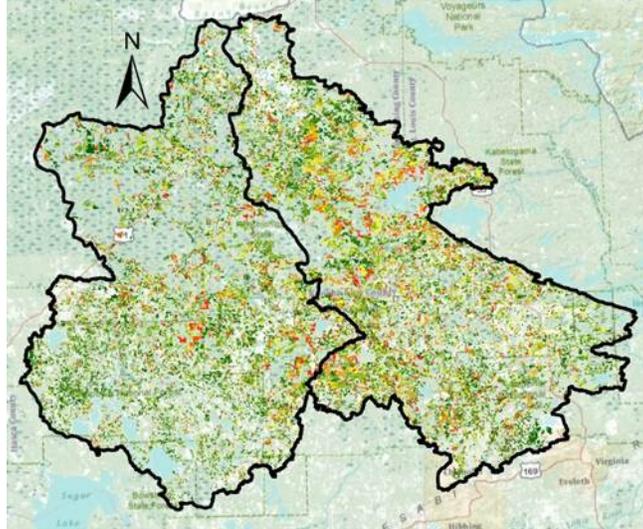
Abstract

With approximately 40 percent of Minnesota's waters listed as impaired, including sections of the Lake of the Woods, the state of Minnesota adopted a holistic watershed-scale approach to monitoring, assessment, and Total Maximum Daily Load (TMDL) development. The **Hydrological Simulation Program-FORTRAN (HSPF)** modeling package is one of the primary tools employed by the Minnesota Pollution Control Agency (MPCA) to accomplish this task. **HSPF** is a premier, comprehensive watershed model of hydrology and water quality and is currently being used to conduct watershed assessments at (the 8-digit Hydrologic Unit Code (HUC) level) throughout the state. Once initial assessments are made, understanding how future changes in land use, management practices, and climate will potentially impact the coupled hydrologic and chemical response will be critical for managing water resources, understanding ecosystem impacts, and developing mitigation strategies. An overview of the development of an **HSPF** model application for two tributary basins of the Lake of the Woods (Big and Little Fork Rivers) will be presented with a focus on how the model can be adjusted to represent future changes through parameterization (land development, Best Management Practice (BMP) scenarios) and by using the **BASINS Climate Assessment Tool** (climate change).

Watershed-scale hydrology and water-quality modeling in Rainy River tributary basins subject to regular timber harvest

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Abstract

The **Hydrological Simulation Program-FORTRAN (HSPF)** model was used to model hydrology and water quality in the Little Fork and Big Fork Watersheds that drain the Rainy River and Lake of the Woods Basin. **HSPF** is considered a premier, high-level model among those currently available for comprehensive watershed assessments and is a primary tool used by the Minnesota Pollution Control Agency (MPCA) in their holistic approach to watershed-scale monitoring, assessment, and Total Maximum Daily Load (TMDL) development. The Little Fork River Watershed has multiple turbidity-impaired stream segments while the Big Fork River Watershed has no turbidity-impaired streams and three nutrient-impaired lakes. Both watersheds are subject to regular timber harvests, and the model application was designed to represent impacts of these practices on watershed hydrology and water quality. Forest and woody wetlands are two dominant land use categories in these watersheds. Because regular timber harvest is occurring in these dominant land uses, and because timber harvest can alter runoff volumes and timing, a method was developed to ensure that changes in forest age were represented in the model. This presentation will focus on the techniques and methods used in the Little Fork River and Big Fork River Watershed model applications, including the representation of timber harvest, and will discuss initial hydrology calibration results.