



Proceedings of the

15th Annual



**International
Rainy-Lake of the Woods
Watershed Forum**

March 7 - 8, 2018

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 15th International Rainy-Lake of the Woods Watershed Forum, from summaries of presentations and from the March 7 & 8 symposium poster and presentation abstracts as supplied by the presenting authors.

We are grateful to the International Joint Commission for financial support to prepare this report.

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

Todd Sellers
Executive Director
Lake of the Woods Water Sustainability Foundation

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Executive Summary

Lake of the Woods and its watershed went under the microscope at the 2018 International Rainy-Lake of the Woods Watershed Forum, March 7-8 at the Rainy River Community College in International Falls, Minnesota. The auditorium was jam-packed with close to 170 researchers, resource managers and policy makers – a record attendance!



Dr. Brenda Hann, U. Manitoba, presents to a near-capacity crowd, providing details on hotspots of the invasive spiny water flea in Lake of the Woods and the threats they may pose to our lakes.

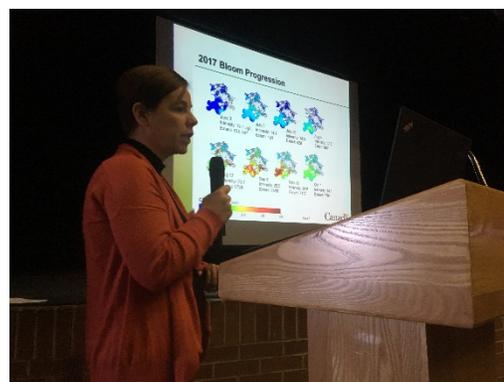
Participants reflected a broad range of interests and involvement in the watershed, representing 72 organizations, including local governments, soil and water conservation districts, provincial and state governments, federal governments, U.S. Tribes, Canadian First Nations, the International Joint Commission, industry, non-governmental organizations, universities, undergraduate and graduate students, and citizens interested in the future health of our watershed. A list of organizations attending the Forum is found in Appendix A.

The Forum is the only professional symposium for scientists and resource managers working on research and management activities related to the binational Rainy-Lake of the Woods watershed. The Forum's ecosystem focus is a venue for presentations from all disciplines relevant to water quality and aquatic ecology in the watershed.

This year's Forum featured a two-day symposium and an evening poster session, together totalling 35 presentations. Unfortunately, the planned panel discussion on policy needs, "Moving from Science to Action", did not take place due to several panelists being snowed-in at the Minneapolis airport. Nevertheless, the schedule was full, with research presentations covering a wide range of disciplines including studies on cyanobacteria and algal blooms, flora and fauna, fish ecology and binational management, remote sensing and invasive species research and monitoring.

There was a dedicated session for presentations on the science program underway on Lake of the Woods by Environment and Climate Change Canada (ECCC). Of note were reports from:

- Dr. Reza Valipour, who presented progress on developing linked computer models of the watershed, the lake and its response to various nutrient management scenarios. When completed, this can be used to propose nutrient management objectives and targets in the future.
- Dr. Caren Binding, who detailed her work to develop



Dr. Caren Binding (ECCC) shows progression of algae blooms in 2017 from satellite tracking system under development.

satellite remote sensing systems to monitor the extent, severity and type of algae blooms, which will be used to develop indicators and tools to assess the lake's health, to develop ecosystem objectives, and to measure the lake's response to nutrient reduction efforts.

- Dr. Arthur Zastepa, who presented details of work underway to assess the factors driving algae blooms and algae toxin production on Lake of the Woods, including assessing the distribution of algae and toxins across the lakes, the contribution of legacy phosphorus from the lake bottom vs. current sources, as well as determining the contributions of deep-living algae to seasonal surface blooms.

The Minnesota Pollution Control Agency presented a first look at its draft target reduction numbers for sources of phosphorus pollution to the Rainy River and Lake of the Woods. This is the result of Minnesota declaring the U.S. portion of Lake of the Woods as an "impaired water" which kicked off a multi-year project to reduce phosphorus loads so that Lake of the Woods comes back within Minnesota's water quality standards for phosphorus and algae.

There was also a major session featuring current research and joint fishery management initiatives between Ontario and Minnesota, including highlights from the recently released Ontario-Minnesota Boundary Waters Fisheries Atlas. Presentations provided a deep-dive into the status of fish stocks and fisheries in Lake of the Woods and Rainy Lake by several presenters from the Ontario Ministry of Natural Resources and Forestry and the Minnesota Department of Natural Resources.



Clare Nelligan, PhD candidate at Queen's University delivers the Deborah Battigelli Memorial Presentation on changes in nutrients and dissolved oxygen habitat for lake trout in Lake of the Woods.

Clare Nelligan, Queen's University PhD candidate, delivered the Deborah Battigelli Memorial presentation on her research using historical cores of the lake bottom sediments and monitoring data to identify how and why conditions and habitat for lake trout have changed over time in Lake of the Woods and other Ontario lakes. Clare was the recipient of the 2018 Deborah Battigelli Memorial Award, a fund at the Lake of the Woods Water Sustainability Foundation established by the family of the late Deborah Battigelli. The fund supports post-graduate students to present their research at the Forum.

The International Joint Commission (IJC) provided an update on contributions to binational water management being made by its Rainy-Lake of the Woods Watershed Board and its committees, and the local stakeholders. The success of the recent IJC Rainy-Namakan Lakes Rule Curves Review was highlighted as a major achievement in engaging citizens and science in shared decision making. The IJC applauded the partnerships that have developed across the border that, in many ways, epitomize the values of the IJC's International Watersheds Initiative. The International Multi-Agency Arrangement (IMA) presented an update on its activities during 2017, with focus on the group's recent meetings to look at alternatives for the IMA's role in the basin and an effective structure and work planning strategy.

The Foundation reception and poster session on the evening of March 7th once again provided a collegial atmosphere to review the day's work, discuss the research poster presentations and develop professional networks. At the reception, a number of guest speakers addressed the attendees. Richard Sjoberg, a U.S. Director for the Lake of the Woods Water Sustainability Foundation, introduced Mr. Anthony Pagliai, Consul and Principal Officer at the United States Consulate in Winnipeg, Manitoba. Mr. Pagliai expressed his interest in the research that is being done in the basin and made particular comment of the obvious and apparent collaborative atmosphere and partnership building that occurs at the Forum.

Mr. Sjöberg then introduced the Honourable Bob Nault, Member of the Parliament of Canada for the Kenora riding. In his remarks MP Nault spoke to the importance of the International Joint Commission (IJC) and its Rainy-Lake of the Woods Watershed Board to our lake and to us all. He thanked attending Commissioner Richard Moy (IJC U.S. Section) for his years of dedication to our watershed. MP Nault emphasized the importance of Lake of the Woods water quality and affirmed his commitment to working with the responsible federal Ministers in Ottawa to develop the strategy and policy and next steps to take action with the science that is being completed. MP Nault also impressed on the audience the important role that they had, as researchers, in making sure that science was communicated more effectively to the public and to public policy makers to ensure that well informed decisions were made.



The Hon. Robert Nault, member of the Parliament of Canada, affirmed support for developing the policy pieces needed to take action to protect Lake of the Woods. Photo credit: Ryan Young, office of MP Bob Nault.

The 2018 Kallemeyn Award was presented to three deserving individuals this year. For the first time, the selection committee decided to make more than one award, recognizing excellence in different aspects of the Kallemeyn Award criteria.

Kat Rühland, Kevin Peterson and Gail Faveri each received the 2018 Kallemeyn Award, recognizing their outstanding professional achievements and contributions to research and resource management in the Rainy-Lake of the Woods basin. With this award, the research and resource management community recognized:

- Kat Rühland, of Queens's University, for over a decade of scientific excellence and collaboration on studies that have significantly advanced our understating of how recent warming has shaped the type of algae blooms that plague Lake of the Woods. Kat has also had an important role as an academic supervisor and mentor of the next generation of graduate student scientists working on Lake of the Woods.
- Kevin Peterson, of the Minnesota Department of Natural Resources, for excellence in managing and restoring the fish and fisheries of some of the major lakes in our watershed, including Rainy Lake, Namakan Lake and Kabetogama Lake to name just a few. Kevin was also recognized for his leadership in major habitat restoration projects, key roles in fostering inter-agency collaboration and coordination between Minnesota, Ontario, the U.S. National Parks Service and the IJC and for his effectiveness in outreach and engagement with the public in natural resource management.
- Gail Faveri for her outstanding contributions as an engineer to the water management of the Rainy-Namakan Lakes reservoir system and Lake of the Woods. The selection committee noted among other things, her efforts during the 2014 flood, to meet with affected stakeholders and to incorporate their concerns in decision making to balance extreme conditions and conflicting values across the upstream and downstream waters in the watershed.



Kevin Peterson, Gail Faveri and Kat Rühland each were honoured with the Kallemeyn Award, recognizing their outstanding achievements in research, resource management and contributions to collaborative and cooperative approaches internationally. Photo credit: Ryan Young, office of MP Bob Nault.

The Foundation presented the Gerry Wilson Stewardship Award to the White Iron Chain of Lakes Association (WICOLA) for their leadership in civic engagement, outreach, research and partnerships. Teresa Sagen, WICOLA president, accepted the award on behalf of the Association and all its members who have worked for over 25 years to develop and conduct programs in partnership with Minnesota's natural resource agencies to fill gaps in monitoring and science and engage hundreds of volunteers in work to protect the headwaters in the Rainy-Lake of the Woods watershed.

Over the years, the Forum has become the "hub" for all groups working to ensure the future ecological integrity of the waters of the Rainy-Lake of the Woods Basin. Several groups held their annual meetings on the margins of the Forum program, including:

- The International Multi Agency Arrangement — held a joint meeting of its managerial Work Group and its Technical Advisory Committee to discuss a strategic review of its roles, structure and committees, and relationships to other governance structures in the Basin, such as the IJC Rainy-Lake of the Woods Watershed Board.
- The International Rainy-Lake of the Woods Watershed Board's Water Levels Committee met to review and consider technical needs, decision making processes, and communications protocols related to its expanded roles provided in the March 1, 2018 Supplementary Order for Rainy and Namakan Lakes. Follow this meeting, the WLC held a public outreach session, providing an opportunity for public engagement and feedback on a presentation on basin conditions and seasonal forecasts leading into the spring freshet, presented by the engineering advisors to the WLC.
- International Rainy-Lake of the Woods Watershed Board, held an Adaptive Management Workshop that engaged resource agencies and the public in a scoping of what adaptive management for the Rainy and Namakan Lakes and the Rainy River would entail in terms of monitoring and research and institutional requirements.
- The Industry Advisory Group to International Rainy-Lake of the Woods Watershed Board met and received updates from the International Joint Commission and from its Water Levels Committee on current water level conditions. The group also received presentations from Norbord and New Gold.
- A Civic Engagement Workshop, held by the Foundation's International Watershed Coordination Program, brought together individuals from both Canada and the U.S. who are delivering civic engagement programming or were interested in becoming involved and meeting colleagues. Presentations were made by local agencies and organizations with topics ranging from partnerships in streambank rehabilitation to exploring water values within communities to engaging resort owners in aquatic invasive species prevention efforts.
- Minnesota's Lake of the Woods TMDL Technical Advisory Committee met to review the process and status of the TMDL, draft determinations of loadings, draft phosphorus reduction goals and next steps in the TMDL process.

The 15th annual Rainy-Lake of the Woods Watershed Forum was a tremendous success and many thanks go out to the strong collective of sponsors that make this Forum happen each year – it could not happen without their support. This event saw record attendance, up over recent years and more than double the participation historically. Sustaining and growing this event for a decade and a half speaks volumes to the passion and commitment of the research and resource management professionals working in the Rainy-Lake of the Woods watershed. It also is indicative of the value that is consistently placed on the Forum itself as a meeting place, catalyst and incubator for research and international collaboration in our watershed. As with every year, special thanks are due to all who have helped organize and run the Forum over the years and to making this one the largest yet.



Teresa Sagen, President of the White Iron Chain of Lakes Association, accepted the Wilson Stewardship Award on behalf of WICOLA and its members.

Program At A Glance

DAY 1 – MARCH 7

08:50 Welcome & Introductions

09:00 Session 1 – Binational Updates

1. **International Joint Commission update**
[Commissioner/Staff](#). International Joint Commission
2. **International Rainy-Lake of the Woods Watershed Board Update**
[Board Chairs/Members](#). International Rainy-Lake of the Woods Watershed Board
3. **RLWWB – Objectives & Alerts Study Team Workshop Report**
[TBA](#). RLWWB Objectives & Alerts Study Team
4. **International Multi-Agency Work Group Update**
[IMA Work Group Member TBD](#). International Multi-Agency Arrangement

09:40 Session 2 – From Science To Action: Discussion On Policy Paths

5. **Introduction to Session**
[Felicia Minotti](#). Global Affairs Canada
6. **Imagining the future: options and lessons from other basins**
[Steve Cobham](#). Environment and Climate Change Canada

10:20 Break

7. **Open Discussion on Policy Paths from Science to Action**
[All](#). Facilitator – Mike Kennedy

12:00 Lunch

13:00 Session 3 – Ecology Part 1

8. **Beavers as engineers of wildlife habitat**
[Steve Windels¹](#) and [Carol Johnston²](#). ¹Voyageurs National Park; ²South Dakota State University
9. **Beaver ponds alter the water cycle**
[Carol Johnston¹](#), [Terry N. Brown²](#), [Kirsten Cahow-Scholtes³](#). ¹South Dakota State University; ²U.S. Environmental Protection Agency; ³Wisconsin Department of Natural Resources
10. **What is driving the decline of nesting Osprey at Voyageurs National Park?**
[Jennyffer Cruz^{1*}](#), [Steve K. Windels²](#), [Wayne E. Thogmartin³](#), [Shawn M. Crimmins⁴](#), [Leland H. Grim⁵](#), [Benjamin Zuckerberg⁴](#). ¹University of Wisconsin; ² Voyageurs National Park, NPS; ³USGS; ⁴University of Wisconsin; ⁵VNP (retired)
11. **Distribution and abundance of secretive marshbirds in Voyageurs National Park**
[Claire Kissane](#), [Bryce T. Olson](#) and [Steve K. Windels](#). Voyageurs National Park

14:20 Break

14:50 Session 4 – Fish & Fisheries Part 1

12. **The Ontario – Minnesota Boundary Waters Fisheries Atlas: Fisheries management and collaboration on shared border waters**
[Kevin E. Peterson](#). Minnesota Department of Natural Resources
13. **Biological Reference Point Framework**
[Blair Wasylenko](#). OMNRF
14. **Fish stock status – Lake of the Woods in Ontario**
[Victoria Danco](#). Ontario Ministry of Natural Resources and Forestry
15. **Status and management of the fishery – Lake of the Woods in Minnesota**
[Phil Talmage](#). Minnesota Department of Natural Resources

DAY 1 – MARCH 7 (Cont'd)

16:10 7th Inning Stretch – Brief Bio Break

16:25 Session 5 – Paleolimnology

- 16. 15 years of paleolimnological research on Lake of the Woods: What have we learned?**
[Kathleen M. Rühland](#)¹, [Andrew M. Paterson](#)², [John P. Smol](#)¹. ¹Queen's University; ²Ontario Ministry of the Environment and Climate Change
- 17. Long-term trends in dissolved oxygen, nutrients and primary production in embayments of Lake of the Woods that support Lake Trout**
[Clare Nelligan](#)¹, [Adam Jeziorski](#)¹, [Kathleen M. Rühland](#)¹, [Andrew M. Paterson](#)², and [John P. Smol](#)¹. Queen's University; ²Ontario Ministry of the Environment and Climate Change
- 18. The large shallow lakes of northern Minnesota: How does the recent history of Upper and Lower Red Lakes contrast the history of more heavily impacted Lake of the Woods?**
[Burge, D.R.L.](#)^{1,4*}, [Edlund, M.B.](#)¹, [Heathcote, A.J.](#)¹, [Leavitt, P.R.](#)², [Bowe, S.](#)³. ¹St. Croix Watershed Research Station; ²University of Regina; ³Red Lake Department of Natural Resources; ⁴University of Minnesota

17:35 Poster Set Up / Free Time

18:15 Foundation Reception & Poster Session (AmericInn)

Guest Speakers

- Government of Canada (TBA)
- Government of USA (TBA)

Award Presentations

- Kallemeyn Award
- Wilson Award

Poster Displays

- a) **Mitigating the contaminated source of traditional foods with an uncontaminated river system**
[Peter Ferguson Lee](#)¹, [Kristi Dysievick](#)^{*1}, and [John Kabatay](#)². ¹Lakehead University; ²Seine River First Nation
- b) **Algal blooms, toxin production, and potential effects on ecosystem health, Kabetogama Lake, USA**
[Victoria G. Christensen](#)¹, [Ryan P. Maki](#)², [Erin A. Stelzer](#)¹, and [Jaime F. LeDuc](#)². ¹U.S. Geological Survey, ²National Park Service
- c) **Historic water routes in the Lake of the Woods - Rainy Watershed**
[Paul A. Anderson](#).
- d) **Algal Toxin Test Strips: Effectiveness for Public Use**
[Jaime F. LeDuc](#)¹, [Victoria G. Christensen](#)², [Ryan P. Maki](#)¹. ¹National Park Service - Voyageurs National Park; ² U.S. Geological Survey
- e) **Restoration of hybrid cattail dominated wetlands in Voyageurs National Park**
[Bryce Olson](#), [Claire Kissane](#), [Steve Windels](#). National Park Service Voyageurs National Park
- f) **Phosphorus and mercury reduction as a result of plant upgrades at NKASD**
[Cyndy Strand](#). North Koochiching Area Sanitary District
- g) **Distribution and flux of microcystin congeners in lake sediments**
[Arthur Zastepa](#)¹, [France R. Pick](#)² & [Jules M. Blais](#)². Environment and Climate Change Canada; University of Ottawa

DAY 2 – MARCH 8

08:30 Session 6 – ECCC Science

19. **Remote sensing indices for enhanced monitoring of algal blooms on Lake of the Woods**
[Binding, C. E.*¹](#), [Zeng, C.¹](#), and [Narayanan, A.¹](#). ¹Environment and Climate Change Canada
20. **Cyanobacterial and Harmful Algal Blooms in Lake of the Woods**
[Arthur Zastepa](#). Environment and Climate Change Canada
21. **Loading of nutrients from cottages and other developments to the nearshore of Lake of the Woods**
[Dale R. Van Stempvoort¹](#), [Will Robertson²](#), and [Ross MacKay¹](#), [Pamela Collins¹](#), and [Susan Brown¹](#).
¹Environment and Climate Change Canada; ²University of Waterloo
22. **ECCC's Lake of the Woods Integrated Modelling**
[Reza Valipour](#), [Isaac Wong](#), [Craig McCrimmon](#), [Jun Zhao](#), [Felix Ouellet](#), [Paul Klawunn](#) and [Ram Yerubandi](#).
Environment and Climate Change Canada
23. **Lake of the Woods Monitoring Updates from ECCC: pre-mining metal concentrations in Lake of the Woods and Rainy River**
[Tana McDaniel](#) and [Tim Pascoe](#). Environment Canada, Science and Technology Branch, PO Box 5050, 867 Lakeshore Rd E, Burlington, ON L7R 4A6

10:10 Break

10:40 Session 7 – Rainy-Lake of The Woods Basin South - Minnesota

24. **Trends in weather variables and modeled thermal structure for southern Lake of the Woods from 1962-2016**
[Almendinger, J.E.¹](#), [Edlund, M.B.¹](#), [Heathcote, A.J.¹](#), and [Hernandez, C.²](#). ¹St. Croix Watershed Research Station; ²Minnesota Pollution Control Agency
25. **Lake of The Woods Total Maximum Daily Load Study: A progress report**
[Cary Hernandez¹](#), [Mike Hirst²](#), [Geoff Kramer³](#). ¹Minnesota Pollution Control Agency; ²Lake of the Woods Soil and Water Conservation District; ³RESPEC
26. **The Watershed Pollutant Load Monitoring Network –program overview and water quality results**
[Patrick Baskfield](#). Minnesota Pollution Control Agency
27. **Lake of the Woods Watershed (MN): A One Watershed, One Plan Update**
[Jeremiah Jazdzewski](#). Houston Engineering

12:00 Lunch – Walleye Fry

13:30 Session 8 – Fish Part 2, Invasives And More

28. **Hotspots of *Bythotrephes* (Spiny Water Fleas) in Lake of the Woods: Where? When? Why?**
[Brend Hann](#). University of Manitoba
29. **Fish and fishery monitoring in Rainy-Lake of the Woods Watershed**
[Kim Armstrong](#). Ontario Ministry of Natural Resources and Forestry
30. **MN DNR update on the current status of fish stocks in Rainy Lake and the Namakan Reservoir**
[Ben Vondra](#). Minnesota Department of Natural Resources
31. **Sampling techniques for juvenile Lake Sturgeon in the lower Rainy River: Past, present, and future**
[Brett Nelson](#). Minnesota Department of Natural Resources

DAY 2 – MARCH 8 (Cont'd)

14:50 Break

32. **Modelling the effect of juvenile population density on recruitment of lake sturgeon in the Namakan Chain of Lakes**

[Jim Burchfield](#) and [Brian McLaren](#). Lakehead University

33. **Rusty crayfish (*Orconectes rusticus*) monitoring and control in the Rainy Basin**

[Sonja Smerud](#), [Darren Lilja](#), and [Derrick Passe](#). Lake County Soil & Water Conservation District

34. **Regression-based peak flow analysis in StreamStats for the Lake of the Woods—Rainy River Basin**

[Pete Steeves](#)¹, [Chris Sanocki](#)¹, [Tara Williams-Sether](#)¹, and [Michael Laitta](#)². ¹USGS; ²IJC.

16:20 Closing Remarks

Forum Partners – Sponsors

The organizing committee would like to thank our 2018 partners and sponsor's for assisting with the 15th annual International Rainy-Lake of the Woods Watershed Forum. This event would not be possible without the assistance of the following groups:

- International Joint Commission
- Voyageurs National Park
- Consulate General of Canada - Minneapolis, Global Affairs Canada
- Minnesota Pollution Control Agency
- Manitoba Sustainable Development
- Rainy River Community College
- Lake of the Woods District Property Owners Association
- St. Cloud State University
- Dorset Environmental Sciences Centre (Ontario Ministry of Environment & Climate Change)
- Rainy Lake Conservancy
- Rainy Lake Property Owners Association
- Lake of the Woods Water Sustainability Foundation



Organizing Committee

Todd Sellers

Executive Director
Lake of the Woods Water Sustainability
Foundation
P.O. Box 112
Kenora, ON P9N 3X1
Toll free 866-370-8891 | fax 204-489-0252
tsellers@lowwsf.com

Nolan Baratono

Watershed Ecology
909 Riverside Drive
International Falls, MN 56649
ngbaratono@paulbunyan.net

Andrew Paterson

Research Scientist
Ontario Ministry of Environment & Climate
Change
1026 Bellwood Acres Rd., PO Box 39
Dorset, ON POA 1EO
705-766-2951 | fax 705-766-2254
andrew.paterson@ontario.ca

Matthew Julius

St. Cloud State University
Department of Biological Sciences
WSB-225, 720 Fourth Avenue South
St. Cloud, MN 56301-4498
320-308-6684 | fax: 320-308-4166
mljulius@stcloudstate.edu

Anna DeSellas

Scientist
Ontario Ministry of Environment & Climate
Change
1026 Bellwood Acres Rd., PO Box 39
Dorset, ON POA 1EO
705-766-2150 | fax 705-766-2254
Anna.desellas@ontario.ca

Kelli Saunders

International Watershed Coordinator
Lake of the Woods Water Sustainability
Foundation
P.O. Box 112
Kenora, ON P9N 3X1
807-548-8002
ksaunders@lowwsf.com

Ryan Maki

Aquatic Ecologist
Voyageurs National Park
360 Highway 11 East, International Falls, MN
56649
763-783-3112 | fax 218-327-2557
ryan_maki@nps.gov

Tim Pascoe

Physical Sciences Specialist
Environment Canada – CCIW
867 Lakeshore Rd., Burlington, ON L7R 4A6
905-336-6239 | fax 905-336-4699
tim.pascoe@canada.ca

Jesse Anderson

Minnesota Pollution Control Agency
525 Lake Avenue South Suite 400
Duluth, MN 55802
218-529-6218
jesse.anderson@state.mn.us

Kelly Sjerven

Biology Instructor
Rainy River Community College
1501 Hwy 71, International Falls, MN
218-285-2218
ksjerven@rrcc.mnscu.edu

Oral Presentation Abstracts

Session 1 – Binational Updates

International Joint Commission update

[Commissioner Richard Moy, IJC US Section](#)

International Joint Commission

Abstract

The International Joint Commission, through its Rainy-Lake of the Woods Watershed Board, has been active over the past year and has recently released a new rule curve for Rainy Lake and the Namakan Chain of Lakes. Commissioner Moy reviews the key aspects of the new Order and the action that is being taken on investigating adaptive management as part of this new approach. The Commissioner also emphasized to the audience the importance of them, collectively, continuing to move forward with the identified research and management needs for the basin's priority issues, as documented in the IJC's Water Quality Plan of Study (January 2015), those being: capacity building, monitoring, nutrient enrichment and HABs, surface and groundwater contaminants and aquatic invasive species.

Brief Bio

Richard Moy was appointed to the U.S. Section of the International Joint Commission (IJC), by President Barack Obama, on July 11, 2011. In his professional career prior to that, for 27 years, Mr. Moy focused on collaborative, strategic and science-based approaches to water policy, management and planning, Native American water rights, and transboundary and regional water and land issues for the Montana Department of Natural Resources and Conservation. Mr. Moy has worked with the Canadian provinces of British Columbia, Alberta, Saskatchewan, and in this basin through the work of the Rainy-Lake of the Woods Watershed Board, Ontario and Manitoba as well. He has attended many Watershed Forums and was actively involved in the Lake of the Woods Water Quality Plan of Study, the Rainy-Namakan Lakes Rule Curves Review and several of the International Watersheds Initiatives projects developed by the Board.

International Rainy-Lake of the Woods Watershed Board Update

Gail Faveri, Board Member and Chair of the Water Levels Committee

International Rainy-Lake of the Woods Watershed Board



Outline

- Board Activities:
 - Aquatic Ecosystem Health
 - Water Levels
 - Public Engagement
- International Watershed Initiative Projects
- International Watershed Coordination Program



2

Abstract

This update includes the activities of the Rainy-Lake of the Woods Watershed Board, highlighting those related to aquatic ecosystem health, water levels and public engagement as well as updates on International Watershed Initiative projects and proposals and the work of the International Watershed Coordination Program. Great strides have been made in the production of the second aquatic ecosystem health report, participation in the multi-board water quality objectives review and development of a transboundary emergency response/coordination document. The presentation also highlights the role of the Water Levels Committee, the communication efforts of the Engagement Committee and the ongoing support provided by the International Watershed Coordinator in linking international, regional and local efforts in the basin.

Brief Bio

Gail Faveri has over 25 years' experience in water resources engineering in both the private and public sector from coast to coast. She is a Professional Engineer with a B.Sc from the University of Manitoba and a Maîtrise en Sciences Appliquées (MScA) in water management from the Ecole Polytechnique of Montreal. Gail is the Canadian Co-Chair of the Water Levels Committee for the Rainy-Lake of the Woods Watershed Board. She also serves as the Board's co-chair on their Engagement Committee and is a member of the Lake of the Woods Control Board. Gail recently retired from her long-time career with Environment and Climate Change Canada.

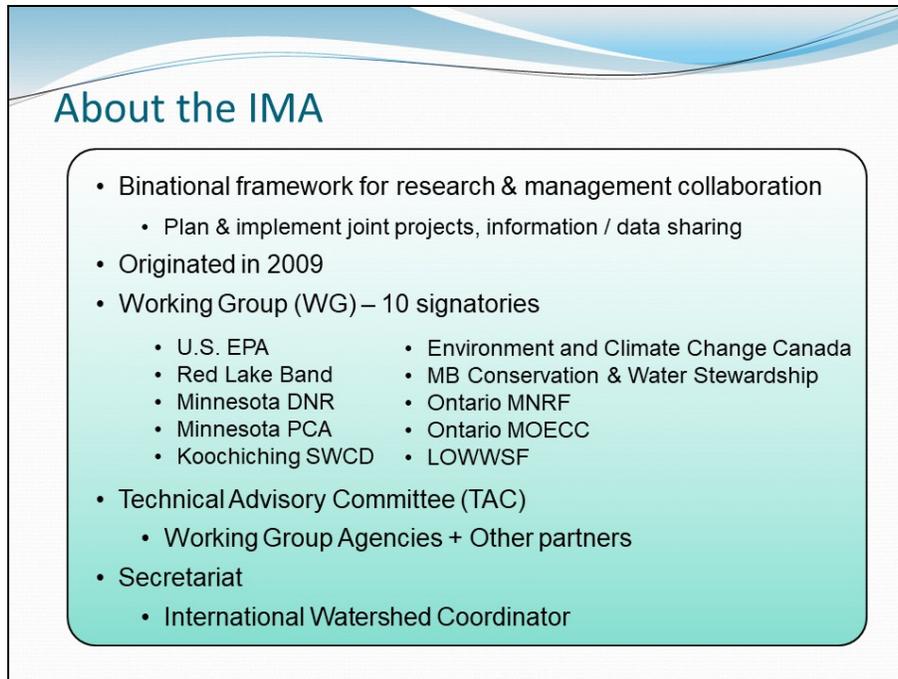
Location of Study

The Board's geographic mandate includes the entire Rainy-Lake of the Woods Watershed.

International Multi-Agency Work Group Update

Janette Marsh, IMA Work Group Member

International Multi-Agency Arrangement



About the IMA

- Binational framework for research & management collaboration
 - Plan & implement joint projects, information / data sharing
- Originated in 2009
- Working Group (WG) – 10 signatories
 - U.S. EPA
 - Red Lake Band
 - Minnesota DNR
 - Minnesota PCA
 - Koochiching SWCD
 - Environment and Climate Change Canada
 - MB Conservation & Water Stewardship
 - Ontario MNRF
 - Ontario MOECC
 - LOWWSF
- Technical Advisory Committee (TAC)
 - Working Group Agencies + Other partners
- Secretariat
 - International Watershed Coordinator

Abstract

The International Multi-Agency Arrangement (IMA) has been working as a collective of cross border agencies focused on water quality in the watershed since 2009. This past year, in response to suggestions of the potential role the IMA could play in a binational approach for the basin, the group has spent time revisiting its purpose, developing revised terms of reference and reassessing its work plans. The IMA is recognized as an important binational, local science and resource management entity. However, there is still work to do to ensure the path forward is clear and the Technical Advisory Committee has an opportunity to provide input and advice in this current “reflection” period.

Brief Bio

Janette Marsh is a Watershed Expert with U.S. Environmental Protection Agency Region 5. She studied at the University of Wisconsin and the University of Canberra and lives in South Milwaukee, Wisconsin. She has been active on the International Multi-Agency Arrangement Work Group over the past few years, providing advice and insight from EPA to this multi-agency collaborative.

Location of Study

For the past nine years, the IMA has focused its interagency collaborative efforts primarily on Lake of the Woods and the Rainy River, with specific focus on nutrients, algae and shoreline erosion. In recent years it has become engaged more broadly on watershed-wide issues such as aquatic invasive species.

Session 2 – Moving From Science To Action: Discussion On Policy Paths

Introduction to Session

[Felicia Minotti](#)

Global Affairs Canada

Abstract

Brief Bio

Felicia Minotti is Senior Policy Analyst, U.S. Transboundary Affairs, Global Affairs Canada. For several years, Felicia has been working to develop a binational approach for Lake of the Woods.

SESSION CANCELLED DUE TO WINTER STORM

Imagining the future: options and lessons from other basins

[Steve Cobham](#)

Environment and Climate Change Canada

Abstract

Each watershed along the Canada-US boundary is distinct and consequently, Canada and the US have developed different types of agreements to address various binational water quality and quantity issues. In moving from science to action in the Lake of the Woods basin, both countries will need to consider both the characteristics of the basin and the perspectives of local stakeholders. Engage in a discussion with a panel of experts drawn from the U.S. and Canada on taking the next step.

Brief Bio

Steve joined the International Affairs Branch of Environment and Climate Change Canada in November 2005, where he specialized in transboundary water issues, including the managing relations between ECCC and the International Joint Commission. Steve has extensive experience advising on a wide range of transboundary water issues along the length of the Canada-U.S. boundary related to water quality, levels and flows.

Steve holds a Bachelor of Arts in Politics from Queen's University and a Master's in Public Policy and Administration from Carleton University's School of Public Policy.

SESSION CANCELLED DUE TO WATER SHORTAGE

Open Discussion on Policy Paths from Science to Action

Facilitator – Mike Kennedy

Abstract

Group discussion and Q&A

SESSION CANCELLED DUE TO WINTER STORM

Session 3 – Ecology Part 1

Beavers as engineers of wildlife habitat

Steve Windels¹ and Carol Johnston²

¹Voyageurs National Park, International Falls, MN 56649 218-283-6692 steve_windels@nps.gov,

²South Dakota State University

At Least 124 Terrestrial Vertebrate Species Use VNP Beaver Habitats

- 61% of mammal species
- 30% of birds
- 100% of amphibians
- 20% of reptiles

= **38% of TOTAL EXTANT VERTEBRATES (excluding fish)**



Abstract

The beaver, *Castor canadensis*, is an ecosystem engineer unrivaled in its capacity to alter boreal landscapes, whose population recovery has re-established environmental conditions that probably existed for millennia prior to its near extirpation by trapping in the 1800s and 1900s. Studies conducted at Voyageurs National Park (VNP) in northern Minnesota illustrate how beaver dams enhance wildlife habitat for a variety of species. Moose and white-tailed deer use beaver-created wetlands for foraging, escape from biting insects, and thermal refugia. Gray wolves use VNP beaver ponds as travel corridors, use abandoned beaver lodges in drained ponds for dens, and hide their pups in the dense grass of beaver meadows while the adults are out hunting. Osprey, woodpeckers, great blue herons, and trumpeter swans have all benefitted from beaver ponds and the snags created when beavers flood lowland forests. All ten species of amphibians present in VNP were found in beaver ponds, and turtles use beaver dams and felled logs for basking. Inventory, monitoring, and research efforts at VNP documented >124 species of terrestrial vertebrates using portions of beaver-affected wetlands for at least a part of their life history, representing 61% of mammal, 30% of bird, 20% of reptile, and 100% of amphibian species in the park. Changes in future beaver population abundance will therefore likely result in cascading effects on other species.

Brief Bio

Steve Windels is a wildlife biologist at Voyageurs National Park, MN, USA. He conducts research and monitoring on a variety of wildlife species including American beaver, muskrat, gray wolf, moose, white-tailed deer, American marten, Canada lynx, bald eagle, common loon, and double-crested cormorant. He also holds adjunct faculty positions at University of Minnesota Fisheries, Wildlife and Conservation Biology Graduate Program (co-advising 1 PhD student) and University of Minnesota-Duluth in the IBS program (advising 1 MS student). He holds degrees from Michigan Technological University (PhD-Forest Wildlife Ecology), Texas A&M Univ.-Kingsville (MS-Wildlife Ecology), and Univ. of Minnesota (BS-Wildlife Management).

Location of Study

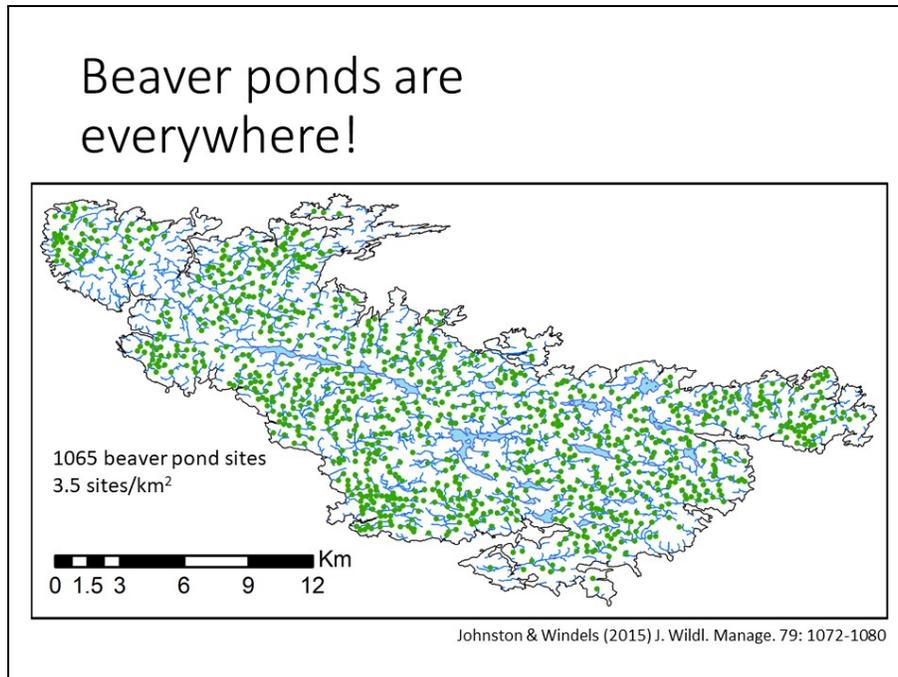
Voyageurs National Park

Beaver ponds alter the water cycle

Carol Johnston¹, Terry N. Brown², Kirsten Cahow-Scholtes³

¹South Dakota State University, Box 2104A, Brookings, SD 57007 (605) 688-6121 carol.johnston@sdstate.edu;

²U.S. Environmental Protection Agency; ³Wisconsin Department of Natural Resources



Abstract

Beaver ponds require a supply of water, which ultimately comes from precipitation. My colleagues and I studied how the form (snow versus rain), seasonality, and amount of precipitation affected water storage in beaver ponds of the Kabetogama Peninsula of Voyageurs National Park. We also studied fluxes of moisture back to the atmosphere via evapotranspiration. Although most of northern Minnesota's precipitation is received in the summer months, snowmelt is the main driver of peak streamflow in the spring. Comparison of NOAA snowpack records with USGS stream flow records show that peak annual streamflow was significantly related to maximum snow water equivalent during the winters of 2005-2016. We conducted intensive field studies of water fluxes in a Kabetogama Peninsula beaver meadow, measuring evapotranspiration, pond level, groundwater, streamflow, and runoff from watershed side slopes. Groundwater measurements showed recharge (i.e., water flowing from the surface into the ground) occurring within most of the beaver meadow, but periodic discharge (i.e., water flowing from the ground toward the surface) in sites closer to the stream flowing through the beaver meadow. Evapotranspiration was a significant source of water loss from the beaver meadow during late summer, with discernable diurnal effects on streamflow, water table, and pond level. Knowing how beavers interact with water under current conditions will aid forecasting of future climate impacts on beaver ponds.

Brief Bio

Carol is a professor at South Dakota State University, where her research focuses on plants as ecological indicators; wetland effects on water quality; soil carbon; and beaver wetlands, with speciality areas of wetland ecosystems and GIS applications in ecology.

She is the primary author of the recently published book "Beavers: Boreal Ecosystem Engineers" which bridges the fields of ecosystem science and landscape ecology, to integrate research on beaver ecosystem alteration at Voyageurs National Park.

<http://www.springer.com/us/book/9783319615325>

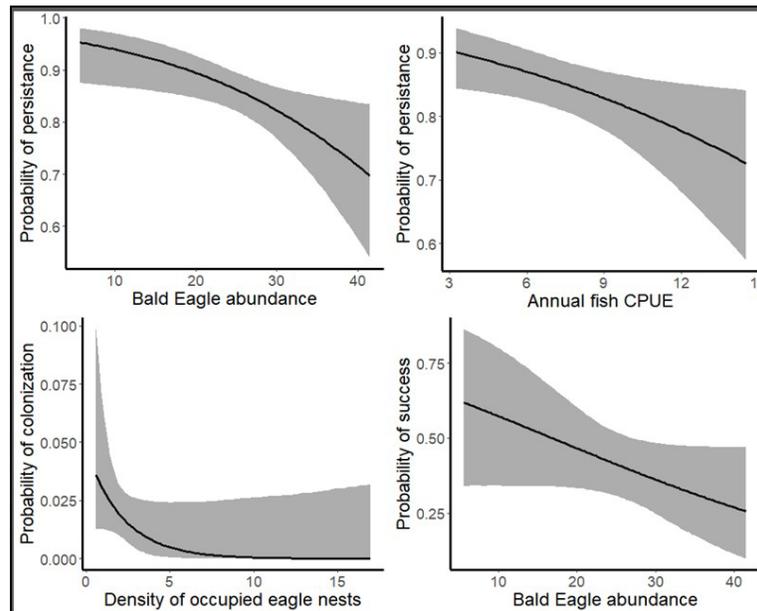
Location of Study

Kabetogama Peninsula, Voyageurs National Park

What is driving the decline of nesting Osprey at Voyageurs National Park?

Jennyffer Cruz^{1*}, Steve K. Windels², Wayne E. Thogmartin³, Shawn M. Crimmins⁴, Leland H. Grim⁵, Benjamin Zuckerberg⁴

¹Department of Forest and Wildlife Ecology, University of Wisconsin – Madison, 1630 Linden Drive, Madison, WI 53706, USA; 6085728891; cruzbernal@wisc.edu; ² Voyageurs National Park, NPS; ³USGS, Upper Midwest Environmental Sciences Center; ⁴University of Wisconsin; ⁵VNP (retired)



Relationships with important predictors driving Osprey dynamics at Voyageurs National Park. Top: probability of an Osprey nest persisting from the previous year vs annual measures of Bald Eagle abundance (left) and Northern Pike and Yellow Perch (combined) catch per unit effort (right). Bottom: probability of a new nest being colonized vs the surrounding density of Bald Eagle occupied nests (left) and probability of a nest being successful vs annual measures of Bald Eagle abundance (right).

Abstract

Top predator recovery has been linked to multiple ecosystem benefits including the suppression of over-abundant mesopredators and prey, and the re-establishment of landscapes of fear. However, little work has been done on assessing the impacts of top predator recovery on other recovering predators. Across North America, Bald Eagles and Osprey have been recovering following the ban of harmful pesticides, including DDT. At Voyageurs National Park (VNP), the breeding population of Osprey increased in numbers and successfully reared young during the 1970s, reaching stable numbers in the mid-80s. In the 1990s and later decades, the breeding population and nesting success of Osprey started to decline, while Bald Eagles continued on their path to recovery. We aim to determine whether competition with Bald Eagles may be driving the observed declines in Osprey nesting dynamics, including nest persistence, colonization and success, or whether these are related to other extrinsic factors including food resources, nest locations, and inclement weather.

Brief Bio

Jennyffer is a postdoctoral researcher interested in predator-prey dynamics, trophic cascades and applying best-practice quantitative methods to solving applied ecological problems.

Location of Study

Voyageurs National Park

Distribution and abundance of secretive marshbirds in Voyageurs National Park

Claire Kissane, Bryce T. Olson and Steve K. Windels

Voyageurs National Park, 360 Highway 11 E, International Falls, MN 56649

218-283-6622

claire_kissane@nps.gov



Abstract

Secretive marshbirds are indicators of wetland quality due to their sensitivity to water level regulation, disturbance, and vegetation composition. We conducted three rounds of call-back surveys in wetlands (N=64) of Voyageurs National Park during the breeding season of 2017. American Bitterns, Soras, and Virginia Rails were common throughout the survey sites. Least Bitterns and Yellow Rails were thought to be rare in the region but were detected at multiples sites. Red-necked Grebes, Pied-billed Grebes, and Black Terns were only found on Kabetogama Lake. Potential factors for observed distribution patterns will be discussed. We also discuss potential impacts of a multi-year invasive cattail removal and wetland restoration project on marshbirds in the park.

Brief Bio

Claire Kissane is a biological technician at Voyageurs National Park where she has worked for five years. She holds a Bachelor of Science in Integrative Biology and a Master of Science in Natural Resources and Environmental Sciences. At Voyageurs she has worked on aquatic ecology and wetland restoration. She is currently involved in a project to remove hybrid cattails from the park and promote a healthy wetland ecosystem. She likes running and playing outside with her dog Fran.

Location of Study

Voyageurs National Park

Session 4 – Fish & Fisheries Part 1

The Ontario – Minnesota Boundary Waters Fisheries Atlas: Fisheries management and collaboration on shared border waters

Kevin E. Peterson

Minnesota Department of Natural Resources, 392 Highway 11 East, International Falls, MN 56649; 218-286-5220; kevin.peterson@state.mn.us



Abstract

For more than thirty years Fisheries Managers and Biologists from Ontario and Minnesota have worked together to manage shared waters along the International border. Working under the direction of the Ontario-Minnesota Fisheries Committee (representing the Ontario Ministry of Natural Resources and Forestry and the Minnesota Department of Natural Resources) the Atlas was developed “to provide the necessary background information to allow development of options for managing these border waters fisheries”. A secondary purpose of the Atlas was to share information with stakeholders, resource users, and the public. The Atlas was first published in 1984 with updates in 1992, 1998, 2004, and 2017 and covers the shared boundary waters of Lake of the Woods, Rainy River, Rainy Lake, Namakan Lake, and Sand Point Lake. This talk will summarize the history of the Atlas, its content, function, and offer thoughts on how to achieve its purpose in the digital age.

Brief Bio

Kevin joined the Minnesota Department of Natural Resources Fisheries division in 1978 and has served as the Area Fisheries Supervisor at International Falls since 1998. This office manages 135 lakes and numerous rivers/streams in Koochiching and northern St. Louis Counties, including several large water bodies on the International border. His work in this position has included management and research of various fish species and populations. He has served on numerous committees related to fisheries issues on border waters and was Editor of the 2017 update of the Ontario-Minnesota Boundary Waters Fisheries Atlas.

Location of Study

Boundary waters between Minnesota and Ontario, with focus on Lake of the Woods, Rainy River, Rainy Lake, Namakan Lake, and Sand Point Lake.

Biological Reference Point Framework

[Blair Wasylenko](mailto:Blair.Wasylenko@ontario.ca)

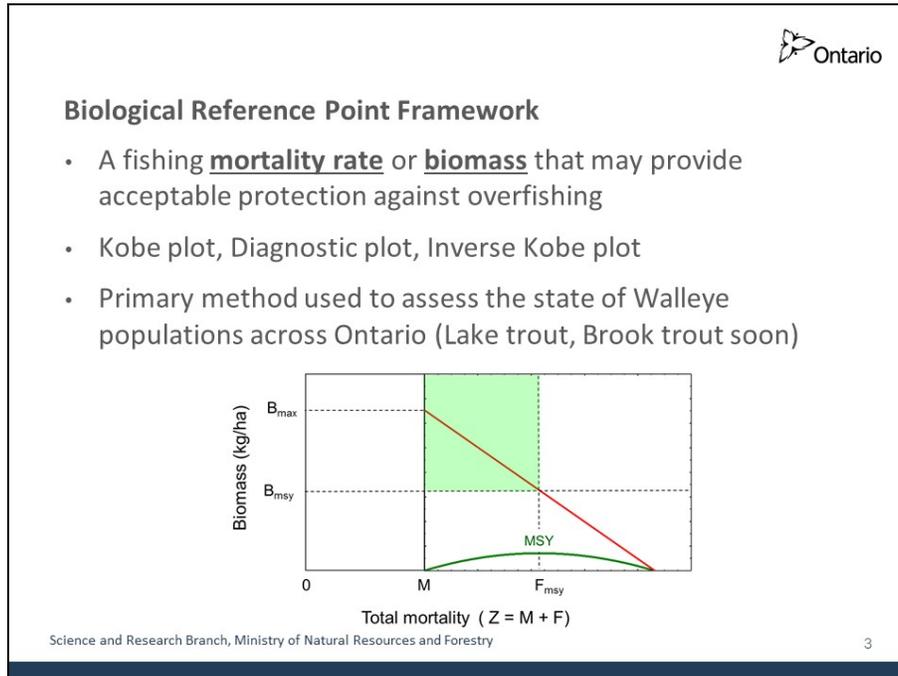
OMNRF

#173 – 25th Side Road

Rosslyn, ON P7K 0B9

(807)939-3138

Blair.wasylenko@ontario.ca



Abstract

Biological reference points can be used to assess the state of fish populations, and help set management objectives. The two main biological indicators used in Ontario are Mortality and Biomass. From research conducted in Ontario, models have been created that allow biologists to predict natural mortality and biomass at maximum sustainable yield. Having an estimate of natural mortality allows an estimate of allowable total mortality and how much is attributable to fishing. We compare these values to the observed values from monitoring activities. This talk will go into the specifics of model inputs, how the reference points are calculated, and how they can be interpreted in a management context.

Brief Bio

Blair Wasylenko is a Fisheries Population Specialist with the Science and Research Branch of the Ministry of Natural Resources and Forestry based out of Thunder Bay.

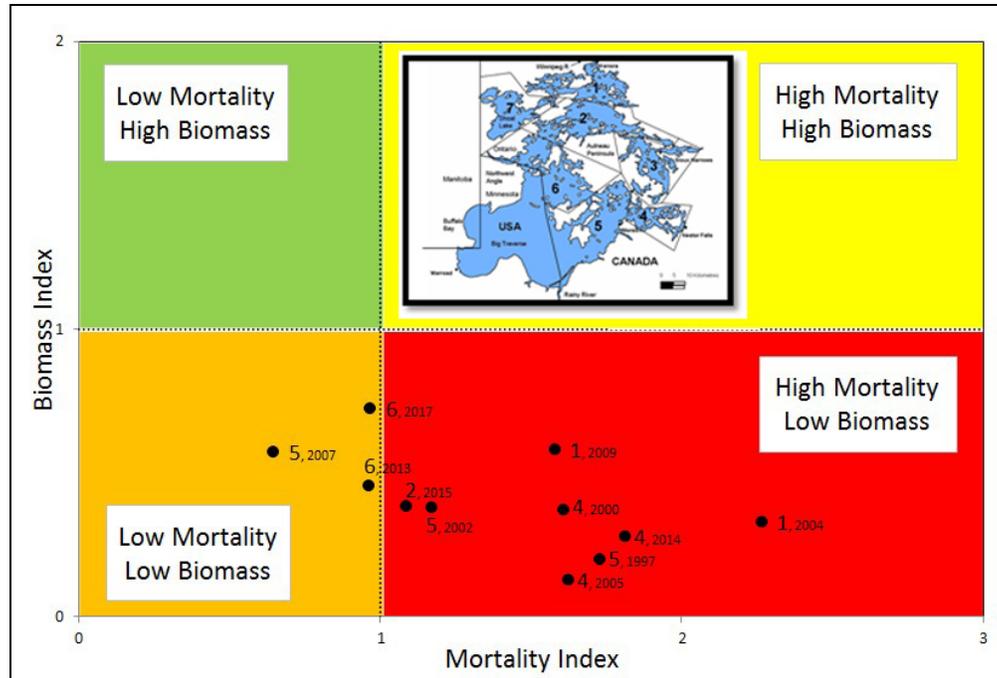
Location of Study

Ontario wide monitoring approach

Fish stock status – Lake of the Woods in Ontario

Victoria Danco

OMNRF, Lake of the Woods Fisheries Assessment Unit
808 Roberston Street, Floor 1, Kenora, ON P9N 3X9
(807)468-2609; Victoria.Danco@ontario.ca



The biological reference point diagnostic plot summarizing the Walleye stock status in Lake of the Woods. Each dot shows the relative situation of the Walleye population observed from Fall Walleye Index Netting Surveys which occurred in different sectors and years (points labelled respectively). The inset map of Lake of the Woods displays the division of the lake into several sectors for past monitoring program logistics. A value below 1 on the Y-axis indicates the biomass is below the expected biomass at maximum sustained yield (B_{MSY}) and a value above 1 on the X-axis indicates that the total mortality is above a sustainable level ($Z_{MSY} > 2M$).

Abstract

The Ontario Ministry of Natural Resources and Forestry has monitored the Lake of the Woods fishery since the early 1980's. The Ontario waters of Lake of the Woods are divided into seven sectors based on observed differences in fish populations, user group patterns, and physical and chemical characteristics. Annual Fall Walleye Index Netting (FWIN) surveys since 1997 and North American (NA) gill net assessments commencing more recently in 2016 were conducted on rotation among the different sectors. Walleye population status is primarily described with the recently developed biological reference point diagnostic. Additional stock status Indicators of key sport fish will be presented, including age when 50% of fish mature, fish condition, and Shannon Diversity Index of breeding females. Emphasis is placed on the most recent stock assessments conducted over the past two decades.

Brief Bio

Victoria Danco is a Fisheries Monitoring and Assessment Biologist with the Science and Research Branch based out of Kenora, Ontario. The Lake of the Woods Intensive Inland Lake Monitoring Unit implements the fishery assessment monitoring program and Victoria has a lead role in the analysis and interpretation of the Lake of the Woods fisheries data.

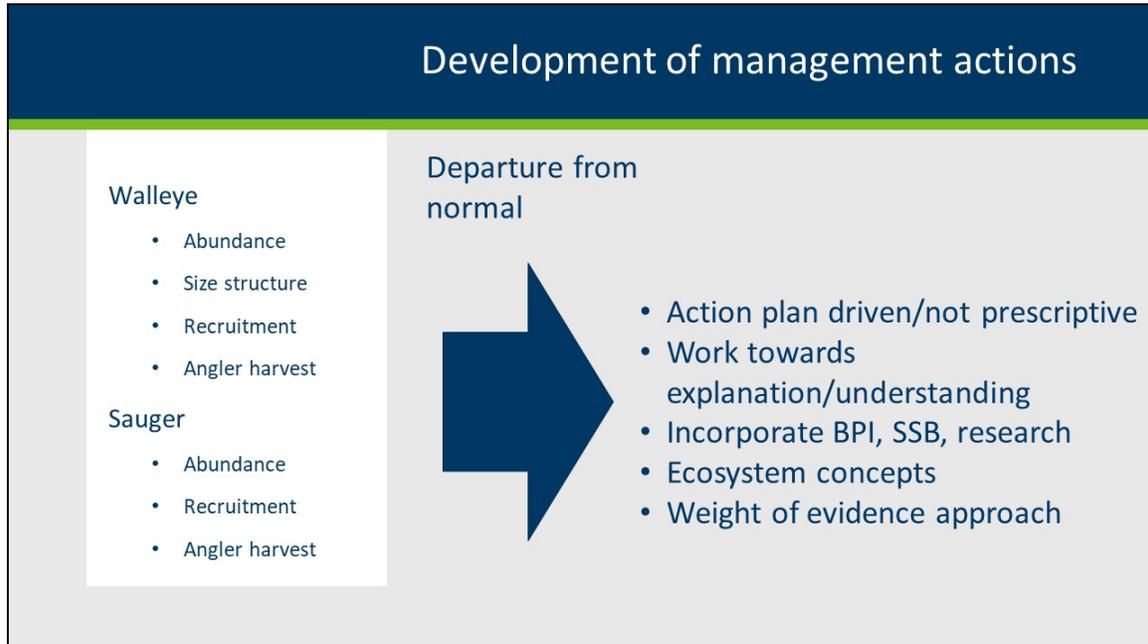
Location of Study

Ontario waters of Lake of the Woods – seven assessment sectors as designated by MNR

Status and management of the fishery – Lake of the Woods in Minnesota

[Phil Talmage](#)

Minnesota Department of Natural Resources
204 Main Street East
Baudette, MN 56623
Phone: 218-634-2522 ext 230
phil.talmage@state.mn.us



Abstract

Lake of the Woods is a highly valued resource located along the international border between Minnesota and Canada. With a diverse fish population, Lake of the Woods is a primary destination of anglers from all over the United States and especially Midwestern states. Walleye and Sauger, are the primarily targeted species within the Minnesota waters of the lake. I will provide an update on Walleye and Sauger populations, angler-use information, and Minnesota Department of Natural Resources management of the resource.

Brief Bio

Phil Talmage is Area Fisheries Supervisor, Division of Fish and Wildlife, Minnesota Department of Natural Resources, in Baudette Minnesota.

Location of Study

Minnesota waters of Lake of the Woods.

Session 5 – Paleolimnology

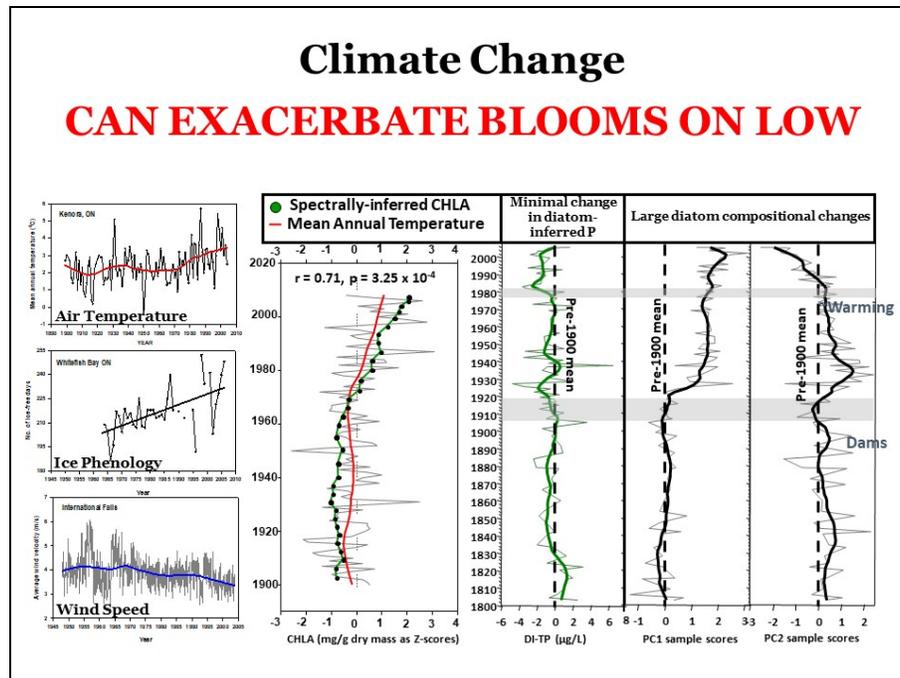
15 years of paleolimnological research on Lake of the Woods: What have we learned?

[Kathleen M. Rühland](#)¹, [Andrew M. Paterson](#)², [John P. Smol](#)¹

¹Paleoecological Environmental Assessment and Research Laboratory (PEARL), Department of Biology, Queen's University, Kingston, ON, Canada, K7L 3N6

613-533-6000 ext. 77337 ruhlandk@queensu.ca

²Ontario Ministry of the Environment and Climate Change, Dorset Environmental Science Centre, 1026 Bellwood Acres Road, Dorset, Ontario, P0A 1E0



Abstract

Paleolimnological research on northern Lake of the Woods (LOW) over the past 15 years has focused on a better understanding of this large and complex system with an aim to guiding stewardship and lake management decisions. Numerous challenges impede the assessment of aquatic ecosystem concerns such as establishing natural or pre-disturbance conditions, identifying whether water quality has changed, determining the timing of purported changes, identifying potential cause(s) or triggers of these changes, and ultimately using this information to recommend realistic mitigation targets. To address these questions, a variety of paleolimnological approaches have been used to quantitatively and qualitatively track past aquatic conditions using a selection of biological proxy data archived in lake sediments.

This presentation will provide an overview of some of the main findings to date from our paleolimnological research undertaken on the northern portion of LOW. For example, what have we learned about water quality and the potential triggers for the purported increase in the frequency and intensity of nuisance algal blooms? What roles have nutrients and accelerated regional warming played in aquatic ecosystem changes? To address these questions, paleolimnological inference models for total phosphorus (TP) and deep water dissolved oxygen (DO) concentrations were developed and applied to biological sedimentary assemblages (diatoms and midges), tracking the past ~150 years of environmental change across various bays of LOW. Spectral inferences of sedimentary chlorophyll-a (chl-a) concentrations were used to examine the seeming disconnect between recent increases in aquatic primary production and decreases in external phosphorus inputs. Changes in midge-inferred DO, diatom-inferred TP, and

sedimentary chl-a have also been used to track historical changes in Lake Trout habitat. Pushing the paleolimnological record back several thousand years, biological proxies have provided new perspectives on how warming in the mid-Holocene affected water quality, providing a longer-term perspective on recent biological and limnological changes in LOW. Although we have gained a considerable understanding of the complexities of environmental change in LOW, many questions remain unanswered. The continuing threat of increased warming, coupled with the effects of multiple environmental stressors, will undoubtedly continue to challenge lake managers tasked with developing evidence-based policies for the future management of LOW.

Brief Bio

Biography: I received my PhD from Queen's University, Department of Biology, Kingston, Ontario Canada. I am currently a Research Scientist at Queen's University with the Paleocological Environmental Assessment and Research Laboratory (PEARL). My research focuses on using diatom-based paleolimnological methods to study both spatial and temporal trends in climatic and environmental change, in both lakes and peatlands, across broad geographic scales. My research interests span a variety of temporal scales but is particularly focused on the response of lake ecosystems to anthropogenic climate change and other human-induced stressors.

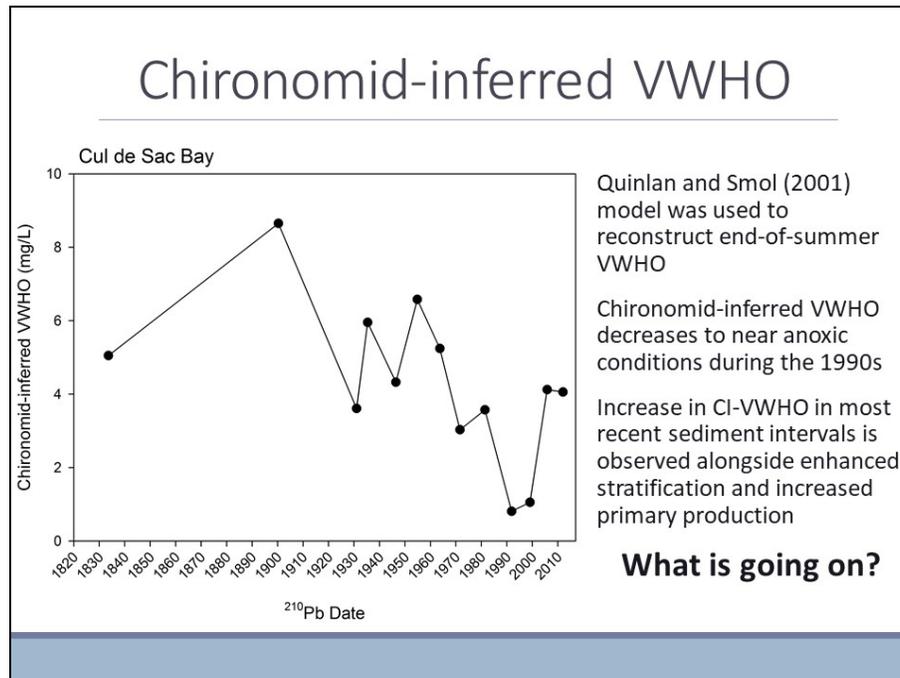
Location of Study

Multiple locations in northern portions of Lake of the Woods.

Long-term trends in dissolved oxygen, nutrients and primary production in embayments of Lake of the Woods that support Lake Trout

Clare Nelligan¹, Adam Jeziorski¹, Kathleen M. Rühland¹, Andrew M. Paterson², and John P. Smol¹

¹Paleoecological Environmental Assessment and Research Lab (PEARL), Dept. Biology, Queen's University, Kingston, Ontario K7L 3N6; ²Ontario Ministry of the Environment and Climate Change, Dorset Environmental Science Centre, 1026 Bellwood Acres Road, Dorset, Ontario, P0A 1E0



Abstract

Lake Trout are an ecologically sensitive species that inhabit the cold, well-oxygenated, and deep bays of Lake of the Woods (LOW). A lack of continuous long-term monitoring data for LOW makes it difficult to answer key questions regarding how conditions for Lake Trout have changed over time, and what stressors may be driving those changes. To address this knowledge gap, sediment cores spanning the past ~200 years were collected from three LOW bays that support Lake Trout (Cul de Sac Bay, Echo Bay and Whitefish Bay). We used: 1) sub-fossil diatoms to infer trends in nutrients and assess the influence of regional warming; 2) spectrally-inferred chlorophyll-a (chl-a) as a proxy for whole-lake primary production; and 3) chironomid remains to reconstruct end-of-summer volume weighted hypolimnetic oxygen (VWHO).

Diatom assemblage shifts were characteristic of increased thermal stability and associated water column changes as a result of warming. However, while this change was common to all bays, the timing varied among sites. Spectrally-inferred chl-a concentrations increased above the pre-1900 mean in Echo (~1960) and in Cul de Sac (~1980) bays despite stable diatom-inferred TP. These data suggest that increased whole-lake primary production in Echo and Cul de Sac bays is likely not a result of external nutrient inputs, but instead due to regional warming and its associated changes. Whitefish Bay has lower concentrations of spectrally-inferred chl-a and undergoes more subtle changes relative to Echo and Cul de Sac bays. Preliminary chironomid results from Cul de Sac Bay indicate that deep-water oxygen concentrations decreased to near-anoxic conditions during the 1980s to mid-1990s. Interestingly, chironomid-inferred VWHO increased in Cul de Sac Bay from the late-1990s to the present day, suggesting the recent influence of another environmental driver (or drivers) in addition to warming. Through assessing long-term environmental trends and identifying stressors influencing Lake Trout habitat, this project can better inform resource managers in the future.

Brief Bio

Claire is a PhD candidate at Queen's University. Her research uses both paleolimnology and the available monitoring data to assess spatial and temporal trends in deepwater oxygen concentrations, nutrient loading, and primary production in Ontario lakes that support Lake Trout. The aim of this research is to better understand how conditions for Lake Trout have changed in Ontario lakes over time and identify stressors (e.g., nutrients, regional warming, changing inputs of dissolved organic carbon, etc.) that may be driving these changes. Nine study lakes across Ontario were selected for this project, one of which is Lake of the Woods. This work is part of a larger collaborative project where modellers, engineers, and biologists are working to develop a new toolset that can provide information on past, present, and future deepwater DO concentrations to better manage Lake Trout habitat in the future.

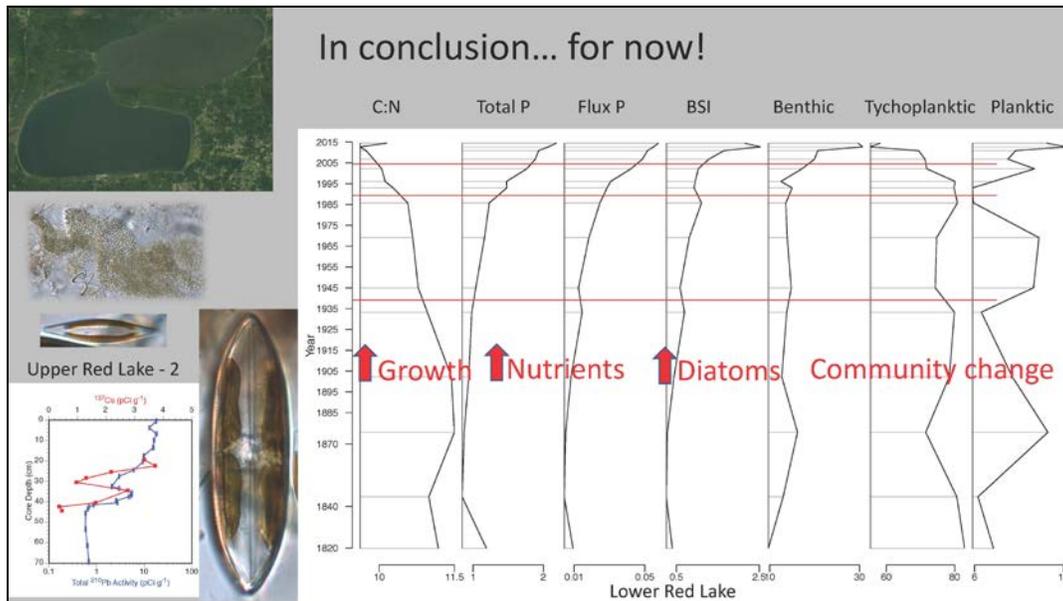
Location of Study

Lake of the Woods (Cul de Sac Bay, Echo Bay and Whitefish Bay) and various lakes across the Province of Ontario.

The large shallow lakes of northern Minnesota: How does the recent history of Upper and Lower Red Lakes contrast the history of more heavily impacted Lake of the Woods?

Burge, D.R.L.^{1,4*}, Edlund, M.B.¹, Heathcote, A.J.¹, Leavitt, P.R.², Bowe, S.³

¹St. Croix Watershed Research Station, Science Museum of Minnesota, 16910 152nd St North, Marine on St. Croix, MN 55047 burge236@umn.edu; ²Canada Research Chair in Environmental Change and Society, University of Regina, Regina, SK S4S 0A2; ³Red Lake Department of Natural Resources, 15761 High School Dr., Red Lake, MN 56671; ⁴Water Resources Science, University of Minnesota, St. Paul, MN 55108



Abstract

Among the large lakes of northern Minnesota, southern Lake of the Woods and the Red Lake system share characteristics of large (fetch >40 km), relatively shallow (<10 m depth) basins, world class fisheries, eutrophic conditions, and frequent and extensive cyanobacterial blooms. Northcentral Minnesota's Upper (URL) and Lower Red (LRL) are two large connected basins in a relatively undeveloped forest and peatland watershed. The URL watershed was the focus of peatland draining in the first half of the 19th century, while the LRL has remained mostly as natural forest and peatlands. We analyzed sediment cores from LRL and URL to provide a contrast between the relatively unimpacted Red Lake system and Lake of the Woods, which had an extensive history of excessive nutrient loading during the 20th century, to examine differences in their nutrient and biological histories. Three sediment cores were taken from each Red Lake basin, each core dated using radioisotopes (²¹⁰Pb, ¹³⁷Cs), and analyzed in a multiproxy fashion for geochemical (loss-on-ignition, P fractions, biogenic silica) and diatom community changes. Additionally, one core from each lake was also analyzed for fossil algal pigments to understand changes in the entire algal community. Changes in geochemistry, pigments, and diatom communities provide the pre-European settlement condition of each basin, the recent history of the lakes, highlight inherent differences and shared history of the two Red Lake basins, and exemplify some of the difficulties of working in large shallow lake sediment records. The 200-year paleolimnological records of the Red Lakes further provide unique opportunities to compare their less disturbed recent history to the Lake of the Woods paleoecological record, which has undergone much greater anthropogenic disturbance.

Brief Bio

David Burge is a graduate student in the University of Minnesota Water Resources Science program and a researcher at the Science Museum of Minnesota's St. Croix Watershed Research Station. In addition to developing identification resources for the *Diatoms of the United States*, David has worked with diatoms as biological indicators from wetlands in the Mississippi Alluvial Plain to Minnesota lakes.

Location of Study

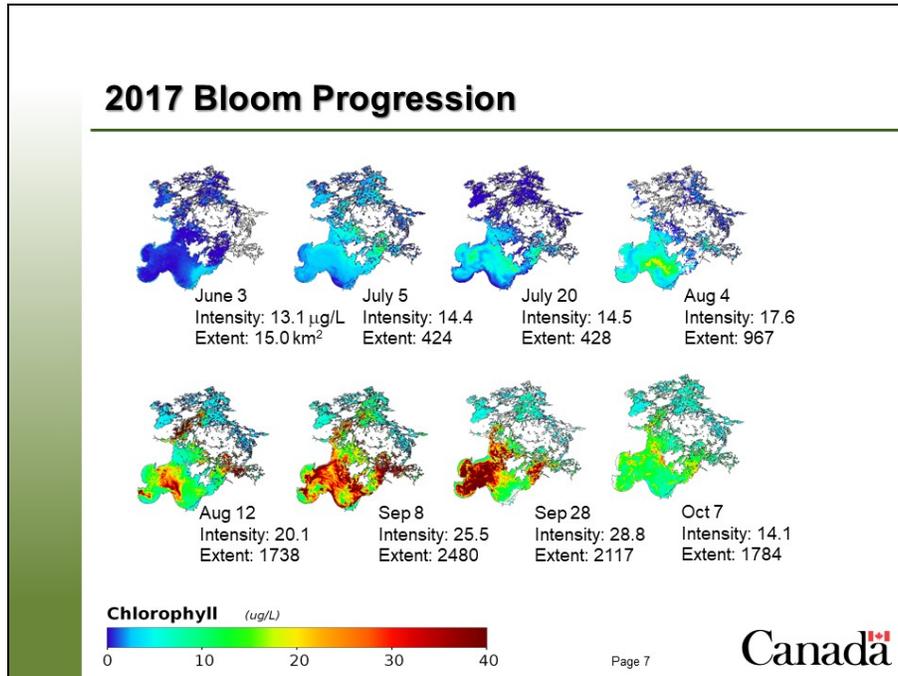
Upper Red Lake & Lower Red Lake Minnesota, Lake of the Woods Minnesota

Session 6 – ECCC Science

Remote sensing indices for enhanced monitoring of algal blooms on Lake of the Woods

Binding, C. E.*¹, Zeng, C.¹, and Narayanan, A.¹

¹Water Science and Technology Directorate, Environment and Climate Change Canada, 867 Lakeshore Rd, Burlington, Ontario, Canada, L7S 1A1



Abstract

Comprehensive lake-wide observations of algal blooms on Lake of the Woods (LoW) are critical to assessing the lake's health status, developing ecosystem objectives, measuring lake responses to nutrient management practices, and providing an improved understanding of the processes driving blooms. Earth observation satellites offer frequent, synoptic views of LoW that enable quantitative assessments of algal biomass and can provide both near-real-time and historical information on algal bloom conditions on the lake. We present progress made on ECCC's satellite remote sensing of LoW blooms using a new generation of satellite sensors on board the European Space Agency's (ESA) Sentinel-3 and Sentinel-2 satellites. Quantitative algal bloom indices are derived for algal bloom intensity, spatial extent, and duration, to give a robust measure of overall bloom severity on the lake. A detailed assessment of the 2017 bloom season imagery will be presented, along with in situ algal and optical observations from coincident field campaigns. Application of those bloom indices to historical imagery from ESA's MERIS (Medium Resolution Imaging Spectrometer) sensor for the period 2002-2011 allows temporal changes in LoW blooms to be assessed and provides baseline bloom conditions for future change detection. Results will form the basis of annual LoW algal bloom reports and a move towards an operational web mapping tool for visualization of near-real-time imagery.

Brief Bio

Caren Binding is a Research Scientist specializing in Aquatic Optics and Remote Sensing with Environment and Climate Change Canada.

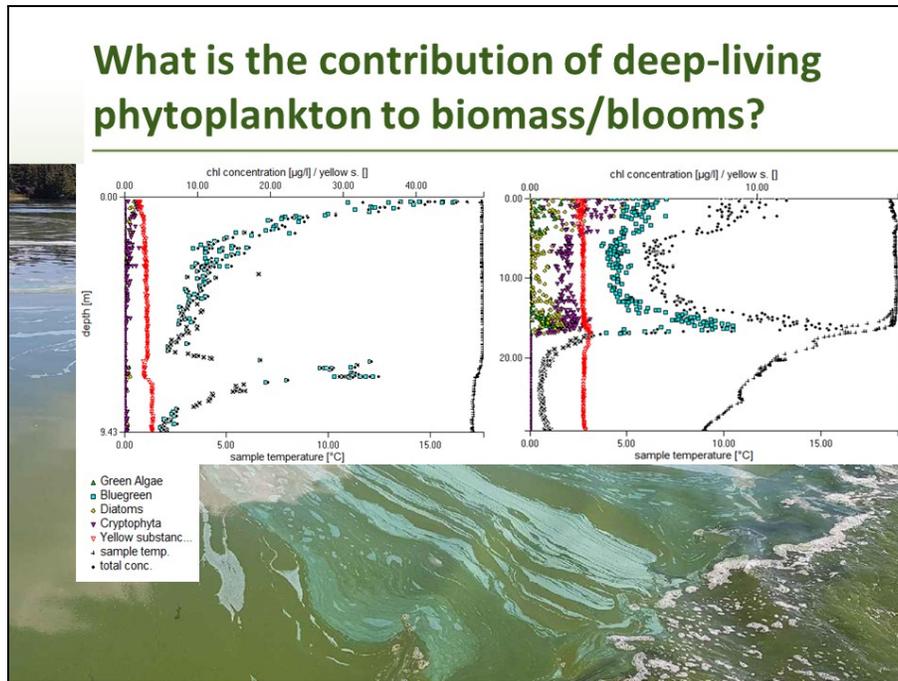
Location of Study

Entire surface waters of Lake of the Woods.

Cyanobacterial and Harmful Algal Blooms in Lake of the Woods

Arthur Zastepa

ECCC, Water Science and Technology, Canada Centre for Inland Waters, Burlington, Ontario, L7S 4A1



Abstract

Lake of the Woods is a complex system, with limited exchange between its multiple basins and strong spatiotemporal variance in physicochemical conditions and susceptibility to cyanobacterial and harmful algal blooms. Nutrient input from tributaries has contributed to a highly productive southern basin with widespread cyanobacterial and harmful algal blooms, which are also present in some northern sub-basins. A recent binational, multi-agency review of the International Joint Commission's 2015 report, "A Water Quality Plan of Study for the Lake of the Woods Basin" has identified key science needs critical to supporting action by governments to protect the Lake of the Woods Basin. Environment and Climate Change Canada's progress and future direction is presented on the recently developed binational science plan as it relates to nutrient enrichment and cyanobacterial and harmful algal blooms. Specifically, nutrient dynamics, internal loads and hypoxia, and the characterization of phytoplankton community structure and associated toxins are discussed.

Brief Bio

Dr. Arthur Zastepa is a research scientist at the Canada Centre for Inland Waters at Environment and Climate Change Canada. He is actively involved in collaborative work with toxigenic and harmful algal blooms and source-water impairment in systems across Canada including in the Lake of the Woods, Lake Winnipeg, Lake Erie, and Lake Ontario. His research examines the factors regulating the abundance and diversity of microbes, their chemical ecology, and the fate and consequences of toxins produced in these systems. Dr. Zastepa has developed expertise in the application of bioanalytical technologies and paleolimnological tools to aquatic ecosystem research and has led the design and execution of large-scale field studies and surveys.

Location of Study

Lake of the Woods, various sites

Loading of nutrients from cottages and other developments to the nearshore of Lake of the Woods

Dale R. Van Stempvoort¹, Will Robertson², and Ross MacKay¹, Pamela Collins¹, and Susan Brown¹

¹Watershed Hydrology and Ecology Research Division, Environment and Climate Change Canada;

²University of Waterloo

Approach of this study

- Sampling of nearshore lake water and groundwater
- Focus on analyses of nutrients
 - total P, dissolved P, nitrate, nitrite, ammonium



Abstract

The preliminary results of a study of loading of nutrients to the nearshore of Lake of the Woods are presented. This study focuses on three nearshore areas: Keewatin Bay, Poplar Bay and the Sioux Narrows area. In addition to analyzing nutrients and major ions, artificial sweeteners have been included as tracers of wastewater. To date (2016, 2017) the majority of samples were obtained from nearshore surface waters. Shallow groundwater samples were also collected (2017) at Keewatin and Sioux Narrows. At Sioux Narrows the groundwater was sampled in the vicinity of two septic fields. This study will continue through 2019.

Brief Bio

Dale Van Stempvoort is a Research Scientist with Environment and Climate Change Canada, Centre for Inland Waters in Burlington, Ontario. His research on contaminants in groundwater, focuses on assessment of the fate of organic contaminants in groundwater, analyses of organic chemicals as tracers of contaminant plumes in groundwater (e.g., artificial sweeteners), and emerging organic contaminants in groundwater (e.g. pharmaceuticals). He is the ECCC lead on groundwater with respect to the Great Lakes Water Quality Agreement and the Canada Ontario Agreement.

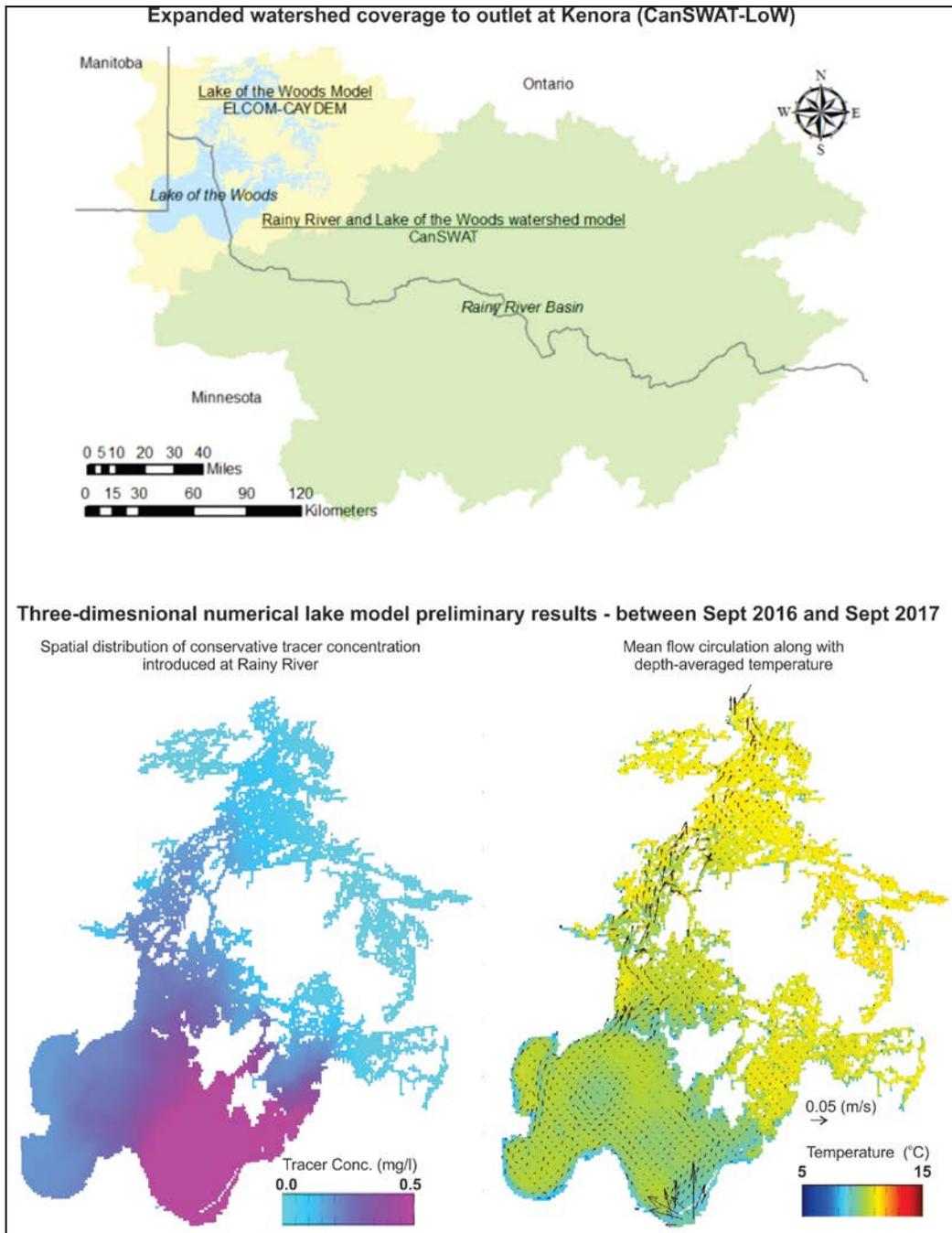
Location of Study

Lake of the Woods, various sites in northern sectors, including Poplar Bay, Keewatin Bay and Sioux Narrows.

ECCC's Lake of the Woods Integrated Modelling

Reza Valipour, Isaac Wong, Craig McCrimmon, Jun Zhao, Felix Ouellet, Paul Klawunn and Ram Yerubandi

ECCC, Water Science and Technology, Canada Centre for Inland Waters, Burlington, Ontario, L7S 4A1



to (i) provide lake input loading estimates for modelling lake responses, (ii) assess a combination of BMPs, particularly for forests and agriculture, for their impact on nutrient dynamics and lake loadings, (iii) assess climate change adaption scenarios (iv) compare results with previous models, and (v) determine if the suggested BMPs can be used to meet targets such as total maximum daily load (TMDL) to the lake. The integrated modelling framework can also be used for proposing bi-national nutrient management objectives as required. Two hydrodynamic- water quality models 1. ELCOM-CAEDYM to simulate seasonal hydrodynamics and water quality in the lake, and Delft 3D model to simulate surface waves and sediment transport are used to assess algal blooms and sediment erosion characteristics in the lake. These models use spatially variable observed winds from bi-national stations, Rainy river inflows and Kenora and Norman dams' outflows, and are initialized using observed hydrodynamic and water quality profiles across the lake. The accuracies of model results are examined using extensive field observations collected during two different years (2009-2010 and 2016-2017).

In addition, a spill risk assessment modelling prototype is being developed for LoW's watershed to understand the extent of spill scenarios using different modelling and GIS approaches. The expected results are risk maps that will be developed to incorporate the results of overland, river and lake modelling of possible road, rail and pipeline spills to show possible locations of at-risk resources, extent of spill, flow paths and travel times, river/lake plumes, and timing to reach locations.

Brief Bio

Reza Valipour is a Research Scientist with Environment Climate Change Canada since 2017 with a focus on lake modeling to three-dimensionally simulate water circulations and water quality in lakes. He received my PhD in Civil Engineering from Queen's University in 2012 and his thesis was to describe predominant lake-wide physical processes and mechanisms behind sediment resuspension in Lake Erie - supervised by Dr. Leon Boegman and Dr. Damien Bouffard. After his PhD and working in private sectors, he joined Environment Climate Change Canada in 2014 as a post-doc to work on lake modeling research projects - supervised by Dr. Ram Yerubandi. He is currently working on the modeling of water circulations, sediment transport and water quality in the Lake of the Woods which includes extensive lake-wide field data collections. In addition, Reza am involved in research projects in other large lakes including Lake Erie, Lake Winnipeg, Lake St. Clair and Lake Ontario.

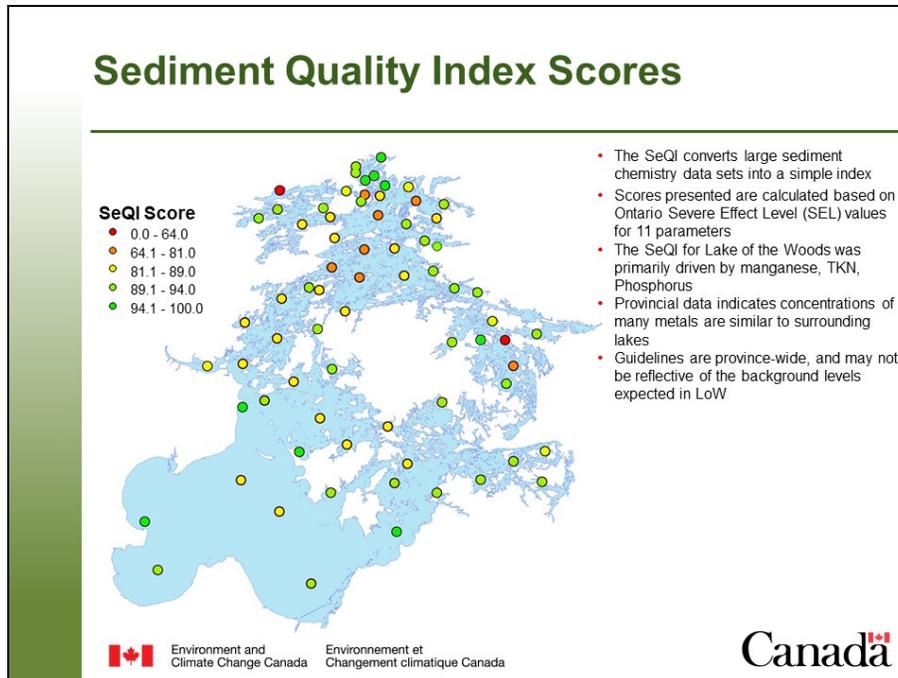
Location of Study

Lake of the Woods and the Rain-Lake of the Woods basin.

Lake of the Woods Monitoring Updates from ECCC: pre-mining metal concentrations in Lake of the Woods and Rainy River

Tana McDaniel and Tim Pascoe

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



Abstract

Environment and Climate Change Canada (ECCC) has been monitoring water quality on Lake of the Woods since 2008, as part of a larger monitoring initiative undertaken to address environmental concerns within the Lake Winnipeg Basin. While nutrients have been the primary focus of the initiative, a risk based analysis identified other potential impacts in the basin which would also benefit from long-term monitoring. Sediment sampling by ECCC during earlier work identified areas in the lake where the concentrations of nutrients and some metal species (Ni, Cu, Cr, Ni, Mn) exceeded provincial sediment quality guidelines. To help interpret these exceedances, and to establish a monitoring baseline for the Lake, ECCC began sampling surface water for metals in the fall of 2015. In 2017, sampling was further expanded to include metals at bottom depths for all ECCC monitoring locations within the lake. An ISCO auto sampler was also deployed in the Pinewood River in the spring of 2017, as part of the expanded monitoring under the new program targeted to the Lake of the Woods basin. This talk will present a preliminary examination of data from both of these efforts, and discuss any emerging patterns.

Brief Bio

After completing a Masters degree in Environmental Planning at the University of Waterloo, Tim joined Environment and Climate Change Canada in 1998. Working with a benthic macroinvertebrate research group, he applied his unique cross-discipline experience to the development of web-enabled tools and distributed data systems for benthic data management and sediment assessment. In 2008, shortly after moving to ECCC's Water Quality Monitoring and Surveillance Division, he became involved in the Lake of the Woods, where he continues to coordinate ECCC monitoring efforts. Tim also continues to work on the integration of new technologies to monitoring, partnering with ECCC research to expand the role genomic barcoding through the use of eDNA for bioassessment.

Location of Study

Multiple locations across entire Lake of the Woods

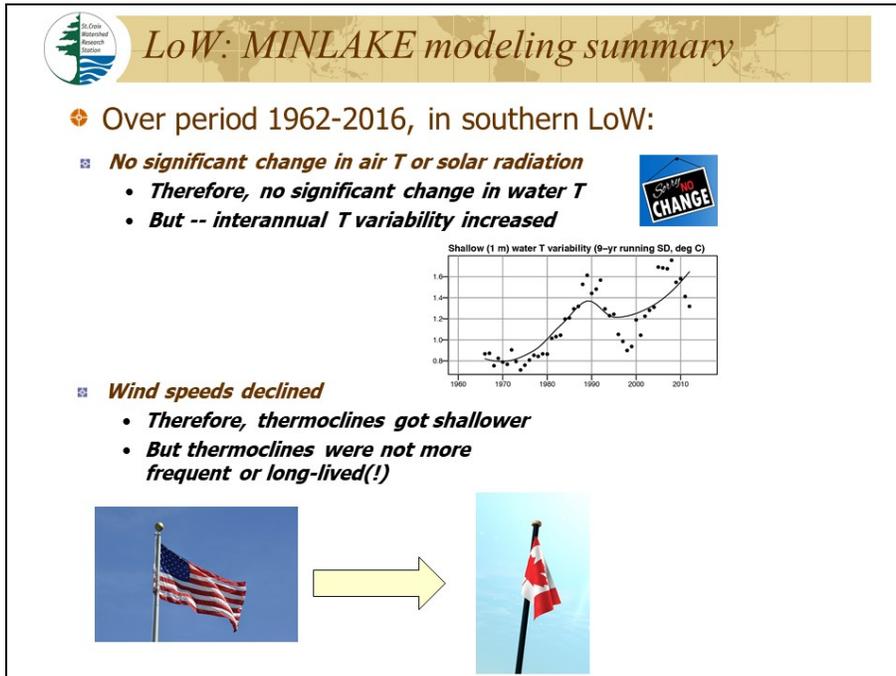
Session 7 – Lake of The Woods Basin South - Minnesota

Trends in weather variables and modeled thermal structure for southern Lake of the Woods from 1962-2016

Almendinger, J.E.^{1*}, Edlund, M.B.¹, Heathcote, A.J.¹, and Hernandez, C.²

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

²Minnesota Pollution Control Agency, 714 Lake Avenue, Suite 220, Detroit Lakes, MN 56501



Abstract

We hypothesized that algal blooms in Lake of the Woods may be driven by release of sediment-bound phosphorus during periods when lake thermal stratification reduces hypolimnetic dissolved oxygen. However, except for two years of high-frequency thermistor string data collected recently (2015-16), the detailed daily thermal structure of Lake of the Woods is virtually unknown, and no long-term records exist to allow trend analysis. To address this knowledge gap, we ran a thermal model for the main basin of Lake of the Woods for a 55-year period (1962-2016) using the MINLAKE2012 modeling program, which uses daily temperatures, wind speeds, and solar radiation inputs to predict lake thermal response, notably thermocline formation. To provide a very simple and robust test of the significance of trends over the 55-year period (1962-2016), we divided the data set into two nearly equal halves (27 and 28 years each) and tested their difference with a Mann-Whitney U test. Mean annual air temperatures increased significantly ($p = 0.006$) by about 1°C . In contrast, summer temperatures did not increase ($p = 0.71$), demonstrating that the annual temperature increase was driven by the other seasons. Likewise, water temperatures did not increase significantly. However, what did increase was interannual variability of water temperature, calculated as a running standard deviation for a 9-year centered window applied sequentially along the data set ($p < 0.001$).

The trend in wind speeds was more obvious, with both annual and summer wind speeds dropping by about 1 m/s ($p \ll 0.001$ in both cases). Reduced wind speeds would reduce turbulent mixing and therefore favor more frequent and stable thermal stratification in the lake, all other factors remaining the same. However, the thermal modeling did not support this result: despite the reduced wind speed, there was no significant increase in the number or duration of events when

the lake was temporarily thermally stratified. If true, then an increase in algal blooms over the past 55 years (if any) is not explained by an increase in stratification events.

Brief Bio

Jim Almendinger is the Director of the Science Museum of Minnesota's St. Croix Watershed Research Station. Beyond the thermal modeling discussed in this presentation, his areas of research include watershed modeling, wetland hydrology, and paleohydrology.

Location of Study

Lake of the Woods, southern basin

Lake of The Woods Total Maximum Daily Load Study: A progress report

Cary Hernandez¹, Mike Hirst², Geoff Kramer³

¹Minnesota Pollution Control Agency, 714 Lake Avenue, Detroit Lakes, MN, 56501, PH 218-846-814, cary.hernandez@state.mn.us; ²Lake of the Woods Soil and Water Conservation District, 119 1st Ave NW PO Box 217, Baudette, MN 56623, PH 218-634-1842 ext#3, mike.hirst@mn.nacdnet.net; ³RESPEC Water & Natural Resources, 1935 West County Road B2, Suite 230, Roseville, MN 55113; PH 651-305-2274, geoff.kramer@respec.com

Reductions at a Glance: Major Categories at the Source

	Source	Existing Load (t/y)	Proposed Load at source (t/y)	Reduction (t/y)	% Change at Source
Waste Load	Wastewater	88.9	45.2	43.7	-49%
	Industrial Stormwater	0.8	0.8	0.0	0%
	Construction Stormwater	0.4	0.4	0.0	0%
Load	Tributaries	373.5	336.4	37.1	-10%
	Lakeshed	17.1	17.1	0.0	0%
	SSTS	0.7	0.4	0.3	-43%
	Shoreline Erosion	72.0	60.5	11.5	-16%
	Atmospheric Deposition	51.4	51.4	0.0	0%
	Internal Loading	282.0	211.5	70.5	-25%
	Total		886.9	723.8¹	163.1¹

1: Total load does not include Reserve Capacity (0.9 t/y) or Margin of Safety (46.3t/y)

Abstract

In 2008, the U.S. Environmental Protection Agency placed the Lake of the Woods on the "Impaired Waters List" for failing to comply with water quality standards conducive to aquatic recreation due to eutrophication. The U.S. Clean Water Act requires states to perform Total Maximum Daily Load (TMDL) studies on their impaired waters. TMDL studies identify water quality standards and goals/targets for U.S. waterbodies, recommend pollutant load allocations to meet the targets, and provide opportunities for stakeholders and communities to engage in the process of watershed management planning to adopt protection and restoration practices. In 2015, the Minnesota Pollution Control Agency (MPCA), in partnership with the Lake of the Woods Soil and Water Conservation District and RESPEC Water and Natural Resources, began working on the Lake of the Woods TMDL study.

To prepare the TMDL, discharge and nutrient loading from Lake of the Woods' tributaries were characterized using the Hydrologic Simulation Program-Fortran (HSPF), which was run for the period 1996-2014 and calibrated to available tributary monitoring data. HSPF output for the TMDL study period (2005-2014) was used to develop a Bathtub model for the lake, which is used to determine the in-lake response to nutrient loading and thereby the loading capacity of the lake. A mass balance analysis of internal phosphorus loading was conducted to quantify internal loading for use in Bathtub. The Bathtub model has been used to determine the annual loading the lake can support while achieving its water quality standards. While declines in phosphorus loading have occurred as wastewater treatments have improved, further reductions are needed. Internal loading also remains a major phosphorus source. A review of US and Canadian point source discharges is underway to finalize present and future conditions including growth expectations. TMDL allocations are being finalized as part of the TMDL report.

Brief Bio

Cary Hernandez is a watershed project manager working out of the MPCA's Detroit Lakes Office. Cary works with watersheds throughout the Red River Valley and the Lake of the Woods/Rainy River Basin. Cary has been with the MPCA for the past 26 years.

Mike Hirst holds a B.S. in Geology and Technology from the University of North Dakota and has been employed with LOW SWCD for 14 years. His background in natural resources conservation includes: water quality monitoring, data analysis, water management planning, wetland conservation, aquatic invasive species, working with private landowners on water quality projects and compliance with regulations, education & outreach and serving on local & international boards/committees in the Rainy – Lake of the Woods Watershed.

Geoff Kramer holds an M.S. in Biosystems and Agricultural Engineering from the University of Minnesota. He has extensive experience with hydrologic and water quality modeling in diverse areas such as snowmelt modeling and lake nutrient modeling. He has extensive experience with agricultural drainage design, policy, and related water quality BMPs. He also has experience with economic analysis and complex analysis related to cost effectiveness of BMPs and BMP treatment trains.

Location of Study

Lake of the Woods and its tributaries.

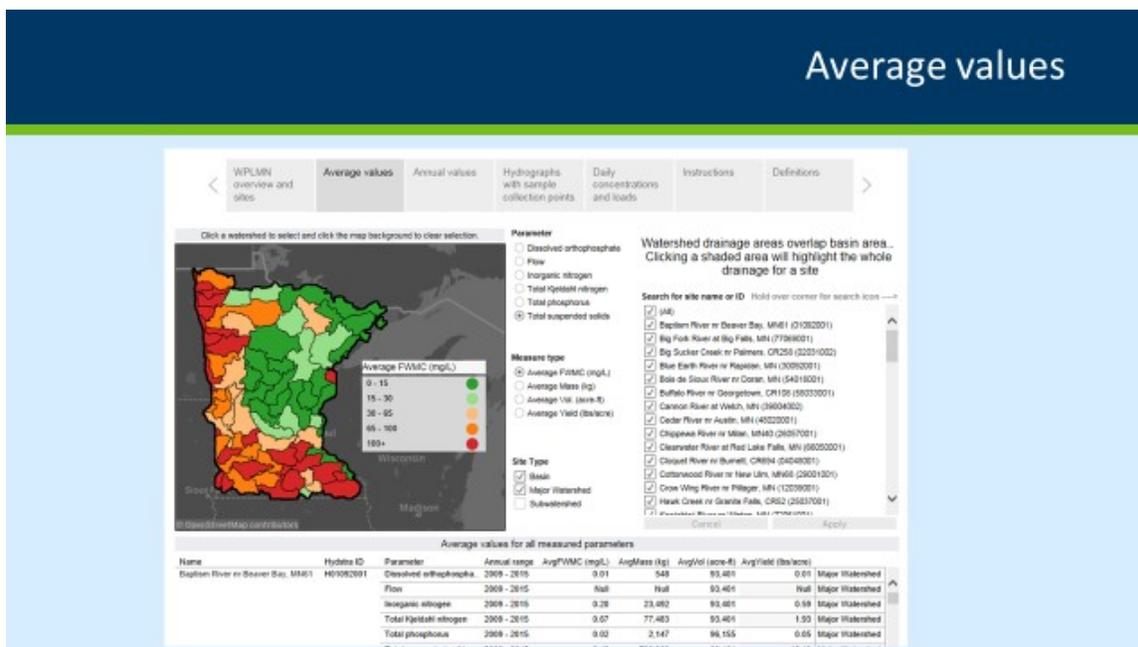
The Watershed Pollutant Load Monitoring Network –program overview and water quality results

Patrick Baskfield

MPCA, 12 Civic Center Plaza, suite 2165, Mankato, MN 56001

507-344-5240

pat.baskfield@state.mn.us



Abstract

The Clean Water Land and Legacy Amendment is providing an unprecedented opportunity to enhance monitoring of Minnesota waters and our understanding of the relative contributions of pollutants from various sources and waters. One example is the Minnesota Pollution Control Agency's (MPCA) Watershed Pollutant Load Monitoring Network (WPLMN), a long-term statewide river monitoring network initiated in 2007 and designed to obtain pollutant load information from 199 river monitoring sites throughout Minnesota. The program utilizes state and federal agencies, universities, local partners, and MPCA staff to collect water quality and flow data to calculate nitrogen, phosphorus, and sediment pollutant loads. This presentation includes a brief overview of the WPLMN followed by a detailed demonstration of a recently developed interactive application that allows the user to graphically review and download daily, annual, or average pollutant load, yield, or concentration data calculated by the WPLMN.

Brief Bio

Patrick Baskfield has been employed as a hydrologist by the Minnesota Pollution Control Agency for the past twenty-two years. In 2008 Patrick was hired as the Monitoring Coordinator of the Watershed Pollutant Load Monitoring Network, a statewide river monitoring network of 199 monitoring sites. Program goals include determining spatial and temporal differences in river water quality and tracking water quality trends. Patrick received his undergraduate degree from the University of Minnesota Duluth and a Master's Degree in Forest Hydrology from the University of Minnesota, St. Paul campus.

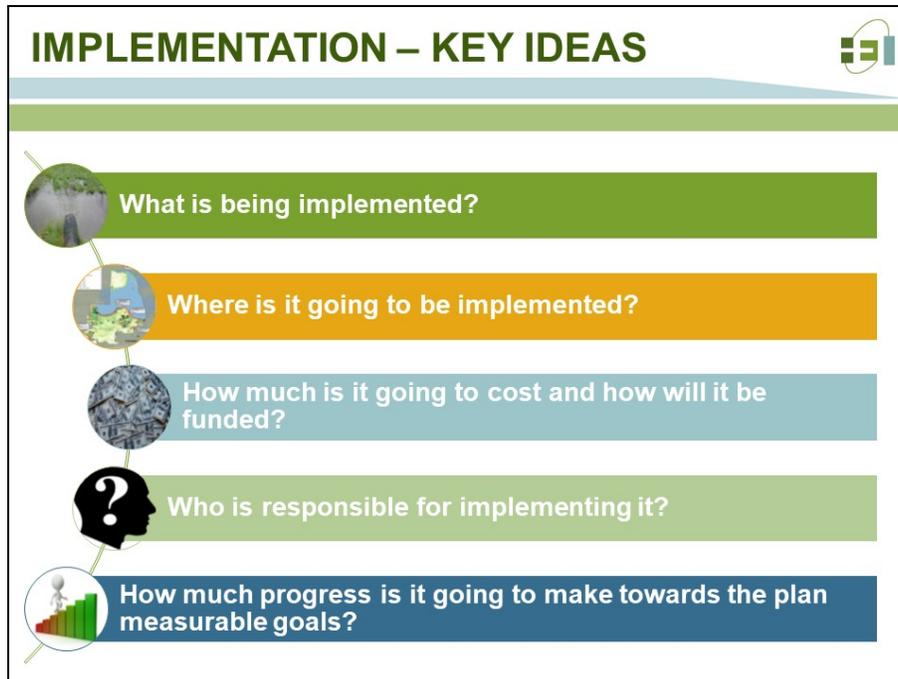
Location of Study

Statewide, including the several sites within the Rainy River watershed.

Lake of the Woods Watershed (MN): A One Watershed, One Plan Update

Jeremiah Jazdzewski

Houston Engineering, Inc., 6901 East Fish Lake Road, Suite 140, Maple Grove, MN 55369
763-493-6689 jjazdzewski@houstoneng.com



Abstract

In 2012, the State of Minnesota, through the Board of Water & Soil Resources (BWSR), initiated a shift in the entire framework of how local watershed planning would occur across the state; this planning framework has come to be known as One Watershed, One Plan (1W1P). BWSR's vision for 1W1P is to align local water planning on major watershed boundaries with state strategies towards prioritized, targeted, and measurable implementation plans. In 2016, Lake of the Woods Watershed (MN) applied and was selected to undergo the 2-year process of developing a comprehensive watershed plan, encompassing portions of Lake of the Woods (including the Northwest Angle) and Roseau counties. The planning partners include both counties, their respective Soil & Water Conservation Districts (SWCDs), the Warroad River Watershed District (WRWD), the Red Lake Department of Natural Resources (DNR), and a variety of State agency personnel. The plan development is currently nearing its halfway point. This presentation will give an update on the planning process and include: an overview of the plan purpose and process, an update on the planning work completed to date, a look at the local engagement and participation applied in the planning, and information about how LOW Watershed Forum participants can keep up-to-date on the planning process and results, as it moves towards finalization in 2019.

Brief Bio

Jeremiah Jazdzewski is a licensed professional engineer with Houston Engineering, Inc. He has a B.A. in Physics from Gustavus Adolphus College and a M.S. in Civil Engineering from the University of Minnesota. He has 15+ years of engineering and research experience, including research at the Saint Anthony Falls Laboratory and private consulting in both environmental remediation and water resources engineering. He has worked on projects in the Lake of the Woods watershed since 2012 and is currently working with the Lake of the Woods – 1W1P, Planning Partners to facilitate the planning meetings and assist with the overall plan development.

Location of Study

Lake of the Woods Watershed (Minnesota)

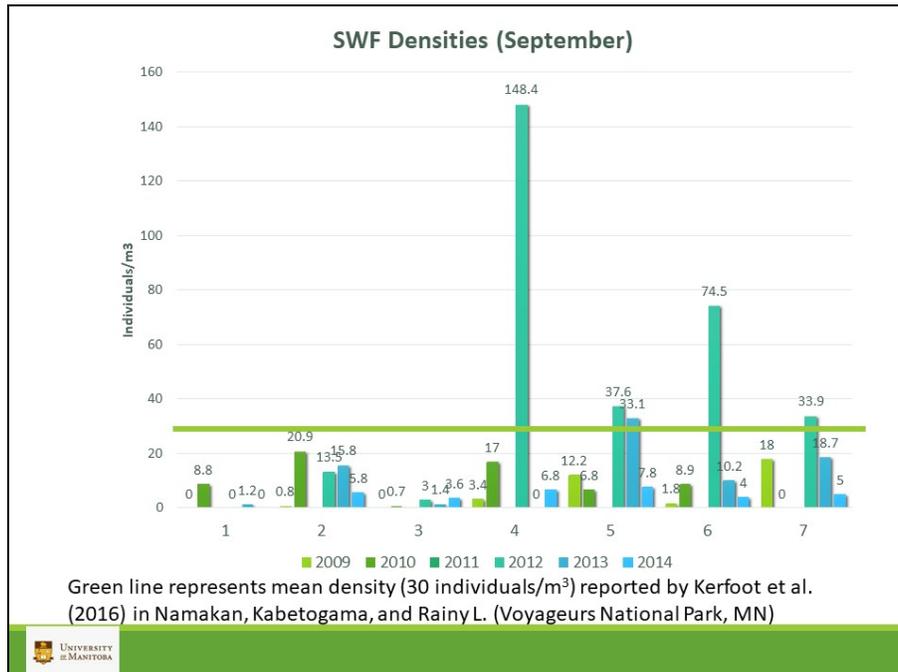
Session 8 – Fish Part 2, Invasives And More

Hotspots of *Bythotrephes* (Spiny Water Fleas) in Lake of the Woods: Where? When? Why?

Brend Hann

Department of Biological Sciences, University of Manitoba, Winnipeg, MB, Canada.

Brenda.Hann@umanitoba.ca



Abstract

Bythotrephes longimanus, an invasive zooplankton from Eurasia, invaded Lake of the Woods around 2007. Once established, it has had a strong negative impact on the zooplankton community in other large lakes. Sampling programs to evaluate the population densities of SWF and zooplankton have been carried out with the assistance of Environment Canada (June/September, 2009-2014) and Ontario Ministry of Natural Resources (May-October, 2007-2013) at numerous sampling stations throughout the lake. Highest densities were recorded in late summer/early fall from 2009, primarily along the main current flow pathway from the Rainy River outlet to Kenora and the Normal Dam. Environmental factors influencing these distribution patterns were explored. Preliminary impacts on zooplankton populations will be evaluated.

Brief Bio

Brenda is a Professor in the Department of Biological Sciences, University of Manitoba. Her research focuses on biodiversity, ecology and environment, ecology of benthic and planktonic communities in Lake Winnipeg and Lake of the Woods, invasive zooplankton species, ecology of littoral invertebrate communities, invertebrate grazer-algal interactions, Cladocera ecology, palaeoecology of communities in the littoral zone of lakes, and systematics.

Location of Study

Lake of the Woods, various locations

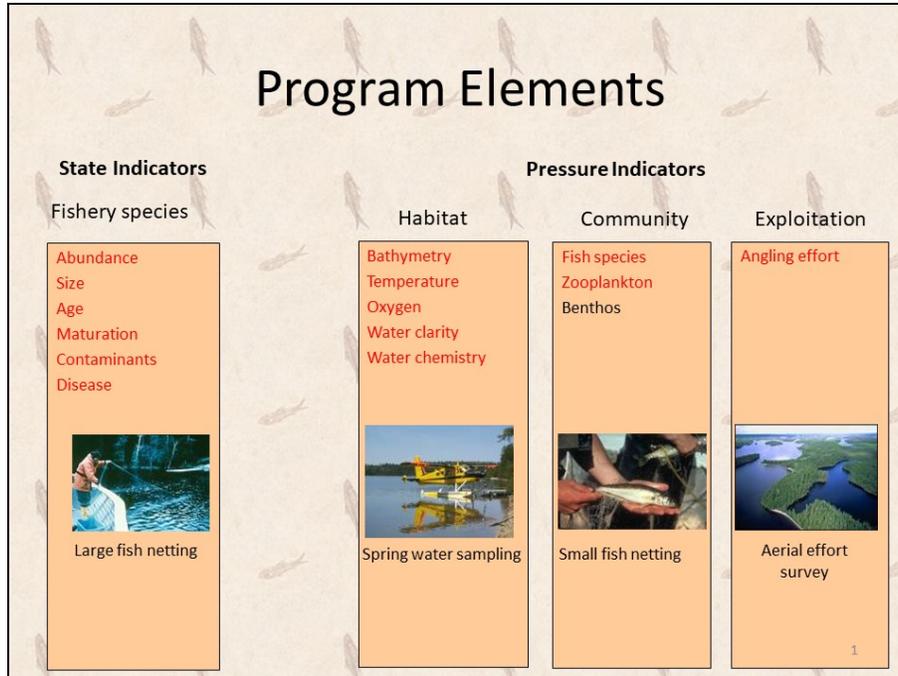
Fish and fishery monitoring in Rainy-Lake of the Woods Watershed

Kim Armstrong

OMNRF

#173 – 25th Side Road, Rosslyn, ON P7K 0B9

(807)939-3138; kim.armstrong@ontario.ca



Abstract

The monitoring of Ontario's fisheries resources has shifted focus from individual lake management to landscape level management. The Broad-scale Monitoring (BsM) program is now the primary program used to assess the status and trends in Ontario's fisheries resources. The BsM netting protocol samples all areas and depths of the lake which strives to capture the entire fish community including the small fish community. To date approximately 1,500 surveys have been completed in the province of Ontario. Within the Lake of the Woods watershed, 135 lakes have been sampled including Namakan, and sectors on Lake of the Woods. This presentation will talk about the components of the program, how lakes are selected, some results from the Lake of the Woods watershed, the calibration of new gear to old, and an introduction to the analysis used.

Brief Bio

Kim has worked for more than 30 years for the Ontario Ministry of Natural Resources & Forestry. Kim has worked in number of locations across the province and is now located in Thunder Bay. He started his career doing graduate research on Lake of the Woods in the early 1980s. Kim has worked in a variety of positions including Fisheries Research, Regional Aquatic Science support and Water Management. He is currently the Program Lead for the Provincial Aquatic Monitoring programs (e.g. Broad-scale Monitoring) as well as providing Science support for fisheries management.

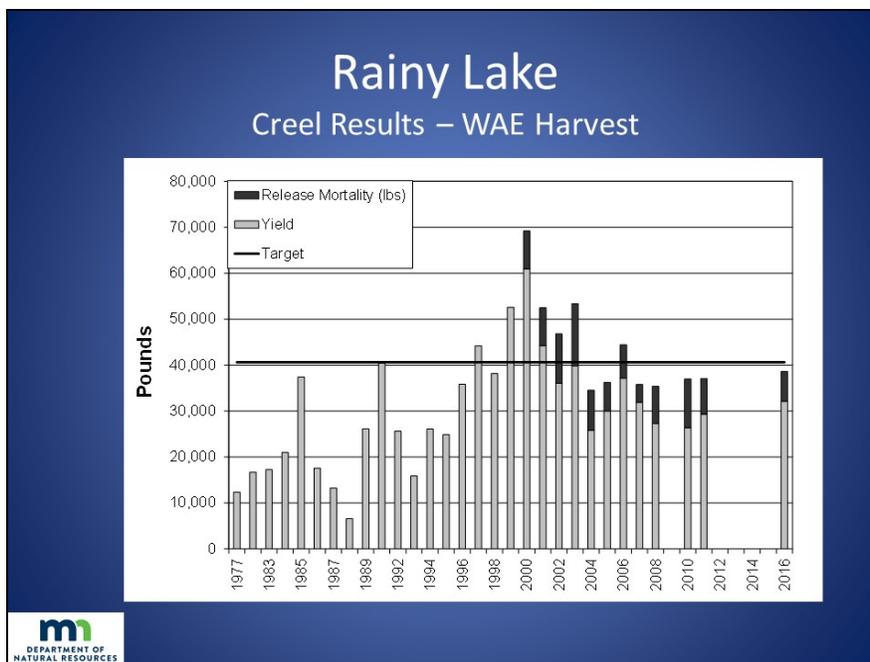
Location of Study

Province-wide in Ontario, 135 lakes in the Lake of the Woods watershed including Namakan Lake and sectors of Lake of the Woods.

MN DNR update on the current status of fish stocks in Rainy Lake and the Namakan Reservoir

Ben Vondra

Minnesota Department of Natural Resources
392 Hwy 11 East, International Falls, MN 56649
218-286-5220 Ext. 223; benjamin.vondra@state.mn.us



Abstract

The Minnesota Department of Natural Resources manages the fisheries on the Minnesota side of Rainy Lake and the lakes within the Namakan Reservoir. Rainy and Kabetogama Lakes are part of the MN DNR Large Lake Monitoring Program which includes rigorous, standardized, annual sampling on each of the ten largest Walleye Lakes in Minnesota. The Large Lake Program was implemented in 1983, which has allowed for the compilation of a large data set of standardized fisheries population information. This presentation will focus on the results of the annual sampling on Rainy and Kabetogama Lakes as well as periodic creel surveys that have been carried out on these lakes. Namakan and Sand Point Lakes have also been sampled annually with gill nets since 1983 and a brief status of these fisheries will be presented. Walleye, the most sought after and harvested species on this chain of lakes, will be the main focus of the presentation. Many changes have occurred in these bodies of water over the years and I will discuss the management strategies employed in the past, how they have impacted these lakes, as well as current strategies and regulations.

Brief Bio

Ben Vondra is a Large Lake Specialist for the Minnesota Department of Natural Resources Fish and Wildlife Division. His career has spanned 11 years working in several offices across the state of Minnesota. Ben has worked at the International Falls Fisheries Office as the Large Lake Specialist since 2011. His primary responsibilities include carrying out the monitoring program for the two large Walleye lakes in the International Falls work area; Kabetogama and Rainy Lake. This work includes a rigorous annual sampling program maintaining and interpreting the long-term data sets for these lakes, and annual reporting and presenting of the findings. He also designs and implements periodic creel surveys and studies as needed. Ben has a Bachelor of Science degree in Biology from the University of Iowa and a Master of Science degree in Fisheries and Aquatic Resources from the University of Minnesota-Twin Cities campus.

Location of Study

Minnesota side of Rainy Lake and the lakes within the Namakan Reservoir, including Rainy Lake, Namakan Lake and Sand Point Lake.

Sampling techniques for juvenile Lake Sturgeon in the lower Rainy River: Past, present, and future

Brett Nelson

Minnesota Department of Natural Resources
204 Main Street East, Baudette, MN 56623
Phone: 218-634-2522 ext 230
Email: brett.nelson@state.mn.us

Summary

- **Unique life history**
- **Over harvest/habitat degradation**
 - Nearly extirpated/WQ hinder recovery
- **Stock Status**
 - CPUE has increased (Reach 1)
 - Most vulnerable at age-1 to 5 (82%)
 - Develop a length-at-age criteria – monitor growth
 - Need a wide range of mesh sizes
 - Expand to Upper Rainy River/Tributaries
 - Inclusion of site specific habitat parameters



15

Abstract

Lake Sturgeon is an ancient fish species inhabiting the Lake of the Woods – Rainy River ecosystem. Over-exploitation due to commercial fishing and anthropogenic habitat degradation nearly extirpated Lake Sturgeon from the Rainy River watershed. With the enactment of the Clean Water Act and more conservative harvest regulations, Lake Sturgeon stocks have steadily improved. Lake Sturgeon have a complex life history that requires specific spatial and temporal habitat conditions. Lake Sturgeon are long-lived, slow to mature, and spawn intermittently. Maturity for male Lake Sturgeon is reached around age-12 and age-20 for females. This unique characteristic makes them extremely vulnerable to over-harvest. Reproductive success and population trends can be identified by assessing juvenile life stages. Since 1991, small mesh gillnetting (19.05 mm to 50.8 mm) has been done in the Rainy River to assess fish populations. Improvements in assessment protocols have improved our ability to effectively sample juvenile Lake Sturgeon in the lower Rainy River. This talk explores past, present, and future sampling methodology employed in the Rainy River and provides an update on juvenile stock of Lake Sturgeon inhabiting the Lower Rainy River.

Brief Bio

Brett Nelson is a fisheries specialist, Baudette Area Fisheries, Minnesota Department of Natural Resources.

Location of Study

Lower Rainy River.

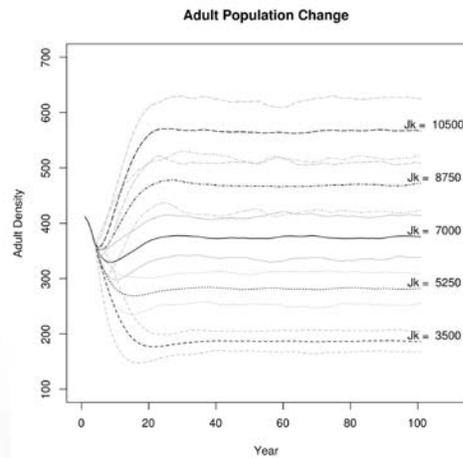
Modelling the effect of juvenile population density on recruitment of lake sturgeon in the Namakan Chain of Lakes

Jim Burchfield and Brian McLaren

Lakehead University
955 Oliver Road, Thunder Bay, ON P7B 5E9
(831) 713-8555; jburchfi@lakeheadu.ca

Results

Scenario	Time to Equilibrium (years)	Magnitude of Change
decreased from 7000 to 3500	21	-273
decreased from 7000 to 5250	17	-142
increased from 7000 to 8750	20	+124
increased from 7000 to 10500	25	+216
Recovery	42	+376



Abstract

Lake sturgeon occupy distinct and probably more restrictive habitat as juveniles compared to adults of the species. Conserving juvenile habitat is widely regarded as important to management of lake sturgeon. Not enough is known, however, about how juveniles use habitat. The Namakan Chain of Lakes presents a good opportunity to study habitat use by juvenile lake sturgeon and its effects on recruitment in a relatively stable population. In this study we fit an autoregressive model to the age-structure data of lake sturgeon captured in the Namakan Chain of Lakes to test whether population density in the juvenile stage affects recruitment. We then examined the effect of juvenile density on the overall health of the population in a stock-recruitment context by modifying an existing stage-structured model to include density dependent mortality in the juvenile stage. Varying the maximum population of juveniles within the system immediately affects the overall population, reaching a new post-recruitment carrying capacity within 25 years. The limiting effect of reduced recruitment during periods of high juvenile population density suggests that the availability of high quality juvenile habitat may be an important bottleneck here and within similar river and lake complexes in the region.

Brief Bio

Jim Burchfield is a PhD candidate in the Faculty of Natural Resources Management at Lakehead University. His research interest is the effect of juvenile habitat use on lake sturgeon populations in Northwestern Ontario, with a particular focus on the Namakan River.

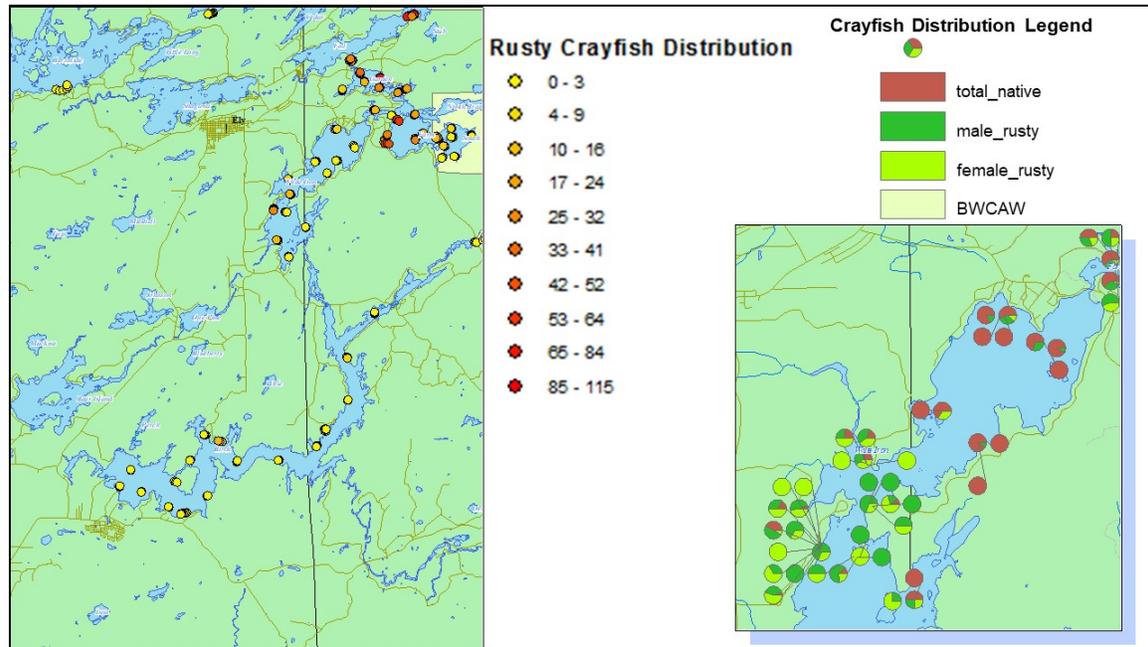
Location of Study

Namakan chain of lakes.

Rusty crayfish (*Orconectes rusticus*) monitoring and control in the Rainy Basin

Sonja Smerud, Darren Lilja, and Derrick Passe

Lake County Soil & Water Conservation District
408 1st Avenue, Two Harbors, MN 55616
(218) 834-8370
sonja.smerud@co.lake.mn.us



Abstract

Lake County SWCD and the U.S. Forest Service have been monitoring *O. rusticus* infestations in the Rainy Basin since 2005. Starting in the Summer of 2015, intensive crayfish trapping began along the White Iron Chain of Lakes, the Kawishiwi River, Birch Lake and Dumbbell Lake. Minnow traps were modified with a larger entry for crayfish, baited, and placed in selected locations overnight. Historical trapping sites determined locations, although additional sites were added. Crayfish at each trapping location were identified, sexed, and counted. Data was subsequently analyzed geographically and statistically. Certain chemical conditions, such as calcium, may have an effect on rusty crayfish population establishment and size. Biological catch data indicates the relationship between native and invasive crayfish caught is significant, with *O. rusticus* often the sole catch in waterbodies with long-established populations. Male crayfish are caught significantly more frequently than females in both native and invasive species, although that relationship is slightly less, but still significant, for *O. propinquis*. *O. rusticus* control through trapping, as hypothesized and with a focus on elimination of large breeding males, is not effective with established populations. However, some *O. rusticus* populations have plateaued in growth independently, resulting in a slight native crayfish population rebound in some instances. Focusing intensive trapping efforts on the leading edge of invasions has initially shown effective control for *O. rusticus* where waterbody channels are narrow or more geographically isolated, such as Birch Lake. The Kawishiwi River shows an average *O. rusticus* size of 4.51cm (n=9314). Citizen trapping and monitoring has been a key method of establishing trends in invasive crayfish populations, especially along the White Iron Chain of Lakes, although trappers do not reliably report catch numbers. Citizen science and transparency of data from agencies aids outreach. Prevention of additional populations and outreach is the most effective control of *O. rusticus* at this time. Although Lake County SWCD intends to continue selective crayfish trapping, additional research on advanced and effective control methodology and the impacts of invasive crayfish on lake systems is needed.

Brief Bio

Sonja Smerud is the AIS and Water Plan Coordinator for Lake County SWCD. Through her work, she has focused on integrated citizen science and biological monitoring of aquatic invasive species. Sonja has a dual degree in Biology and Political Science from St. Olaf College, Masters Certificate in Education from University of Minnesota-Duluth in cooperation with Wolf Ridge ELC, and has completed graduate research on environmental policy in Munich, Germany.

Darren Lilja is the Rainy River Headwaters Outreach Coordinator with Lake County SWCD and Superior National Forest Aquatic Technician with the U.S. Forest Service.

Derrick Passe is the District Engineer at Lake County SWCD. Derrick previously served as the Rainy River Project Coordinator and led the Kawishiwi Watershed Protection Project. He specializes in rusty crayfish and water quality.

Location of Study

White Iron Chain of Lakes

Regression-based peak flow analysis in StreamStats for the Lake of the Woods—Rainy River Basin

Pete Steeves¹, Chris Sanocki², Tara Williams-Sether³, and Michael Laitta⁴

¹USGS, New England Water Science Center / National Geospatial Program
508-490-5054; IJC Washington DC. psteeves@usgs.gov;

²USGS, Midwest Region; ³USGS, North Dakota Water Science Center; ⁴IJC Washington, DC



Abstract

Typically, the United States and Canada perform independent regression-based peak flow analyses for regions within their own borders and incorporate their results into national online water-data applications. The Rainy River Basin straddles the United States/Canadian border and extends across two Canadian Provinces and the State of Minnesota. Data for the U.S. side of the basin are collected State by State by the U.S. Geological Survey and incorporated into the StreamStats application. On the Canadian side, data are incorporated into the Ontario Flow Assessment Tool. With a growing population and increasing demands on shared water resources, the Rainy River Basin is the first binational River Basin for which peak flow analysis will be publicly shared online for the entire Rainy River Basin upstream of Kenora, Ontario.

Brief Bio

Pete Steeves is a USGS GIS Specialist, and has been a member of the National StreamStats Team since its inception in the late 90s. He also has been a member of the International Joint Commission Trans-boundary Data Harmonization Task Force - tasked with geospatial hydrography and watershed coordination between the USA and Canada - since its inception 10 years ago.

Location of Study

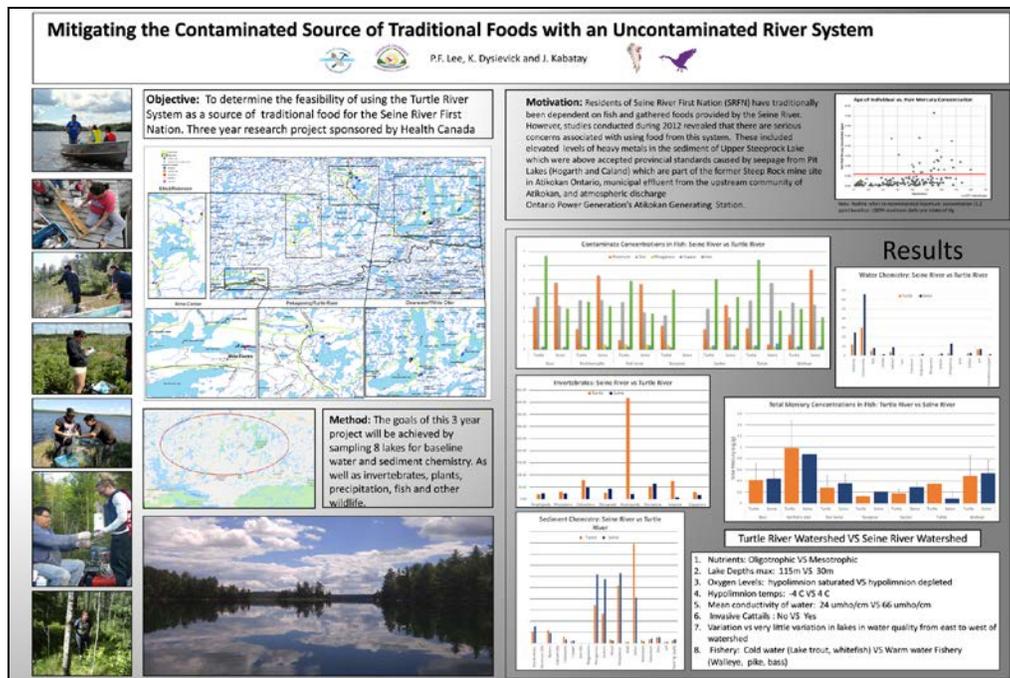
Rainy River basin

Poster Session Abstracts

Mitigating the contaminated source of traditional foods with an uncontaminated river system

Peter Ferguson Lee¹, Kristi Dysievick^{*1}, and John Kabatay²

¹Department of Biology, Lakehead University; ²Seine River First Nation



Abstract

Seine River First Nation (SRFN) residence are dependent on fish and other gathered foods from their traditional lands. Studies concluded in 2013 revealed concerns with using food from this watershed. These included elevated levels of heavy metals in the sediment of Upper Steeprock Lake below the former Steeprock mine site which were above accepted provincial standards, municipal effluent from the upstream community of Atikokan, and atmospheric discharge from Ontario Power Generation's Atikokan Generating Station. A particular issue was the incidence of high mercury levels in fish regularly consumed by community residents which was reflected in high mercury concentrations in the hair of frequent fish consumers. Wild rice, another traditional staple, was found to have increased levels of lead and mercury in normally harvested areas. Ducks, inhabiting the rice areas, further bio-accumulated mercury. Other terrestrial plant species were shown to vary in mercury concentration versus concentrations in the soil. This was an added concern, since, as well as being consumed by residents, concentrations of mercury could be further elevated in deer, moose and grouse as they browsed on these plants. Controlled experiments using *Lumbriculus variegatus* showed that future elevated sulphate levels from various point sources would further increase mercury concentrations.

Brief Bio

Kristi Dysievick is a Master student in the department of Biology at Lakehead University. Miss. Dysievick completed her honours bachelor's of water resource at Lakehead University in 2013. Kristi has experience working in Lakehead University Environmental Laboratory, which is an ISO 170025 accredited Laboratory. Her thesis is focusing on the re-establishment of Wild Rice and the potential influence of cattails on sediment characteristics which may be detrimental for Wild Rice development, growth and productivity.

Location of Study

Upper Steeprock Lake, Seine River, Turtle River (Rainy Lake Watershed).

Algal blooms, toxin production, and potential effects on ecosystem health, Kabetogama Lake, USA

Victoria G. Christensen¹, Ryan P. Maki², Erin A. Stelzer¹, and Jaime F. LeDuc²

¹U.S. Geological Survey, ²National Park Service



Abstract

Harmful algal blooms (HABs) containing toxin-producing cyanobacteria are a growing worldwide concern because they release toxins that can negatively affect humans, animals, and ecosystems. Microcystin is a widely monitored toxin associated with cyanobacteria; however, other toxins associated with HABs are not well characterized in the environment. Anatoxin-a and saxitoxin, two potent algal toxins, are not widely monitored despite known acute effects. We collected water samples from Kabetogama Lake in northern Minnesota from June through September in 2016-17 for laboratory analyses including phytoplankton identification, microcystin, anatoxin-a, and saxitoxin. In addition, quantitative polymerase chain reaction analyses were used to examine the cyanobacteria's DNA and determine potential for toxin production. Microcystin concentrations were lower than previous years; however, anatoxin-a and saxitoxin genes were present. Additional testing will indicate the concentrations of anatoxin-a and saxitoxin in Kabetogama Lake. An important finding related to public safety is that anatoxin-a and saxitoxin producing strains were present before the blooms were visible; thus development of screening programs for these toxins may benefit public health. The occurrence of anatoxin-a and saxitoxin in Minnesota waters also has implications for chronic health effects due to repeated exposure and effects on lake ecosystems.

Brief Bio

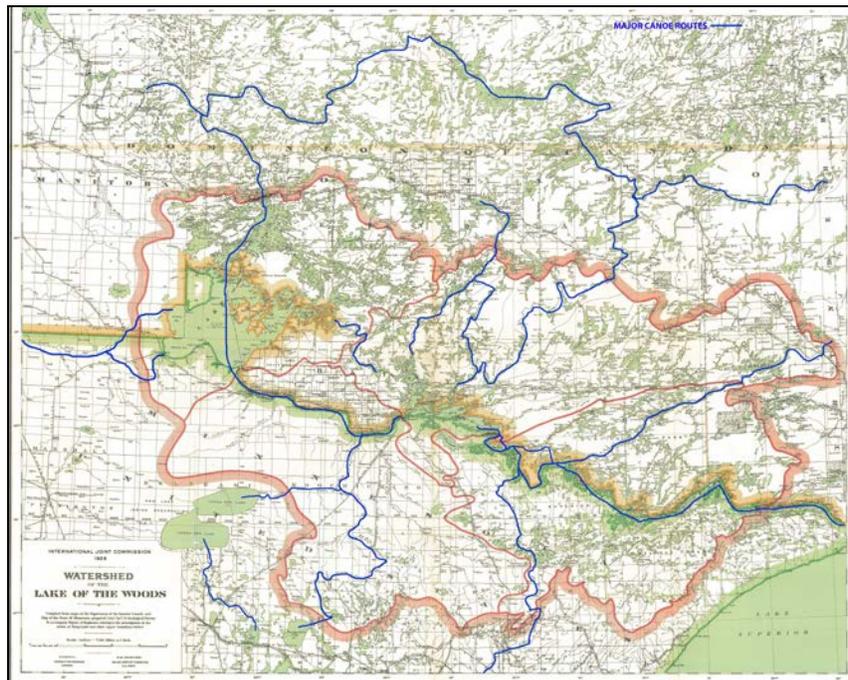
Victoria Christensen received her B.A. from Hamline University and B.S. and M.S. degrees from the University of Kansas. Her master's research examined the occurrence and fate of dissolved solids, nutrients, atrazine, and bacteria in an agricultural watershed. She joined the USGS Kansas Water Science Center in 1992 and the USGS Minnesota Water Science Center in 2002. Her interests and project work include real-time water-quality monitoring, effects of land use on water quality, the fate of nutrients in agricultural and reservoir systems, and reservoir sediment studies. She also has an interest in writing and communicating science topics to broad audiences and is a trainer and USGS Subject Matter Expert on Scientific Project Management.

Location of Study

Kabetogama Lake

Historic water routes in the Lake of the Woods - Rainy Watershed

Paul A. Anderson



Abstract

The LOW/Rainy Watershed is a crossroad for many water routes. Its location on one of only two major interior East-West water routes in North America further contributed to the frequent passage of French, British, Canadian and American explorers and fur traders through the region. Consequently, a high level of mapping activity occurred.

The poster session presents a sample of historic maps demonstrating the evolution of regional mapping and discusses and locates key portages and water routes in and out of the watershed.

Brief Bio

Location of Study

Rainy-Lake of the Woods Basin

Algal Toxin Test Strips: Effectiveness for Public Use

Jaime F. LeDuc¹, Victoria G. Christensen², Ryan P. Maki¹

¹ National Park Service - Voyageurs National Park, 360 Hwy 11 E Int'l Falls, MN 56649
(218) 283-6686 jaime_leduc@nps.gov;

² U.S. Geological Survey



Abstract

Algal toxins are a growing concern across the world. However, laboratory analyses for these toxins are time-consuming and expensive. Therefore, this project was designed to evaluate the effectiveness of newly available rapid assessment algal toxin test strips. The hope is that the test strips will be used for early warning of toxins. We used 58 Abraxis test strip kits to detect the presence of microcystin, anatoxin-a, and cylindrospermopsin at sites in Voyageurs National Park where harmful algal blooms frequently occur. We had a trained reader and an untrained reader interpret the results so we could evaluate how effective the test strips will be for public use. The results of the 58 test-strips used will be compared to toxin concentration data from a concurrent project at the same sites, where water samples were collected for analysis of toxins using quantitative polymerase chain reaction.

Brief Bio

Jaime LeDuc is a biological science technician employed at Voyageur's National Park.

Location of Study

Voyageurs National Park, Int'l Falls, MN USA

Restoration of hybrid cattail dominated wetlands in Voyageurs National Park

Bryce Olson, Claire Kissane, Steve Windels

National Park Service Voyageurs National Park, 360 Highway 11 E, International Falls, MN 56649
218-283-6694; bryce_olson@nps.gov



Abstract

The non-native narrowleaf cattail (*Typha angustifolia*) has the ability to hybridize with native broadleaf cattail (*Typha latifolia*) creating what is commonly known as 'hybrid cattails' (*Typha x glauca*). This aggressive hybrid is known to disrupt ecosystem balance by creating dense monotypic stands which displace native species and reduce biological diversity. Hybrid cattail is the dominant species in most wetlands in Voyageurs National Park, MN. A new project started in 2016 to reduce cattail abundance to help restore these wetlands to more diverse, natural states to improve habitat for wildlife, fish, and other taxa. We are testing various methods to remove invasive cattails and restore native plant species in Rainy and Kabetogama Lakes, designated as "Outstanding Resource Value Waters" where the use of herbicide is prohibited. Treatments include: mechanical harvesting machines, burning, winter scraping, and combinations of these methods timed with water level changes which are regulated under specific rule curves. We also are exploring the role of muskrats (*Ondatra zibethicus*) as natural biocontrol of cattails, including their role in creating and maintaining open water in large patch of cattails.

Brief Bio

Bryce Olson is a biologist for Voyageurs National Park where he has worked since 2008. He holds a Bachelor of Science in Fish & Wildlife Biology and a Master of Science in Biology. At Voyageurs, Bryce has worked on a variety of projects including forest restoration, air quality monitoring, and multiple wildlife research studies on moose, deer, bears, wolves, beaver, cormorants, and eagles. He is currently involved in a project to reduce exotic cattail abundance to help restore wetland habitats to a more diverse natural state.

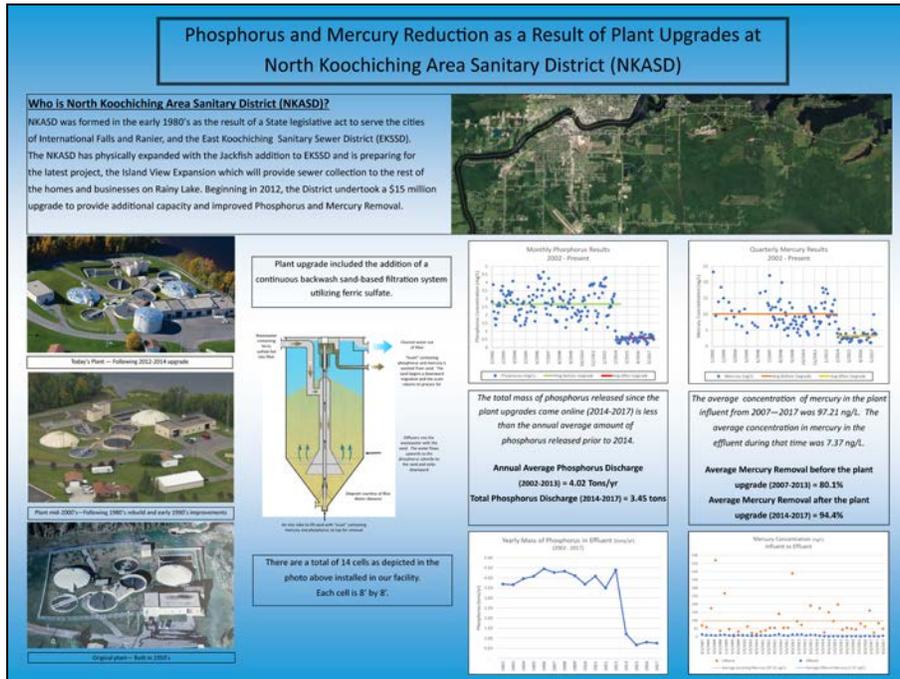
Location of Study

Rainy Lake, Namakan Lake, Voyageurs National Park

Phosphorus and mercury reduction as a result of plant upgrades at NKASD

Cyndy Strand

North Koochiching Area Sanitary District
1412 Highway 71, International Falls, Mn 56649
218.283.9388
cyndystrand@northkooch.com



Abstract

The North Koochiching Area Sanitary District was created in the early 1980's to treat the sanitary wastewater from International Falls, Ranier, and the East Koochiching Sanitary Sewer District (EKSSD). Following the creation of NKASD, the 1950's vintage plant had its first upgrade in the mid 80's. As time progressed, discharge standards evolved, and the physical coverage of the district increased with the first expansion of the EKSSD, as sewer collection and treatment expanded along the shores of Rainy Lake. By 2012, the NKASD treatment facility was undergoing its second major upgrade – a \$15 million project. This investment was primarily driven by aging infrastructure and changes to its discharge permit, which set limits on the amount of phosphorus that the plant could discharge into the Rainy River. Not only did the improvements significantly reduce the phosphorus discharges, but mercury removal rates also significantly increased.

Brief Bio

Cyndy Strand is currently the Executive Director at North Koochiching Area Sanitary District (NKASD) in International Falls, Minnesota. Previously, she worked in the paper industry in roles varying from chemical sales to environmental manager. She has a B.A. in Chemistry from The College of St. Scholastica and a B.S. in Paper Science and Engineering from The University of Minnesota, Twin Cities.

Location of Study

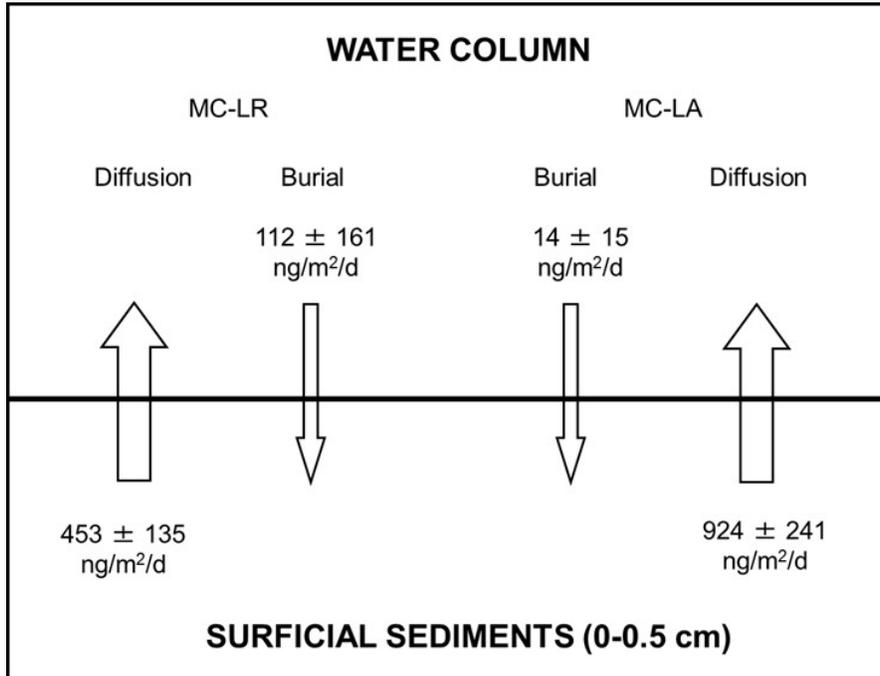
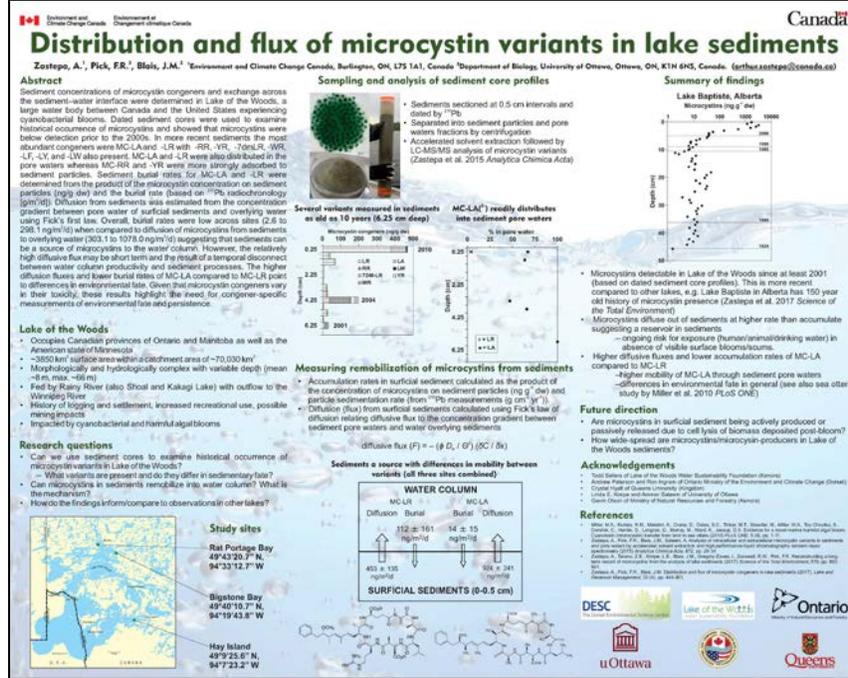
International Falls, Koochiching County. MN; Rainy River.

Distribution and flux of microcystin congeners in lake sediments

Arthur Zastepa¹, France R. Pick² & Jules M. Blais²

¹ECCC, Water Science and Technology, Canada Centre for Inland Waters, Burlington, Ontario, L7S 4A1;

²Department of Biology, University of Ottawa, Ottawa Ontario



Abstract

Sediment concentrations of microcystin congeners and exchange across the sediment–water interface were determined in Lake of the Woods, a large water body between Canada and the United States experiencing cyanobacterial blooms. Dated sediment cores were used to examine historical occurrence of microcystins and showed that microcystins were below detection prior to the 2000s. In more recent sediments the most abundant congeners were MC-LA and -LR with -RR, -YR, -7dmLR, -WR, -LF, -LY, and -LW also present. MC-LA and -LR were also distributed in the pore waters whereas MC-RR and -YR were more strongly adsorbed to sediment particles. Sediment burial rates for MC-LA and -LR were determined from the product of the microcystin concentration on sediment particles (ng/g dw) and the burial rate (based on ^{210}Pb radiochronology [g/m²/d]). Diffusion from sediments was estimated from the concentration gradient between pore water of surficial sediments and overlying water using Fick's first law. Overall, burial rates were low across sites (2.6 to 298.1 ng/m²/d) when compared to diffusion of microcystins from sediments to overlying water (303.1 to 1078.0 ng/m²/d) suggesting that sediments can be a source of microcystins to the water column. However, the relatively high diffusive flux may be short term and the result of a temporal disconnect between water column productivity and sediment processes. The higher diffusion fluxes and lower burial rates of MC-LA compared to MC-LR point to differences in environmental fate. Given that microcystin congeners vary in their toxicity, these results highlight the need for congener-specific measurements of environmental fate and persistence.

Brief Bio

Dr. Arthur Zastepa is a research scientist at the Canada Centre for Inland Waters at Environment and Climate Change Canada. He is actively involved in collaborative work with toxigenic and harmful algal blooms and source-water impairment in systems across Canada including in the Lake of the Woods, Lake Winnipeg, Lake Erie, and Lake Ontario. His research examines the factors regulating the abundance and diversity of microbes, their chemical ecology, and the fate and consequences of toxins produced in these systems. Dr. Zastepa has developed expertise in the application of bioanalytical technologies and paleolimnological tools to aquatic ecosystem research and has led the design and execution of large-scale field studies and surveys.

Location of Study

Meetings of Other Research / Working Groups Co-located Around The Forum Program

The following invitational meetings of collaborative groups are co-scheduled around the Forum program.

	Tues March 6	Wed March 7	Thurs March 8	Fri March 9	
8:30-9:00			Forum (Theatre)	Adaptive Management Workshop - VNP	
9:00-9:30		Forum (Theatre)	S6 – ECCC Science		
9:30-10:00	IMA (Joint TAC/WG) (30-40) RRCC S-119 Phone		S7 – R-LoW Basin MN		
10:00-10:30					
10:30-11:00		CAG (15) RRCC H-118 Phone	S1 – IJC Updates S2 – Policy Options Discussion		
11:00-11:30		IAG (10) RRCC SC-114 Phone			
11:30-12:00			Forum Lunch (Commons)		
12:00-12:30			Forum Lunch (Commons)		
12:30-1:00					
1:00-1:30			Forum (Theatre)		
1:30-2:00	IRLWWB (joint Board/CA G/ IAG) (45) RRCC S-119 Phone		S3 – Ecology P1	Forum (Theatre) S8 – Fish & Fisheries P2 S9 – Ecology P2	
2:00-2:30			S4 – Fish & Fisheries P1 S5 – Paleolimnol.		
2:30-3:00		IRLWWB (20) RRCC S-119 Phone			
3:00-3:30		LoW TMDL TAC (15) RRCC H-118 Phone			
3:30-4:00		Civic Eng. Workshop (15) Webinar /Phone RRCC SC- 114			
4:00-4:30	WLC RRCC (30) S-119 Phone				
4:30-5:00					
5:00-5:30			Forum Ends 4:30		
5:30-6:00			Poster Set-up (Hotel)		
6:00-6:30			Reception (Hotel)		
6:30-7:00			Guest Speakers		
7:00-7:30			Kallemeyn Award		
7:30-9:30			Wilson Award		

Acronyms

IJC	International Joint Commission
IRLWWB	IJC International Rainy-Lake of the Woods Watershed Board
CAG	Community Advisory Group to the RLWWB
IAG	Industrial Advisory Group to the RLWWB
IMA WG	International Multi-Agency Arrangement Working Group (managers)
IMA TAC	International Multi-Agency Arrangement Technical Advisory Committee
VNP	Voyageurs National Park (Park Headquarters)

Appendix A: Organizations Represented at Forum

Barr Engineering Co.
Big Grassy First Nation
Citizens – unaffiliated
Cook County Soil & Water Conservation District
Environment and Climate Change Canada
Global Affairs Canada (Could not attend due to winter storm)
Grand Council Treaty #3
Heart of the Continent Partnership
Houston Engineering, Inc.
IISD-Experimental Lakes Area
Independent Researcher
International Joint Commission
International Rainy-Lake of the Woods Watershed Board
International Rainy-Lake of the Woods Watershed Board - Community Advisory Group
Itasca County Soil & Water Conservation District
Koochiching County
Koochiching County Soil & Water Conservation District
Lake County Soil & Water Conservation District
Lake of the Woods Control Board
Lake of the Woods County
Lake of the Woods District Property Owners Association
Lake of the Woods County Soil & Water Conservation District
Lake of the Woods Water Sustainability Foundation
Lakehead University
Manitoba Sustainable Development
Member of the Parliament of Canada for Kenora
Miette Environmental
Minnesota Board of Water and Soil Resources
Minnesota Department of Natural Resources
Minnesota Pollution Control Agency
Nature Conservancy of Canada
Norbord Inc.
North Koochiching Area Sanitary District
North St. Louis County Soil & Water Conservation District
Northern Ontario School of Medicine
Office of MP Robert Nault
Ontario Ministry of Environment and Climate Change
Ontario Ministry of Natural Resources and Forestry
Ontario Ministry of the Environment and Climate Change
Packaging Corporation of America
Queen's University
Rainy Lake Conservancy
Rainy Lake Property Owners Association
Rainy River Community College
Red Lake Department of Natural Resources
RESPEC
Shooniyaa Wa-Biitong
Stewardship Youth Ranger Program
Rainy River District Stewardship Council
South Dakota State University
St. Cloud State University
St. Croix Watershed Research Station
Superior National Forest
Tokyo Gakugei University

Trent University
U.S. Army Corps of Engineers
U.S. Consulate Winnipeg
U.S. Department of State (could not attend due to winter storm)
U.S. Environmental Protection Agency
U.S. Geological Survey
University of Wisconsin - Madison
University of Manitoba
University of Minnesota
University of Minnesota Duluth
US Forest Service
Vermilion Community College
Voyageurs National Park - National Park Service
Voyageurs National Park Association
Watershed Ecology
Wetlands Action Group
White Iron Chain of Lakes Association
Wolframe's World of Water