Forum Partners – Sponsors
The organizing committee thanks our 2020 sponsor’s for assisting with the 16th annual International Rainy-Lake of the Woods Watershed Forum. This event would not be possible without them:

- Lake of the Woods Water Sustainability Foundation
- International Joint Commission
- Voyageurs National Park – National Parks Service
- Consulate General of Canada - Minneapolis, Global Affairs Canada
- Minnesota Pollution Control Agency
- Rainy River Community College
- Lake of the Woods District Stewardship Association
- St. Cloud State University
- Rainy Lake Conservancy
- Rainy Lake Property Owners Association
- Environment and Climate Change Canada / Environnement et Changement climatique Canada
- Voyageurs National Park Association
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Trends in regional wet mercury deposition and lacustrine mercury concentrations in four lakes in Voyageurs National Park—an update

Mark E. Brigham

Summary of Fish and Invertebrate Responses to a Whole-Ecosystem Nanosilver Addition at the IISD-Experimental Lakes Area

Lauren Hayhurst¹,², Jonathan Martin³, Valerie Langlois⁴, Sarah Wallace⁵,⁶, Brenden Slongo², Tyler Ripku², Chris Metcalfe⁵, and Michael D. Rennie¹,²

Monitoring HABs in the Southern Basin of Lake of the Woods: A Collaborative Effort

Adam J. Heathcote¹, Mark B. Edlund¹, Shane Bowe²; Cary Hernandez³

Lake of the Woods Watershed Comprehensive Watershed Plan: Putting Science into Action

Jeremiah Jazdzewski¹ and Mike Hirst²

Dispersal of Floating Cattail Mats in Rainy Lake, Minnesota

Chandra L. Wiley¹, Reid T. Plumb¹, Bryce T. Olson², Steve K. Windels¹

Potential role of sediment resuspension on nutrient dynamics in Lake of the Woods

Reza Valipour, Ian Droppo, Johann Biberhofer, Jun Zhao, and Yuanrong Pan

Modelling the loading of nutrients from nearshore developments to Poplar Bay

Dale R. Van Stempvoort, Craig McCrimmon, Reza Valipour and Serban Danielescu

Forum Week Overview: Meetings & Forum Symposium
# Program At A Glance

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<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
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<tbody>
<tr>
<td>8:30</td>
<td>Coffee available in Rainy River Community College Cafeteria</td>
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<tr>
<td>9:00</td>
<td>Welcome &amp; Traditional Protocols</td>
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### Session 1 - Governance Updates

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tbody>
<tr>
<td>9:40</td>
<td>International Rainy-Lake of the Woods Watershed Board update</td>
</tr>
<tr>
<td></td>
<td>Board Co-Chair (M. Goffin or Col K. Jansen TBD)</td>
</tr>
<tr>
<td>9:55</td>
<td>Global Affairs Canada binational update</td>
</tr>
<tr>
<td></td>
<td>Felicia Minotti, GAC</td>
</tr>
<tr>
<td>10:05</td>
<td>Nibi (water) Declaration: Anishinaabe water governance in the Treaty 3 area in Northwestern Ontario</td>
</tr>
<tr>
<td></td>
<td>Lucas King, Grand Council Treaty 3</td>
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<tr>
<td>10:25</td>
<td>International Multi-Agency Arrangement update</td>
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<td>Shane Bowe, IMA WG US Co-Chair</td>
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### Session 2 - Cyanotoxins

<table>
<thead>
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<th>Time</th>
<th>Activity</th>
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<tr>
<td>11:10</td>
<td>Lake of The Woods Total Maximum Daily Load Study: A progress report</td>
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<td>Cary Hernandez, MPCA; G. Kramer, J. Blackburn, RESPEC</td>
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<tr>
<td>11:30</td>
<td>UC Objectives and Alert Levels Project</td>
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<td>IJC Objective and Alerts Study Team</td>
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<td>15:50</td>
<td>Update on the MPCA’s watershed approach to restoring and protecting water quality in the Rainy Basin</td>
</tr>
<tr>
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<td>Mike Kennedy, Lindsey Krumrie and Amy Mustonen, MPCA</td>
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<tr>
<td>16:10</td>
<td>Do muskrats eat hybrid cattail? An experimental approach using feeding trials with wild-caught muskrats</td>
</tr>
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<td></td>
<td>Steve K. Windels et al., Voyageurs National Park</td>
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<tr>
<td>16:30</td>
<td>WIN English-Wabigoon Rivers Remediation Project</td>
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<td></td>
<td>Marvin McDonald, Wabaseemong Independent Nations</td>
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<tr>
<td>16:50</td>
<td>Hybrid cattail removal and wetland restoration in Voyageurs National Park</td>
</tr>
<tr>
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<td>Reid Plumb, VNP</td>
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<tr>
<td>17:10</td>
<td>Grand Council Treaty #3: Community based monitoring</td>
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<tr>
<td></td>
<td>Chris Herc and Len Gibbons, Grand Council Treaty 3</td>
</tr>
<tr>
<td>17:30</td>
<td>Free Time &amp; Poster Setup</td>
</tr>
<tr>
<td>18:00</td>
<td>Poster Session &amp; Foundation Reception / Buffet Dinner (AmericInn)</td>
</tr>
</tbody>
</table>

*(See next page)*
EVENING DAY 1 – MARCH 11

6:00  Foundation Reception & Poster Session (AmericInn, buffet dinner)

**Guest Speakers**
-- Dignitary welcome addresses
-- Pauline Gerrard, IISD-ELA  "Building relationships: Lessons from a western science facility located in First Nations territory"

**Awards Presentations**
Kallemeyn Award
Wilson Stewardship Award Presentation

**Posters**
1  Trends in regional wet mercury deposition and lacustrine mercury concentrations in four lakes in Voyageurs National Park—an update.  Mark Brigham, USGS
2  Summary of fish and invertebrate responses to a whole-ecosystem nanosilver addition at the IISD-Experimental Lakes Area.  Lauren Hayhurst, IISD-ELA
3  Monitoring HABs in the southern basin of Lake of the Woods: A collaborative effort!  Adam Heathcote et al.
4  Lake of the Woods watershed Comprehensive Watershed Plan: Putting science into action.  Jazdzewski & Hirst, Houston Engineering Inc (HEI) & LOW SWCD
5  Dispersal of floating cattail mats in Rainy Lake, Minnesota.  Chandra Wiley, Voyageurs National Park
6  Potential role of sediment resuspension on nutrient dynamics in Lake of the Woods.  Reza Valipour*, Ian Droppo, Johann Biberhofer, Jun Zhao, and Yuanrong Pan, ECCC
7  Modelling the loading of nutrients from nearshore developments to Poplar Bay  Dale R. Van Stempvoort, Craig McCrimmon, Reza Valipour and Serban Danielescu
# DAY 2 – MARCH 12

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<td>Coffee available in Rainy River Community College Cafeteria</td>
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<td>8:25</td>
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<td>Day 2 Welcome and Introductions</td>
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<tr>
<td>8:30</td>
<td>0:20</td>
<td><strong>Session 4 - Canadian Tributary Hydrology</strong></td>
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<td>Longitudinal patterns in nutrient export in the lower Rainy River watershed</td>
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<td>Kelly Macgillivray, Trent U.</td>
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<tr>
<td>8:50</td>
<td>0:20</td>
<td>Characterizing the hydrology of the Lake of the Woods watershed: the potential influence of basin storage on flow regime and streamflow response to extreme weather</td>
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<td></td>
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<td>Wes Greenwood, Trent U.</td>
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<tr>
<td>9:10</td>
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<td><strong>Session 5 - Environment &amp; Climate Change Canada’s Lake of the Woods Science Program</strong></td>
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<tr>
<td></td>
<td></td>
<td>Introduction and overview of the ECCC science session</td>
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<td></td>
<td>Mohamed Mohamed, ECCC</td>
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<tr>
<td>9:40</td>
<td>0:20</td>
<td>10 Years On: A Summary of ECCC Monitoring in Lake of the Woods</td>
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<td>Tim Pascoe, ECCC</td>
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<tr>
<td>10:00</td>
<td>0:30</td>
<td>Break</td>
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<tr>
<td>10:30</td>
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<td>Phosphorus loading in the LOW watershed: tributaries and atmospheric deposition</td>
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<td>Catherine Eimers, Trent U.</td>
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<td>10:50</td>
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<td>Loading of nutrients from nearshore developments to Lake of the Woods</td>
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<td>Dale Van Stempvoort, ECCC</td>
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<tr>
<td>11:10</td>
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<td>Spatiotemporal diversity of phytoplankton structure and function in Lake of the Woods: Insights into bloom formation and toxin production</td>
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<td>A. Zastepa, ECCC</td>
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<tr>
<td>11:30</td>
<td>0:20</td>
<td>An overview of ECCC's progress in satellite remote sensing of algal blooms on Lake of the Woods</td>
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<td>Caren Binding, ECCC</td>
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<tr>
<td>11:50</td>
<td>0:20</td>
<td>Application of CanSWAT watershed modelling for Lake of the Woods</td>
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<td>Craig McCrimmon, ECCC</td>
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<tr>
<td>12:10</td>
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<td>Slack – Overrun</td>
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<tr>
<td>12:15</td>
<td>1:30</td>
<td>Lunch - Walleye Fry</td>
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<tr>
<td>13:45</td>
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<td>Phosphorus loads and algal response scenarios: outcomes from the application of a coupled watershed-lake model of Lake of the Woods</td>
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<td>Reza Valipour, ECCC</td>
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<td>14:05</td>
<td>0:10</td>
<td>Summary and synthesis of ECCC science presentations</td>
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<td></td>
<td></td>
<td>Mohamed Mohamed, ECCC</td>
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<tr>
<td>14:15</td>
<td>0:20</td>
<td>ECCC Policy: Path forward</td>
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<td></td>
<td></td>
<td>Michael Goffin, ECCC</td>
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<tr>
<td>14:35</td>
<td>0:15</td>
<td>Break – 7th inning stretch</td>
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<tr>
<td>14:50</td>
<td>1:10</td>
<td><strong>Session 6 Moderated Panel Discussion</strong></td>
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<td>&quot;Opportunities moving forward: Building from the science to date to address ecosystem health&quot;</td>
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<td>Michael Goffin/Tricia Mitchell, ECCC; Janette Marsh, USEPA; Nicole Blasing, MPCA; Jeff Hrubes,BWSR</td>
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<tr>
<td>16:00</td>
<td>0:10</td>
<td>Closing Remarks - Forum Ends 4:10 pm</td>
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</tbody>
</table>
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Session 1 – Watershed Governance

International Rainy-Lake of the Woods Watershed Board update
Board Co-Chairs: M. Goffin and Col. K. Jansen
International Rainy-Lake of the Woods Watershed Board

Abstract
This update includes the activities of the Rainy-Lake of the Woods Watershed Board during 2019 – 2020 to date, 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. The Board completed Phase 1 of a project to review and make recommendations on water quality and aquatic ecosystem health Objectives and Alert Levels as well as finalization 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

Location of Study
The Board’s geographic mandate includes the entire Rainy-Lake of the Woods Watershed.
Global Affairs Canada binational update
Felicia Minotti
Global Affairs Canada, 125 Sussex Drive, Ottawa, Ontario K1A 0G2

Abstract
An update will be presented on development of a binational approach to research and management in the Rainy-Lake of the Woods Basin.

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.

Location of Study
Binational Rainy-Lake of the Woods Basin
Nibi (water) Declaration: Anishinaabe water governance in the Treaty 3 area in Northwestern Ontario

Lucas King
Grand Council Treaty 3

Abstract

Based on the responsibility and sacred connection that Anishinaabe women have to water, the Women’s Council of GCT3 have lead a nation-based development of a Nibi (water) Declaration. Grounded in Indigenous values, the Declaration provides water policy to guide watershed management planning in Treaty 3 Territory.

Beginning from the premise that water has a spirit, this project, the development of the Nibi Declaration probes Indigenous knowledge of sacred, cultural and spiritual relationships with water. The Declaration builds on land-based contextual knowledge of the Anishinaabe people of Treaty 3, an area which houses a significant amount of freshwater in Northwestern Ontario.

This presentation focuses on the development of the Declaration and how as an indigenous values policy, the declaration, can influence and guide watershed management planning. Extending from the understanding of the obligations and responsibilities that flow from the sacred relationship with water will impact individuals, families and communities in their actions. This will assist with principled nation-based, external policy and decision-making relating to the watershed and territories that continue to face growing pressure from forestry and mining, sport and commercial fishing and water extraction for commercial use.

Grand Council Treaty 3 (GCT3) and Decolonizing Water Governance have jointly supported the Women’s Council in community-led and community-engaged research and collaborative governance for the development of a nation-based Nibi (Water) Declaration. Prioritizing the need to strengthen Treaty 3’s Indigenous water governance, the purpose of this project is to support the development and ratification of a Nibi Declaration based on Indigenous normative values, principles and protocols. This will assist in clarifying roles and responsibilities that Anishinaabe, Anishinaabe Government, allies and external entities and decision-makers have in support of the exercise of those responsibilities.

The Nibi Declaration was initiated by the Women’s Council of the Grand Council Treaty 3 (GCT3) the traditional government of 28 First Nations communities. The women who represent the various regions with the GCT3, along with other Anishinaabe have asserted their inherent stewardship for water and developed a statement of the nation’s relationship with water, which will serve to provide policy and project guidance the creation of an indigenous values foundation for watershed management planning.

Through the series of regional and national engagement sessions, guidance and teachings were shared to develop the Nibi (water) Declaration. Elders and knowledge keepers talked about the veins of the Territory and the water that flows through them connecting the Nation. The toolkit will not only support the Declaration but also enhance the process of Treaty 3 watershed management planning. Planning will be guided using interactive Treaty 3 maps online, developing the understanding of past impacts, current state of the Territory and future implications. This coincides with the GCT3 community based monitoring program as data can be stored and viewed to inform decision making, water policy and management planning on a community, regional and national level.

Treaty 3 is marked by rapid expansion in resource development such as mining, forestry and nuclear waste management. Indigenous knowledge speaks to water being alive and having a spirit, therefore the activities to protect it must respect this spirit and personhood. The Declaration will influence watershed management planning from a foundation of Indigenous values, bringing together the two paths of ceremony and management practices to protect Treaty 3 water for future generations. This creates a holistic approach, respecting all beings in creation, in water management unseen in current western practices.

Brief Bio

Lucas King is Director (Acting) of the Territorial Planning Unit.

Location of Study

Treaty 3 Territory
International Multi-Agency Arrangement update
Shane Bowe, IMA Work Group US Co-Chair
International Multi-Agency Arrangement

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, progress of the IMA Technical Advisory Committee (TAC) subcommittees for Aquatic Invasive Species and Water quality (current focus on nutrients and algae) are highlighted including the development of a project for AIS risk assessment, in support of the IJC Rainy-Lake of the Woods Watershed Board and a white paper on development of nutrient objectives.

Brief Bio
Shane Bowe is the US Co-chair of the IMA Working Group and the water resources director of the Red Lake Department of Natural Resources.

Location of Study
Rainy-Lake of the Woods watershed
Lake of The Woods Total Maximum Daily Load Study: A progress report
Cary Hernandez¹; Geoff Kramer², Julie Blackburn²

¹Minnesota Pollution Control Agency, 714 Lake Avenue, Detroit Lakes, MN, 56501, PH 218-846-814, cary.hernandez@state.mn.us;
²RESPEC Water & Natural Resources, 1935 West County Road B2, Suite 230, Roseville, MN 55113; PH 651-305-2274, geoff.kramer@respec.com; 651-305-2272, julie.blackburn@respec.com

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) model, which was run for the period 1996-2014 and calibrated to available tributary monitoring data. The HSPF output for the TMDL study period (2005-2014) was used to develop a BATHTUB model for the lake, which was used to determine the in-lake response to nutrient loading. A mass balance analysis of internal phosphorus loading was conducted to quantify internal loading for use in BATHTUB. The BATHTUB model was then 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 remains a major phosphorus source. A review of US and Canadian point source discharges was conducted to finalize present and future conditions including growth expectations. The 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 29 years.

Geoff Kramer holds an M.S. in Biosystems & Agricultural Engineering from the University of Minnesota. He has extensive experience with hydrologic, hydraulic, and water quality modeling in urban, rural, and forested watersheds. He has experience with lake TMDLs and the BATHTUB eutrophication model. He also has experience with water quality BMPs, economic analysis, and analysis related to cost effectiveness of BMPs and BMP treatment trains.

Julie Blackburn is the Minnesota Area Manager for RESPEC. She has worked extensively with SWCDs, watershed districts, state and federal conservation agencies in the fields of watershed management, drainage management, TMDL implementation, and resource conservation planning. She has also provided leadership to watershed districts, overseeing all facets of comprehensive watershed management.

Location of Study
Entire Rainy/Lake of the Woods Watershed
IJC Objectives and Alert Levels Project
TBD
RLWWB Objectives & Alerts Study Team

Abstract
TBD

Brief Bios
TBD

Location of Study
Entire Rainy-Lake of the Woods Basin, with particular focus on boundary waters.
Session 2 – Cyanotoxins

Algal toxin exposures on Reserved Federal Lands and Trust Species

Zachary R. Laughrey1, Robert J. Dusek2, Victoria G. Christensen*3, Sarena Senegal1, Lee Jones4, Tracy Ziegler5, Daniel K. Jones6, Brianna M. Williams6, Stephanie E. Gordon6, Julia S. Lankton2, and Keith A. Loftin1

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5National Park Service, National Parks of Eastern North Carolina, Manteo, NC 27954
6United States Geological Survey, Utah Water Science Center, West Valley City, UT 84119

Abstract

Toxic harmful algal blooms (HABs) are perceived to be increasing in frequency and duration in US surface waters. The US Federal government holds approximately 640 million acres of land, many of which contain surface water, in trust (Federal lands). These lands are managed by federal agencies for flood control, habitat preservation, and recreation. Waterbodies within these holdings are comprised of fresh, marine, and estuary waters and each contains different species of algae and cyanobacteria, which may produce toxins that could affect ecosystem, animal, and human health. For this study, peer reviewed literature, government reports, and government issued warnings/closures were divided into four tiers of increasing likelihood of health impacts: occurrence; occurrence that exceeded a state or local threshold; suspicions of animal deaths or illness; or animal illness or death confirmed to have been caused by HAB toxins. From this review, it was determined that approximately 12% of Federal lands (parks, reserves, reservoirs, etc.) met at least one of the four criteria used for inclusion. Additionally, the US Federal government protects certain species of animals (Trust Species) due to laws and treaties (endangered species, migratory birds, and marine mammals). To date, over 60 trust species have been exposed to toxins produced by algae and cyanobacteria leading to illness and death. The history of HABs on US Federal lands and trust species, data gaps, and possible future studies will be discussed.

Brief Bio

Victoria Christensen is a Research Scientist at U.S. Geological Survey. She is a member of the USGS Integrated Ecosystems and Toxins Science Teams, and serves as Associate Editor of the USGS GeoHEALTH news. Her research focuses on nutrient enrichment and algal bloom formation in lake and river systems, with a focus on toxins.

Location of Study

US Federal lands
EPA Region 5 Harmful Algal Blooms Update  
Janette Marsh and Wendy Drake  
US EPA Region 5, 77 W. Jackson Blvd., Chicago, IL 60604  312-886-4856 marsh.janette@epa.gov

Abstract

EPA Region 5 staff will present information about what EPA is doing in the region, as well as nationally, related to harmful algal blooms (HABs). For example, Region 5 has been convening regular (e.g., triannual) calls with the six states in the region (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin) to discuss related EPA research and share information about state initiatives. EPA HAB-related guidance and projects will be briefly summarized during this presentation, including the EPA/NASA/NOAA/USGS Cyanobacteria Assessment Network mobile application (CyAN app), Regional Applied Research Effort (RARE) projects, and other EPA-funded initiatives. Additional EPA HAB-related resources are available online: https://www.epa.gov/cyanohabs.

Brief Bio

Janette Marsh is the International Watersheds lead with US EPA Region 5. Wendy Drake is the Harmful Algal Blooms (HABs) lead with US EPA Region 5.

Location of Study
Freshwater neurotoxins and concerns for human, animal, and ecosystem health with a focus on Kabetogama Lake, Voyageurs National Park

Victoria G. Christensen*, Ryan P. Maki, Erin A. Stelzer, Jaime F. LeDuc, Jack Norland, and Eakalak Khan

*North Dakota State University, Environmental and Conservation Sciences Program, Fargo, ND, and U.S. Geological Survey, Upper Midwest Water Science Center, Mounds View, MN, USA, 2280 Woodale Drive, Mounds View, MN 55112, 612-759-3187, vglenn@usgs.gov

Abstract

Toxic cyanobacteria are a growing concern worldwide because they can negatively affect humans, animals, and ecosystems. We reviewed studies of anatoxin-a and saxitoxin, two of the most potent of the known classes of cyanobacteria-produced neurotoxins, which are understudied in freshwater environments. Examples of human and animal health concerns can range from acute to chronic. However, few studies have focused on chronic or sub-lethal effects of the neurotoxins, even though these neurotoxins have been detected regionally, including Voyageurs National Park. In Kabetogama Lake, we documented the presence of neurotoxin-forming cyanobacteria, as well as anatoxin-a and saxitoxin, indicating that additional sampling for neurotoxins may be necessary to fully assess human health risk. Ecosystem health also is a concern, as the effects of toxicity may be far reaching and include consequences throughout the food web. The growing concern over cyanotoxins will require further study of: 1) neurotoxins such as anatoxin-a and saxitoxin, 2) their occurrence and biogeography, 3) triggers of production and release, 4) environmental fate and degradation, 5) primary and secondary exposure routes, diurnal variation, food web effects, 6) the effects of cyanotoxins mixtures, and 7) sublethal health effects on individual organisms and populations.

Brief Bio

Victoria Christensen is a Research Scientist at U.S. Geological Survey. She is a member of the USGS Integrated Ecosystems and Toxins Science Teams, and serves as Associate Editor of the USGS GeoHEALTH news. Her research focuses on nutrient enrichment and algal bloom formation in lake and river systems, with a focus on toxins.

Location of Study

Kabetogama Lake, Voyageurs National Park
Abstract

Harmful cyanobacterial algal blooms (cyanohABs) are an increasing concern at Lake Kabetogama in Voyageurs National Park (VOYA). Toxin producing genes from cyanobacteria responsible for hepatotoxins (microcystin) and neurotoxins (saxitoxin and anatoxin-a) were found in water samples from bloom sites. Our study investigated whether these toxins were present in walleye, yellow perch, smallmouth bass, and white suckers from Lake Kabetogama and Rainy Lake at VOYA. Measuring cyanotoxin concentrations in fish fillets allows us to help inform human health risk. Adult fish were sampled by gillnetting, and young of year (YOY) fish were sampled by seining from July to September in 2017 and 2018. We extracted toxins from whole YOY fish and the liver and muscle from adult fish using established extraction methods. Toxin concentrations of fish were measured using ELISA. For anatoxin-a and microcystin, toxins were >5 parts per billion (ppb), which is outside the detection range for ELISA testing (0.15 to 5.0 ppb). Further analysis with LC/MS/MS will confirm toxic samples and reveal false positives, a common issue with ELISA tests.

Brief Bio

Seth McWhorter is studying ecotoxicology at Warnell School of Natural Resources (University of Georgia) in Athens, GA. Specifically, Seth is interested in studying harmful cyanobacterial algal blooms that release hepatotoxins, neurotoxins, and dermatoxins into water systems. Working with Voyageurs National Park, USGS, and University of Georgia, Seth aims to further research the ecological fate of microcystin, anatoxin-a, and saxitoxin in water bodies as well as in animal tissues. At the University of Georgia, Seth works with Susan Wilde's lab to examine characteristics of the novel cyanotoxin aetokthonos in the southeastern United States. In studying cyanobacteria and cyanotoxins, Seth hopes to contribute to ecological risk assessments in areas impacted by cyanobacterial harmful algal blooms.

Location of Study

Rainy Lake and Lake Kabetogama in Voyageurs National Park
Rapid-assessment test strips: Effectiveness for cyanotoxin monitoring in a north temperate lake
Jaime F. LeDuc*, Victoria G. Christensen, Ryan P. Maki
*Voyageurs National Park, 360 Highway 11 East, International Falls, MN 56649, 218-283-6686, jaime_leduc@nps.gov

Abstract
Precise and rapid methods of determining toxin levels are needed in lakes used for recreation and drinking water to facilitate a quick risk assessment during cyanobacteria blooms. Therefore, we tested rapid-assessment test strips, a newer technology for estimating the toxicity of algal blooms, in Kabetogama Lake, a popular recreational area of Voyageurs National Park in northern Minnesota (USA). Sixty-seven percent of the test strip results matched results of enzyme-linked immunosorbent assays, with individual toxin results matching in 75% (anatoxin-a), 80% (cylindrospermopsin), and 64% (microcystin) of tests. These results provide some evidence that the test strips may be effective for rapid detection of toxins in north temperate lakes, although some improvements to the test strips may be beneficial. Despite the intensive processing required and uncertainty of some results, the availability of a rapid and inexpensive field method allowed us to sample opportunistically in the fall, when we documented dangerously high toxin concentrations at places where waterfowl retrieving dogs may be at particular risk of exposure.

Brief Bio
Jaime LeDuc is a shared employee between the Great Lakes Network and Voyageurs National Park where she is stationed. She received her B.S. degree from Bemidji State University, where she majored in Aquatic Biology (Fisheries Management and Aquatic Systems) and minored in Environmental Science. She received her M.S. degree in Biological Sciences from Michigan Technological University studying spiny water flea and fish interactions.

Location of Study
Distribution and flux of microcystin congeners in lake sediments
Zastepa, A.*, Pick, F.R., Blais, J.M.
*Environment and Climate Change Canada, Canada Centre for Inland Waters, Burlington, Ontario, Canada, arthur.zastepa@canada.ca

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 210Pb 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
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. He 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
Session 3 – Ecosystem Monitoring, Research and Management

Update on the MPCA’s watershed approach to restoring and protecting water quality in the Rainy Basin

Mike Kennedy, Lindsey Krumrie, and Amy Mustonen
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Abstract

The Minnesota Pollution Control Agency employs a watershed approach to restoring and protecting Minnesota's surface waters. Through this approach, the MPCA and its local partners undertake intensive water quality monitoring and assessments every ten years. These assessments provide the foundation for the development of Watershed Restoration and Protection Strategy (WRAPS) reports in each major watershed. These WRAPS documents become the foundation of the local water planning process.

The first ten-year cycle of this approach focused on characterizing water quality throughout each major watershed in Minnesota. This comprehensive process provides a statewide baseline of water quality we can measure future change against. All of Minnesota’s major watersheds, including those in the Rainy Basin, have now been monitored and assessed. In addition, many of the major watersheds have undergone stressor identification and watershed restoration and protection strategy development. The associated reports provide a resource for local water quality managers to begin to implement restoration and protection strategies throughout the Rainy Basin.

The second round of the watershed approach focuses on supporting our local partners in developing a firm understanding of the watershed science needed to implement restoration and protection projects. This approach will be customized to the biophysical and social properties of each individual watershed. Investigating water quality protection opportunities and restoration projects on a field scale is imperative to the success of initiating change on the landscape. The outputs of the second round will vary tremendously throughout the Rainy Basin depending on needs, local conditions, and priorities developed by local partners with local watershed community members. The resulting updated WRAPS reports will be designed to include customized products useful to local governments and other watershed stakeholders to accelerate the progress toward water quality restoration and protection.

Come learn about the current work being conducted and the resources available to protect Minnesota watersheds of the Rainy River Basin!

Brief Bio

Mike Kennedy, Lindsey Krumrie, and Amy Mustonen are project managers for the Minnesota Pollution Control Agency’s (MPCA) watershed program. The MPCA employs a watershed approach to restoring and protecting Minnesota’s rivers, lakes, and wetlands. Money to accelerate efforts to monitor, assess, and restore impaired waters, and to protect unimpaired waters was funded by the Minnesota’s Clean Water Legacy Act.

Location of Study
Do muskrats eat hybrid cattail? An experimental approach using feeding trials with wild-caught muskrats

Steve K. Windels1, Benjamin R. Matykiewicz2, Chandra L. Wiley1, Reid T. Plumb1, Adam A. Ahlers2

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Abstract

Muskrats (Ondatra zibethicus) are native semiaquatic herbivores that are thought to be highly selective for Typha spp., and muskrat herbivory could be used as a natural biocontrol agent for invasive Typha. However, the level of selection of muskrats for hybrid vs. native cattail has never been tested. Likewise, limited evidence also exists for how muskrats feed on Typha spp. vs. other native plants such as bulrush (Scirpus spp.), arrowhead (Sagittaria spp.), or wild rice (Zizania palustris). During summer 2019, we placed wild-caught muskrats from Voyageurs National Park into ~2.25m2 wooden enclosures (aka Ratagons!) to examine muskrat feeding rates and selectivity for different food types. Enclosures were equipped with Go-Pro cameras to record all muskrat activity during the 2-hour trials. We completed 33 separate trials: 12 trials testing preferences of hybrid vs. native cattail only, and 21 trials testing both cattail species plus a choice of bulrush, arrowhead, wild rice, and sweet flag (Acorus calamus). We will present preliminary results of this novel approach to understanding interactions of native muskrats with a non-native species.

Location of Study

Voyageurs National Park
WIN-English and Wabigoon Rivers Remediation Project

Marvin Lee McDonald
Wabaseemoong Independent Nations, General Delivery, White Dog, ON, P0X 1P0, (807) 927-2000 ext. 251

Abstract

The Membership of Wabaseemoong independent Nations, are River People they have a long tradition of living off the land and waters, since before recorded time, fish, wild game and plant foods, have served as a dietary staple, however in the 1950’s it was disrupted, due to the development of two hydro-electric dams on the Winnipeg and English/Rivers, and in the 1960’s mercury poisoning of the English River both of which led to the environmental, social and economic degradation. In 2017 the English and Wabigoon Rivers Remediation Project, started.

Brief Bio

Location of Study

English and Wabigoon Rivers, Northwestern Ontario
Hybrid cattail removal and wetland restoration in Voyageurs National Park: A project update
Reid T. Plumb¹, Steve K. Windels¹, Chandra L. Wiley¹, Bryce T. Olson²

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²Ressurs Consulting LLC, Fertile, MN 56540, olson1bry@gmail.com

Abstract

Non-native cattails are known to disrupt ecosystem balance by creating dense monotypic stands which displace native species and reduce biological diversity. Hybrid cattail (Typha x. glauca) is the dominant plant species in most wetlands in Voyageurs National Park, MN. We started a project in 2016 to reduce cattail abundance and restore wetlands to more diverse natural states. Lakes in Voyageurs National Park are designated as “Outstanding Resource Value Waters” where the use of herbicide is prohibited. We treated ~17 acres of invasive cattails in 3 test wetlands using 6 different mechanical methods on Rainy Lake. We conducted pre- (n =125) and post-treatment (n = 201) vegetation surveys of treatment wetlands and compared percent vegetative composition for each treatment type. Total removal of cattail using heavy equipment was the most effective removal treatment method with the presence of cattail being reduced from 98% composition to 0%. We also used mechanical harvesters in Kabetogama Lake to remove a 4.5 acre floating cattail mat which traveled nearly 10 miles from its natal location. This case study, plus an overall project update, will be presented including preliminary findings and the direction of future work

Brief Bio

Reid Plumb is a Wildlife Biologist at Voyageurs National Park. He holds a Master of Science degree in Biology from Kansas State University. At Voyageurs, he is the project manager of the wetland restoration project that aims to reduce hybrid cattail abundance, restore wetlands, and investigate the effects of restoration efforts on wetland wildlife and plant communities.

Location of Study

Rainy Lake and Kabetogama Lake, Voyageurs National Park
Abstract

Abstract: Grand Council Treaty #3’s community based monitoring (CBM) program works with Treaty #3 communities to protect and preserve their traditional waters, collect baseline data & develop monitoring across Treaty #3 territory, and prioritize youth engagement. The CBM program has been in operation since 2018 and currently has three Treaty #3 communities participating in it. Participating communities collect basic water quality data over the field monitoring season, and as of 2019 collect fish tissue samples to be sent away for mercury analysis. This presentation will cover the creation and implementation process of the CBM program, data insights and highlights, and have CBM participants from Treaty #3 discuss how the CBM program has been/will be a benefit to their community.

Brief Bio

Chris Herc has B.Sc. in Environment and Natural Resources from the University of New Brunswick. He has lived and worked across Canada doing natural resource management work & teaching environmental education. Currently he is working for Grand Council Treaty #3 as their environmental monitoring coordinator and implementing/coordinating a community based monitoring program across Treaty #3 Territory.

Location of Study

Lake of the Woods & Winnipeg River
Abstract

How do we begin to build meaningful relationships in a time when bridging Western and Indigenous Science can help in addressing some of the most pressing environmental crises facing our world?

The story of Canada’s most unique scientific research facility has plenty to teach us. IISD Experimental Lakes Area (IISD-ELA) is a freshwater research facility located in the traditional Anishinaabe territory of Treaty #3 in northwestern Ontario. For years, it has been working to expand its portfolio in public communication and prioritizing Indigenous engagement.

Located in Treaty #3 traditional land, IISD-ELA has seized upon a unique opportunity to work more closely with Indigenous communities to look at how the two ways of knowing can work together and benefit each other.

This presentation will explain how IISD-ELA has partnered with Indigenous groups through various projects in areas of mercury contamination, community-based monitoring, and Ojibwe interpretation of scientific research to promote knowledge sharing, highlighting a few key achievements including collaboration on community based monitoring support with the Grand Council of Treaty#3 and Ojibwe Language translation of some key education materials. It will also explore what IISD-ELA has learned along the way, including the importance of individual connection with respect and honesty; understanding communities’ needs; and incorporating the preservation and revitalization of Indigenous culture and language into collaboration efforts.

Brief Bio

Pauline Gerrard is the Deputy Director of IISD Experimental Lakes Area (IISD-ELA). Ms. Gerrard’s educational background is in Environmental Science and Ecology, and she has extensive experience in program management and training program delivery, having worked from 2001-2010 for WWF in Laos as a program manager for both the Greater Mekong Program and WATER (Wastewater Treatment through Effective Wetland Restoration of That Luang Marsh).

Location of Study

Experimental Lake Area, Northwestern Ontario, Canada
Longitudinal patterns in nutrient export in the lower Rainy River watershed
Kelly Macgillivray* and Catherine Eimers
Trent University, School of the Environment, 1600 West Bank Dr., Peterborough, ON K9L 0G2
kellymacgillivray@trentu.ca

Abstract
Oftentimes in watershed monitoring programs, water quality is sampled at a single location along a river course, which is assumed to represent the entire upstream area. However, sampling at a single site and scale makes it difficult to evaluate relationships between water quality and landuse/landcover (LULC). To address this, we sampled water quality both above and below existing long-term monitoring stations on four rivers in the lower Rainy River watershed, that either drain into the Rainy River (Sturgeon, Everett) or the Lake of the Woods directly (Little Grassy and McGinnis). A number of different water quality parameters were analysed at each station during both high flow (spring melt) and low flow periods in 2019, including total phosphorus, total dissolved phosphorus, nitrogen species, metals and total suspended sediments (TSS). Preliminary longitudinal and inter-season differences in water quality and associations between sediment transport and phosphorus export will be evaluated to assess relationships between LULC and nutrient losses. This will ultimately lead to a better understanding of sources of nutrients and best management practices to limit phosphorus loading.

Brief Bio
Kelly Macgillivray is an M.Sc Candidate in the Environmental and Life Sciences Program at Trent University. She is part of Trent University’s Lake of the Woods Watershed Loading Project.

Location of Study
Lower Rainy River watershed
Characterizing the hydrology of the Lake of the Woods watershed: the potential influence of basin storage on flow regime and streamflow response to extreme weather

Wes Greenwood, Catherine Eimers, and Andrew Williams
Trent University - School of the Environment, 1600 West Bank Dr., Peterborough, ON K9L 0G2 (705) 768-4261 wesleygreenwo@trentu.ca

Abstract
Nutrient export from rivers and streams can vary greatly depending on flows; therefore, nutrient budget estimates for the Lake of the Woods (LOW) require reliable flow data and a strong understanding of the local basin hydrology. The sheer size and complex nature of the LOW basin, which spans two major surficial geology types (Canadian Shield and Agassiz clay plain) and is subject to several forms of landscape disturbance (e.g., forestry, mining, farming), makes monitoring costly and exemplifies the importance of efficient monitoring program design. Recent work has shown that rivers and streams draining the Agassiz clay-dominated portion of the LOW basin are very flashy and exhibit much more flow variability relative to those on the Canadian Shield, likely due to the abundance of lakes and dynamic storage in the latter. This, coupled with higher nutrient concentrations and fluxes seen in Agassiz clay plain streams, suggests that high-frequency monitoring is important in this area. Furthermore, previous work has suggested that basins with greater dynamic storage and relatively stable hydrographs (like those on the shield) may be more resilient to both climate change and future land-use disturbance. However, the intermittent nature of flow records in the Canadian portion of the LOW basin have not allowed this spatial pattern to be evaluated over a range of hydro-climatic conditions. Here we compare the flow regimes of rivers on the Agassiz clay plain to those on the Canadian shield during two back-to-back years with very different hydroclimatic conditions (2018 and 2019) in order to assess a) whether or not the pattern of flashy, more variable flow on the Agassiz clay-plain vs. relatively subdued, stable flow on the Canadian Shield persists and b) how these rivers may or may not respond differently to weather extremes (e.g., different snowpack and snowmelt dynamics and extreme summer rainfall events). This information may be used to inform future monitoring design and evaluate potential sensitivity to climate change.

Brief Bio
Wes Greenwood is a surface water specialist based out of Edmonton, AB. He led the field monitoring campaign for the Trent U. watershed loading project in 2018-19, and he is currently assisting with the program’s data analysis and reporting.

Location of Study
Tributaries of the Rainy River and Lake of the Woods in the Canadian portion of the Rainy-Lake of the Woods basin
Session 5 – Environment and Climate Change Canada’s Lake of the Woods Science Program (2016-2020)

Introduction and overview of the ECCC science session

Mohamed Mohamed

Environment and Climate Change Canada, Watershed Hydrology and Research Division, 867 Lakeshore Rd, Burlington, Ontario L7S 1A1

Abstract

Environment and Climate Change Canada (ECCC) has an extensive history of conducting research and monitoring at the Lake of the Woods. The most recent plan of study, which began in 2016, concludes this year. Here, we present an overview of the various components that were included in the plan, providing insight into their motivation, integration, and goals in informing management of the Lake of the Woods and its watershed.

Brief Bio

Location of Study
An integrated modelling and monitoring framework for assessing nutrient dynamics and algal blooms in Lake of the Woods
Ram Yerubandi on behalf of ECCC/WSTD team
Environment and Climate Change Canada, Water Science and Technology, CCIW, 867 Lakeshore Road Burlington, ON, Canada, L7S 4A1 Ram.Yerubandi@Canada.ca 905-3364785

Abstract
Lake of Woods (LOW) is being impacted by enrichment of nutrients as well as extensive algal blooms, which are at times toxic. This impairs water quality and the lake’s value for recreation, drinking water, and fish habitat. Since 2016 ECCC has been conducting integrated research, modelling and monitoring program designed to provide the necessary science to support the assessment of nutrient loads to the LOW and understand the factors responsible for algal blooms and develop predictive models for the potential ecological response to nutrient management decisions and actions. In this talk, I will provide an overview of monitoring, process-based research and state-of-the art modeling (linked watershed and lake model covering the entire LOW. The watershed (CanSWAT) and in-lake models (3D hydrodynamic-ecological coupled model) examined the cycling of nutrients (i.e., phosphorus, nitrogen) within the lake. We examined the lake response (e.g: in-lake nutrient concentrations, algal blooms) for different P-loading scenarios. The next steps will be optimization of Beneficial/Best Management Practice (BMP) scenarios using the watershed model for achieving the necessary load reductions to the lake.

Brief Bio

Location of Study
10 Years On: A Summary of ECCC Monitoring in Lake of the Woods

Timothy Pascoe
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Tim.Pascoe@ec.gc.ca

Abstract
In 2008, Environment and Climate Change Canada (ECCC) initiated a monitoring program in the Lake of the Woods basin as part of its broader efforts to investigate algal blooms in the lake. Developed by the Water Quality Monitoring and Surveillance (WQM&S) division, the goal of the program was to generate foundational data to support ECCC science initiatives, and establish a baseline data set to aid in the assessment of environmental change over the longer term. The presentation will look at three key aspects of the monitoring program: a summary of the data collected to date, an exploration of some parameters of interest across the lake over the ten-year period, and how these data are being used to support both ECCC efforts, as well as partner agencies throughout the basin.

Brief Bio

Location of Study
Phosphorus loading in the LOW watershed: tributaries and atmospheric deposition
*Catherine Eimers, Wes Greenwood, Andrew Williams, Kelly MacGillivray
Trent School of the Environment, Trent University, Peterborough ON K9L 0G2 ceimers@trentu.ca

Abstract
Intensive monitoring within the Canadian portion of the Lake of the Woods (LOW) basin between April 2018 and September 2019 indicate that phosphorus concentrations and export vary greatly across the watershed, and are highly sensitive to geology, extreme weather and seasonal differences from year to year. Atmospheric deposition estimates over this short period of study are higher than previous estimates and suggest that direct atmospheric input to the Lake of the Woods may be an important source of phosphorus nutrition. Phosphorus concentrations in tributaries were particularly high during spring melt, but were also high during summer low flow conditions, perhaps due to redox related release from streambed sediments. Climate conditions in 2018 were in stark contrast to 2019, with vastly different winter precipitation, spring melt magnitudes, summer low flows and fall high flows. Data from these contrasting years suggest that phosphorus export is highly sensitive to hydrologic conditions and provide strong justification for longer-term monitoring.

Brief Bio
Catherine Eimers (PhD) is a professor at Trent University. She is currently leading a 2-year (2018-2020) research program in the LOW watershed to improve estimates of nutrient loading to LOW via tributaries and atmospheric deposition, with funding from Environment and Climate Change Canada.

Location of Study
Update: Loading of nutrients from nearshore developments to Lake of the Woods

Dale R. Van Stempvoort¹, Will D. Robertson², D. Ross MacKay¹, Pamela Collins¹, Susan J. Brown¹ and Serban Danielescu ¹

¹Watershed Hydrology and Ecology Research Division, Environment and Climate Change Canada
²University of Waterloo

Abstract

The focus of this study is loading of nutrients from septic systems to the nearshore waters of Lake of the Woods, with a focus on dissolved phosphorus. Septic wastewater has been suggested as a potential nutrient source that drives localized algal blooms in isolated bays. Septic systems investigated include cottages (Poplar Bay) and other developments in the Sioux Narrows area. Samples were collected periodically (11 visits in 2016-2019) from nearshore surface waters and from shallow groundwater and analyzed for nutrients and major ions. Most of the groundwater samples were collected beneath septic system drainfields and in the immediate vicinity of these drainfields. Analyses of wastewater tracers (artificial sweeteners) in the groundwater, together with analyses of samples of sand collected from the drainage tile fields, provided key evidence that much of the phosphorus load from septic systems is attenuated in the subsurface, mostly within the drainfields, thus preventing seepage of P-rich plumes to nearshore areas of the lake. Modeling and further interpretation of the results are in progress, as described in a separate poster presentation.

Brief Bio

Location of Study
Spatiotemporal diversity of phytoplankton structure and function in Lake of the Woods: Insights into bloom formation and toxin production

Arthur Zastepa
Environment and Climate Change Canada, Canada Centre for Inland Waters, Burlington, Ontario, Canada, arthur.zastepa@canada.ca

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. Lake-wide, multi-year, and seasonal measurements support the association of phosphorus concentration with chlorophyll-a as well as phytoplankton biomass however, our investigations also reveal an unexplained diversity in phytoplankton structure, function, and potential for cyanotoxin production throughout the basin. Focused studies in impacted embayments identified new (internal) sources of nutrients and biomass and suggest proximate drivers of bloom formation. Notably, deep-living phytoplankton/microbial communities and reservoirs of biomass in sediments were identified as potential sources in localized bloom formation. While reducing tributary nutrient loadings are expected to reduce phytoplankton biomass over the long-term, the spatiotemporal heterogeneity in conditions throughout the basin and diversity in bloom formation mechanisms/proximate drivers may result in a heterogeneous response in cyanobacterial bloom formation.

Brief Bio
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. He 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
An overview of ECCC’s progress in satellite remote sensing of algal blooms on Lake of the Woods
Caren Binding*, Larissa Pizzolato, and Chui Zeng
Environment and Climate Change Canada, Canada Centre for Inland Waters, 876 Lakeshore Road, Burlington, ON Caren.Binding@canada.ca

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. The highly dynamic nature of algal blooms means that adequately capturing bloom timing and spatial extent is challenging with limited in situ observations. Earth Observation (EO) satellites offer frequent, synoptic views of LoW, which enable quantitative assessments of algal biomass and can provide both near-real-time and historical information on algal bloom conditions. ECCC’s capacity for operational near-real-time satellite image acquisition and processing, and development of quantitative indices for algal bloom spatial extent, intensity, duration and severity, have dramatically improved bloom monitoring capabilities on LoW. Annual algal bloom reports, and the EOLakeWatch portal, will be presented as key stakeholder deliverables from the project. Quantitative analysis of bloom conditions will also be shown, from 2002 to present, which document significant decreases in all bloom indices, suggesting the lake is responding to historical reductions in loadings. Satellite observations provide benchmark chlorophyll conditions for model validation in determining future LoW response to nutrient reduction scenarios. Further insight on the complexity of bloom drivers will be presented, which suggest that climate variables and related lake processes (water column stability, hypoxia, internal nutrient loading) may be confounding factors in further anticipated lake recovery.

Brief Bio

Location of Study
Application of CanSWAT watershed modelling for Lake of the Woods
Craig McCrimmon, Phil Fong, Luis Leon, Reza Valipour, Ram Yerubandi.
Water Science and Technology, Environment and Climate Change Canada, 867 Lakeshore Rd, 2nd Floor, Office R250 Burlington, Ontario L7S 1A1 905-336-4885 craig.mccrimmon@canada.ca

Abstract
An integrated modelling framework was developed for the US and Canadian watersheds to simulate seasonal hydrodynamics, nutrients transport and algal blooms in Lake of the Woods. The integrated modelling approach aims to assess the lake’s seasonal algal bloom responses to potential nutrient loading strategies as a combination of BMP and climate change adaptation scenarios. A CanSWAT watershed model of the Lake of the Woods entire watershed was built to simulate watershed runoff flow and water quality from 1995-2018 and was used to (i) provide lake input loading estimates for modelling lake responses, (ii) assess a combination of BMPs with particular focus on forests and agriculture impact on nutrient loadings, (iii) examine climate change adaption scenarios (iv) compare results with previous models and observations, and (v) determine if the suggested BMPs can be used to meet targets to the lake.

Brief Bio
Craig is a watershed, river and lake modeller with Environment Climate Change Canada (ECCC) since 1999. Recent work has been on watershed modelling to provide information on nutrients for lake modelling including developing land management options and climate change adaptation scenarios.

Location of Study
Lake of the Woods watershed
Phosphorus loads and algal response scenarios: outcomes from the application of a coupled watershed-lake model of Lake of the Woods
Reza Valipour, Craig McCrimmon, Phil Fong, Luis Leon, and Ram Yerubandi
Water Science and Technology, Environment and Climate Change Canada, 867 Lakeshore Rd, 2nd Floor, Office R250 Burlington, Ontario L7S 1A1 905-319-7204 reza.valipour@canada.ca

Abstract
The Lake of the Woods lake modelling is a part of an integrated modelling framework and aims to replicate and predict water movements and water quality patterns in the lake from the US and Canadian watersheds discharges. Here, we present the lake model results on water circulations, nutrient dynamics (e.g., Total Phosphorus) and algal blooms using ELCOM-CAEDYM. This model is a three-dimensional hydrodynamic-ecosystem process-based model, and was setup at 250m resolution and forced with lake-wide meteorological data, CanSWAT model riverine outputs, and outflows at Kenora and Norman dams. The model was initialized, calibrated and validated using the collected field observations from two year-round mooring deployments, lake-wide water quality measurements, Satellite Images, and different functional groups of total chlorophyll-a. We used the lake model results to develop load-response curves to express the relationships between different Total Phosphorus load reduction scenarios and the response of total algal blooms in the lake and its sub-basins.

Brief Bio

Location of Study
Summary and Synthesis of ECCC Science Presentations

Mohamed Mohamed
Environment and Climate Change Canada, Watershed Hydrology and Research Division, 867 Lakeshore Rd, Burlington, Ontario L7S 1A1

Abstract
We will review the session science presentations, providing a brief summary and conclusions from each, as well as key conclusions and management implications from the previous talks.

Brief Bio

Location of Study
ECCC Policy: Path Forward
Michael Goffin
Environment and Climate Change Canada, Strategic Policy Branch, Ontario Region, 4905 Dufferin St, Office 2S635 Toronto, Ontario M3H 5T4  416-739-4804  michael.goffin@canada.ca

Abstract
This presentation will provide an update on the next steps that will be taken to determine what phosphorus reductions are necessary to achieve desired water quality and ecosystem outcomes, and the actions that can help to achieve those reductions for the Canadian portion of the Rainy-Lake of the Woods Basin. While research scientists can advise on what conditions represent a healthy and sustainable ecosystem, the decision on desirable ecosystem outcomes are best informed by public and stakeholder input. Plans to engage Indigenous Peoples, stakeholders, and the public on appropriate ecosystem outcomes and the potential establishment of phosphorus targets based on Environment and Climate Change Canada’s and partners’ science for Lake of the Woods will be presented. In addition, current information on Canadian sources and potential actions to mitigate their impacts will be discussed.

Brief Bio
Michael Goffin, the Regional Director General for Environment and Climate Change Canada in Ontario has been engaged in policy development and program delivery, most recently focused on water and ecosystem management, intergovernmental affairs and community outreach and engagement.

For more than a decade, he has been responsible for leading Canada’s efforts to restore and protect the water quality and ecosystem health of the Great Lakes and also serves as Canadian Co-chair of the International Rainy Lake of the Woods Watershed Board and as a member of the Aquatic Ecosystem Health Committee.

Location of Study
Canadian portion of the Rainy-Lake of the Woods Basin
Panel Discussion: Opportunities moving forward: Building from the science to address ecosystem health

Panelists: Michael Goffin or Tricia Mitchell (TBD) Environment and Climate Change Canada; Janette Marsh USEPA; Nicole Blasing, MPCA; Jeff Hrubes, BWSR; Other: TBD
Trends in regional wet mercury deposition and lacustrine mercury concentrations in four lakes in Voyageurs National Park—an update
Mark E. Brigham
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mbrigham@usgs.gov

Abstract
Although anthropogenic mercury (Hg) emissions to the atmosphere have been substantially lowered in the United States and Canada since 1990, concerns remain for elevated contamination in fish that inhabit lakes and rivers even in areas where atmospheric deposition is effectively the only source of mercury. The question arises: how have aquatic ecosystems responded? A previous analysis reported decreases in wet Hg deposition in northeastern Minnesota from 1998-2012, and mixed trends in Hg and methylmercury (MeHg) in lake water and fish from four remote lakes within Voyageurs National Park from 2001-2012 (Brigham, M.E. and others, 2014, Environmental Science & Technology, vol. 48, pp. 6115-6123. DOI: 10.1021/es500301a). Here, we report updated trends for the same study area for monitoring through 2018. Wet Hg deposition at two regional Mercury Deposition Network sites (Fernberg and Marcell, MN; http://nadp.slh.wisc.edu/mdn/) declined by an average of 22.5 percent from 1998-2018, with much of the decline occurring prior to 2011. In the four remote lakes, epilimnetic MeHg concentrations declined by an average of 42 percent and total Hg by an average of 27 percent. Although the magnitude of trend in some lakes was small, it is noteworthy that for all the lakes both MeHg and total Hg show declines for the 2001-2018 time period. Epilimnetic MeHg may be responding both to a decline in atmospheric Hg deposition as well as a decline in sulfate deposition, which is an important co-driver of Hg methylation in the environment. Results from this case study suggest that regional- to continental-scale decreases in both Hg and sulfate emissions have benefitted aquatic resources, even in the face of global increases in Hg emissions.

Brief Bio
Mark has degrees in Chemistry and Civil Engineering, and has worked at the Minnesota office of the USGS since 1991. Mark Brigham’s research focuses on contaminants in aquatic ecosystems.

Location of Study
Four remote lakes in Voyageurs National Park
Summary of Fish and Invertebrate Responses to a Whole-Ecosystem Nanosilver Addition at the IISD-Experimental Lakes Area
Lauren Hayhurst1,2, Jonathan Martin3, Valerie Langlois4, Sarah Wallace4,5, Brenden Slongo2, Tyler Ripku2, Chris Metcalfe3, and Michael D. Rennie1,2

1IISD Experimental Lakes Area, 111 Lombard Ave, Suite 325, Winnipeg MB, R3B 0T4, 204-218-5239 lhayhurst@iisd-ela.org
2Department of Biology, Lakehead University, Thunder Bay, ON., Canada
3The School of the Environment, Trent University, Peterborough, ON., Canada
4Institut National de Recherche Scientifique, Québec, QC., Canada
5Biology Department, Queen’s University, Kingston, ON., Canada

Abstract
Nanosilver (AgNP) is an antibacterial agent with widespread commercial and industrial applications. As a result, AgNP has high potential for entering freshwater lakes at point source locations along their shorelines. As part of a collaborative study involving a whole-lake AgNP addition at environmentally-relevant (low ppb) concentrations, researchers evaluated biological responses across trophic levels (i.e., bacteria, algae, zooplankton, benthic invertebrates, fish, etc.) through baseline, two-year AgNP addition and lake recovery periods. Yellow Perch (Perca flavescens) and Northern Pike (Esox lucius) were monitored for multi-scale responses at the cellular (biomarker), individual (bioenergetics) and population levels. While there were minimal short-term effects at the lower trophic levels, fish were negatively affected from the start of the whole-lake manipulation to years after the AgNP additions ceased. At the cellular level, we found evidence of oxidative stress in the liver and gill tissues of perch and pike. At the individual level, bioenergetic models revealed significant changes in perch consumption, metabolism and activity, which declined during AgNP addition and remained depressed into whole-lake recovery. Furthermore, stable isotopes and growth analyses indicated that pike moved from feeding at nearshore locations to offshore prey sources and experienced reduced growth. At the population level, perch densities and gross prey consumption declined after AgNP was added to the lake, and pike experienced decreased survivorship. This whole-ecosystem multi-level and multi-scale response study of AgNP exposure revealed negative long-term impacts on fish, despite few short-term effects at lower trophic levels.

Brief Bio
Lauren Hayhurst is the Fisheries Research Biologist at International Institute for Sustainable Development – Experimental Lakes Area (IISD-ELA), having completed her M.Sc. (Biology) degree studying the effects of nanosilver on fish through Lakehead University in Thunder Bay. She is responsible for long-term fish populations monitoring efforts in the experimental and reference lakes at the IISD-ELA and resulting fisheries database. Lauren’s background involves water quality sampling, bioenergetics modelling, ageing analysis and population estimation, with experience working on whole-lake manipulations and recovery efforts. She attributes her early and ongoing interest in freshwater and fish research to her weekends spent at her family’s island on Lake of the Woods, ON.

Location of Study
Lake 222 (49.694587, -93.724398), IISD-ELA, Kenora District, ON.
Monitoring HABs in the Southern Basin of Lake of the Woods: A Collaborative Effort!
Adam J. Heathcote¹, Mark B. Edlund¹, Shane Bowe²; Cary Hernandez³

¹St. Croix Watershed Research Station, Science Museum of Minnesota, 16910 152nd St North, Marine on St. Croix, MN 55047 (651) 433-5953, aheathcote@smm.org
²Red Lake Department of Natural Resources, 15761 High School Dr, Red Lake, MN 56671
³Minnesota Pollution Control Agency, 714 Lake Avenue, Suite 220, Detroit Lakes, MN 56501

Abstract
Lake of the Woods (LoW) is currently on the United States 303(d) impaired waters list due to the persistence of harmful algae blooms (HABs) in the southern basin of the lake. These blooms continue to occur despite major reductions in point-source nutrients inputs. Previous research has shown that, due to the dynamic nature of the southern basin, high-frequency sensor arrays paired with regular site visits are the only reliable means of assessing the role of lake physics and nutrient cycling on HABs. We aim to build on previous work by continuing our monitoring and deployment of buoys as well as expanding our previous capabilities with the addition of a cyanotoxin monitoring program and a continuous phycocyanin sensor. Here, we present the results from the first year (2019) of our expanded monitoring project. This work is a collaboration between the Science Museum of Minnesota, the Red Lake Department of Natural Resources, and the Minnesota Pollution Control Agency.

Brief Bio
Adam Heathcote is a senior scientist at the Science Museum of Minnesota’s St. Croix Watershed Research Station. Heathcote has experience using high-frequency monitoring techniques in systems ranging from the shallow prairie potholes of Iowa to deep boreal lakes on the Canadian Shield.

Location of Study
Lake of the Woods (Southern Basin)
Lake of the Woods Watershed Comprehensive Watershed Plan: Putting Science into Action

Jeremiah Jazdzewski1 and Mike Hirst2

1Houston Engineering, Inc., 7550 Meridian Circle North, Suite 120, Maple Grove, MN 55369  763-493-6689  jjazdzewski@houstoneng.com
2Lake of the Woods Soil and Water Conservation District, USDA Service Center, 119 1st Avenue, Baudette, MN 56623  218-634-1842  mike.hirst@mn.nacdnet.net

Abstract

In 2017, representatives from Lake of the Woods and Roseau Counties, their respective Soil and Water Conservation Districts (SWCD), and the Warroad River Watershed District, organized to create the Lake of the Woods Watershed (LOWW) One Watershed, One Plan (1W1P) Planning Group. The purpose of the LOWW 1W1P Planning Group was to unite local entities—who would otherwise have separate local plans—under one Comprehensive Watershed Management Plan, creating a cohesive vision for implementing actions to improve locally prioritized water-related issues/concerns. The LOWW 1W1P Planning Group collaborated for the next two years to develop plan, which was adopted in the fall of 2019. The State of Minnesota is funding the implementation of actions identified in the plan through the Clean Water Legacy Amendment. This poster showcases the content of the plan and demonstrates how data and information gathered for the watershed will translate into actionable and measurable implementation over the 10-year lifetime of the plan.

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 began working as a project manager with the Lake of the Woods Watershed Planning Group in 2016, facilitating the development of the Lake of the Woods Comprehensive Watershed Management Plan as part of Minnesota’s One Watershed, One Plan (1W1P) program. The plan was approved by the Board of Water and Soil Resources (BWSR) in 2019 and shortly after, adopted by the participating counties, soil and water conservation districts (SWCDs), and the Warroad River Watershed District (WRWD). The group has now begun implementing the plan with the additional of newly acquired watershed funding.

Mike Hirst is a Resource Conservationist with Lake of the Woods Soil and Water Conservation District in Baudette, MN. He has a B.S. in Geology and Water Resources from the University of North Dakota. He is one of the local coordinators for the Lake of the Woods One Watershed, One Plan effort.

Location of Study

Minnesota Portion of the Lake of the Woods Watershed
Dispersal of Floating Cattail Mats in Rainy Lake, Minnesota
Chandra L. Wiley1, Reid T. Plumb1, Bryce T. Olson2, Steve K. Windels1

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2Ressurs Consulting LLC, Fertile, MN 56540, olson1bry@gmail.com

Abstract
Hybridized cattail (Typha x. glauca) is a prolific invader of wetlands across the Great Lakes states, including those in Voyageurs National Park, MN. It is known for dominating native vegetation, reducing biological diversity, and forming dense, rhizomatous, floating mats. These mats can weaken over time, breaking away from their point of origin and floating throughout the lake system, resulting in navigational hazards for recreators. Once detached, a variety of factors including wind and wave action, water level fluctuations, and human interference can affect the direction and distance a floating mat may disperse. These movements can hinder recreational opportunities, impair cultural resources by damaging archeological sites or reducing wild rice habitat, and negatively affecting wildlife habitat by acting as an avenue for further colonization and spread. Using aerial imagery, we identified detached mats and manually tracked their movements through time to better understand factors influencing their trajectories. Determining the causal mechanisms of detachment and dispersal will allow managers to target cattail stands for treatment, reducing future recreational hazards and minimizing the spread of the species.

Brief Bio
Chandra Wiley is a biological science technician at Voyageurs National Park. She holds a Bachelor of Science in Environmental Science. At Voyageurs, she has worked on projects involving aquatic ecology, wetland restoration and air quality. She is currently involved in a wetland restoration project that aims to reduce hybrid cattail abundance within the park and promote the health of wetland ecosystems.

Location of Study
Voyageurs National Park
Potential role of sediment resuspension on nutrient dynamics in Lake of the Woods
Reza Valipour, Ian Droppo, Johann Biberhofer, Jun Zhao, and Yuanrong Pan

Address

Abstract
Results of field observations, laboratory experiments and a three-dimensional model of Lake of the Woods, provide insight into the resuspension of bottom sediment and the impact that this process may have on the overall nutrient dynamics and ecosystem health of the lake. The study focuses on the dynamics of Total Phosphorus (TP), Total Nitrogen (TN), and Soluble Reactive Phosphorus (SRP) in the overlaying water column in response to these resuspension events. In the field, we distinguished the observed resuspension events according to turbidity, fluorescence, acoustic and backscatter time-series. In the laboratory, we conducted a series of experiments using a 2-m annular flume containing bed sediment samples and bulk water from the Big Traverse to quantify the initiation of resuspension. Our results show that initial flume runs, absent of biofilm growth, required relatively weak shear stresses for resuspension to occur compared to an identical sample subjected to more bio-stabilization time (biofilm development). This suggests that the microbial community may not only have a biogeochemical influence on nutrient dynamics, but also may mediate the mass of sediment/nutrients that can be eroded at any given shear into the water column. Measurement of TP, TN and SRP reveals that during resuspension events there are significant increases in the TP and TN concentration levels, while SRP concentration levels decrease. The lake-wide numerical sediment transport model using observed sediment samples and bed thicknesses in conjunction with laboratory results, can identify the lake-wide hotspots for resuspension, sediment transport, and their potential impacts on nutrient dynamics and lake-wide management plans.

Brief Bio

Location of Study
Big Traverse, Lake of the Woods and laboratory studies
Modelling the loading of nutrients from nearshore developments to Poplar Bay
Dale R. Van Stempvoort, Craig McCrimmon, Reza Valipour and Serban Danielescu
Watershed Hydrology and Ecology Research Division, Environment and Climate Change Canada

Abstract
Modelling the loading of nutrients from septic systems to the nearshore waters of Lake of the Woods is being conducted as four inter-related components: (1) development of conceptual models; (2) numerical modelling of the transport of nutrients in groundwater from septic systems to the shoreline of the lake; (3) tracer-based mass-balance accounting of attenuation of septic derived P in the subsurface and mixing processes in Poplar Bay; (4) numerical modelling of the mixing between Poplar Bay and the open lake, based in large part on water level data. Preliminary modelling indicates extensive attenuation in the subsurface and mixing processes limit the impact of nutrient loading from septic systems on nearshore areas of the lake. The outputs of this study contribute important details towards the overall modelling of nutrients in Lake of the Woods.

Brief Bio

Location of Study
## Forum Week Overview: Meetings & Forum Symposium

Tuesday Mar 10 is reserved for specific groups meeting prior to the March 11-12 Forum sessions

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<th>Time</th>
<th>TUESDAY</th>
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<td>9</td>
<td>IMA WG &amp; TAC Joint</td>
<td>Forum Day 1 Starts 9:00 am</td>
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<td>S119  9 am - 11 am</td>
<td>Theatre - RR Community College</td>
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<td>CAG</td>
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<td>S119  11 am - 12 pm</td>
<td>SC-114 11 am - 12 pm</td>
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<td>S119  12:30 pm - 1:30 pm</td>
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<td>CAG / IAG / IRLWWB</td>
<td>WLC &amp; Dam Operators</td>
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<td>S119  1:30 pm - 2:30 pm</td>
<td>SC-114 6 pm - 7 pm</td>
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<td>IRLWWB</td>
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<td>S119  3:30 pm - 6:30 pm</td>
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<td>Civic Engagement Workshop</td>
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<td>S119  3:30 pm - 6:30 pm</td>
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<td>Reception &amp; Poster Session Starts 6 pm</td>
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### Acronyms
- **IJC**: International Joint Commission
- **IRLWWB**: IJC International Rainy-Lake of the Woods Watershed Board
- **CAG**: Community Advisory Group to the IRLWWB
- **IAG**: Industrial Advisory Group to the IRLWWB
- **IMA WG**: International Multi-Agency Arrangement Working Group (managers)
- **IMA TAC**: International Multi-Agency Arrangement Technical Advisory Committee
- **RRCC**: Rainy River Community College
- **WLC**: Water Levels Committee of IRLWWB