11th Annual

International Rainy-Lake of the Woods Watershed Forum

March 12 - 13, 2014

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 11th International Lake of the Woods Watershed Forum, from summaries of presentations and from the March 12 & 13 symposium poster and presentation abstracts as supplied by the presenting authors.

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

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

Todd Sellers
Executive Director
Lake of the Woods Water Sustainability Foundation

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Executive Summary

The 11th annual International Rainy-Lake of the Woods Watershed Forum (the Forum) was held March 12-13th at the Rainy River Community College in International Falls, Minnesota. Prior to 2014, the Forum was known as the International Lake of the Woods Water Quality Forum – the Forum's name was changed this year to reflect the watershed and broader ecosystem focus of presentations and research and management activities in the basin, including the advent of the International Rainy-Lake of the Woods Watershed board, formed by the International Joint Commission, in April of 2013.

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

The Forum is organized and hosted by a partnership of agencies led by the Lake of the Woods Water Sustainability Foundation.

One hundred and forty researchers, resource managers, and policy makers attended this year's Forum – a record attendance reflecting the increased interest in research and resource management in the broader Rainy-Lake of the Woods basin. Forum participants reflect a broad range of interests and engagement in the watershed, including representation from agencies of local governments, soil and water conservations districts, provincial and state governments, federal governments, US Tribes, Canadian First Nations and Métis peoples industry and non-governmental organizations – all with the common connection of working on water or water-related issues in the Rainy-Lake of the Woods watershed.

This year's Forum featured an extended program, with one and a half days of research presentations, and an expanded poster presentation session. Research topics presented covered a wide range of disciplines reflecting the broad interest in and research underway in the Rainy-Lake of the Woods watershed.

The International Joint Commission's Lake of the Woods Basin Water Quality Plan of Study Team, held a workshop on March 11 and the morning of March 12, leading into the Forum program. The focus of this workshop was on a review of a first cut draft of the Plan of Study, with basin experts. Approximately 80 attended and provided feedback and guidance to Plan of Study Team, on the subjects of: harmful algal blooms, nutrients, aquatic invasive species, and surface and ground water contamination.

Program At A Glance

MARCH 12

10 AM TO NOON – REGISTRATION TABLE OPEN

12:00 LUNCH

13:00 Welcome and Introductions

13:10 SESSION 1 – BI-NATIONAL UPDATES

1. **International Joint Commission Welcome and Update.**
   Commissioner Rich Moy. IJC U.S. Section
2. **International Multi-Agency Working Agreement (IMA) Update.**
   Trina Rawn. IMA Working Group Member; Ontario Ministry of Environment
3. **IMA TAC GIS Subcommittee Update.**
   Todd Sellers. IMA TAC GIS Subcommittee member; LOWWSF
4. **IMA Monitoring Update.**
   Baratono, Nolan. IMA TAC Member - MPCA.
5. **International Watershed Coordinator Program Update.**
   Saunders, Kelli. Lake of the Woods Water Sustainability Foundation.

14:50 Break

6. **SOBR UP: Lake of the Woods and Rainy River Watershed State of the Basin Report – 2014 Edition.**
   Clark, Bev. Lake of the Woods Water Sustainability Foundation.
7. **Moving Towards a Unified Geospatial Framework.**
   Laitta, Mike. Physical Science Advisor/Geospatial Coordinator, International Joint Commission
8. **IJC International Rainy-Lake of the Woods Watershed Board Update.**
   Goffin, Mike - Co-Chair Int'l Rainy-Lake of the Woods Watershed Board; Environment Canada.
9. **IJC Lake of the Woods Water Quality Plan of Study Update / Workshop Reporting.**
   Brigham, Mark[1]; Benoy, Glenn[2]. [1]US Co-chair WQPoS - USGS; [2]Canadian Co-chair WQPoS – IJC Canada Section

17:00 Break

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

Guest Speaker
James R. Stark
Director, USGS Minnesota Water Science Center

- **Kallemeyn Award Presentation**
- **Wilson Award Presentation**

Poster Session

1. **Inland lakes at Voyageurs National Park represent near-pristine conditions in the Environmental Protection Agency's Northern Glaciated Nutrient ecoregion.**
   VanderMeulen, David; Damstra, Richard; LeDuc, Jaime. National Park Service – Great Lakes Inventory and Monitoring Network
2. **Interactive Web Tools for Climate Data Visualization.**
   Hart, Mark[1]; Tercek, Mike[2]. [1]National Park Service, Great Lakes Inventory & Monitoring Network; [2]Walking Shadow Ecology, Gardiner, MT
3. **Lake of the Woods Soil and Water Conservation District: a look at featured projects.**
   Hirst, Mike. Lake of the Woods Soil and Water Conservation District.
4. **A decision support tool using an HSPF watershed model application.**
   Kenner, Seth J.; Oswald, Jared K.; McCutcheon, Cindie. RESPEC Water & Natural Resources.
5. **The Use of Beaver Dams to Reduce Phosphorus Loading to Round Lake in Brainerd, Minnesota.**
   Cibuzar, Alan. A.W. Research Laboratories, Brainerd, MN.

MARCH 13 — 7:30 – 8:20 COFFEE (COMMUNITY COLLEGE CAFETERIA)

08:20 SESSION 2 – NUTRIENTS & MODELING

1. **A historical phosphorus budget for Lake of the Woods: Biogeochemical and diatom records in the southern basin.** *Edlund, M.B.[1]*, Reavie, E.D.[2], Schottler, S.[1], Hougardy, D.[3], Wattrus, N.[3], Baratono, N.[5], Paterson, A.M.[4], Engstrom, D.R.[1]*. [1]St. Croix Watershed Research Station; [2]Center for Water and the Environment, UMN; [3]Large Lakes Observatory & Department of Geological Science; [4]Dorset Environmental Science Centre – OMOE, [5]MPCA
2. **Rainy River/Lake of the Woods hydrology and water quality modeling process and uses.** *Blackburn, Julie A. and Love, Jason T.* RESPEC Water & Natural Resources
3. **All I need is a model that can do everything – The southeast Lake Huron modeling experience and its potential application to Lake of the Woods.** *Olivier, Cecilio and Fleming, Ryan.* Emmons & Olivier Resources Inc.
4. **The first international StreamStats project: Rainy River and Lake of the Woods watershed (a progress report).** *Steeves, Pete[1]; Laitta, Michael[2]*. [1]US Geological Survey; [2]International Joint Commission

09:40 Break

10:10 SESSION 3 – SURFACE & GROUNDWATER CONTAMINATION

5. **Mercury trends in four lakes in Voyageurs National Park, northern Minnesota, 2000-2012.** *Brigham, Mark E.[1]; Sandheinrich, Mark B.[2]; Maki, Ryan P.[3]; Krabbenhoft, David P.[4]*. [1]U.S. Geological Survey; [2]University of Wisconsin; [3]National Park Service; [4]U.S. Geological Survey
6. **Potential environmental impacts of the Twin Metals Mine.** *Baker, Lawrence A.* University of Minnesota.
7. **Potential risks of underground nickel/copper mines in the Kawishiwi watershed.** *Myers, Tom.* Independent Consultant, Hydrology and Water Resources
8. **Minnesota's wild rice standards study.** *Lotthammer, Shannon.* Minnesota Pollution Control Agency
9. **Lost and discarded fishing tackle in Voyageurs National Park: Implications for piscivorous birds.** ***Warmbold, Jerry[1] and Windels, Steve[2]***. [1]University of South Dakota, Vermilion, SD; [2]Voyaguers National Park

11: 50 LUNCH

13:10 SESSION 4 – WATER LEVEL ADAPTIVE MANAGEMENT

10. **Development of an integrated habitat model for Rainy and Namakan Lakes, US-Canada border.** *Morin, Jean; Bachand, Marianne; Tougas-Tellier, Marie-Andrée; Ouellet, Valérie; Champoux, Olivier; Fortin, Patrice; Martin, Sylvain; Novoa, Julio.* Environment Canada.
11. **Improving water level management on the Rainy and Namakan chain of lakes through the identification of potential flood vulnerabilities.** *Shantz, Mike.* Environment Canada.
12. **Managing water levels in the Namakan Reservoir: effects on walleye spawning habitat.** *Papenfuss, Jason; Cross, Tim and Venturelli, Paul.* University of Minnesota.
13. **The effects of water-level regulation on nutrients and plankton: results from a whole-lake experiment at the Experimental Lakes Area.** *Paterson, Michael [1]; Findlay, D.[2]; Beaty, K.[3]*. [1]International Institute for Sustainable Development; [2]Plankton R Us; [3]Fisheries & Oceans Canada.

14:30 Break

15:00 SESSION 5 – AIS AND HABITAT

14. **The role of citizens in AIS and water quality monitoring and the responsibility of agencies to interpret and act citizen-based findings.** *Passe, Derrick.* Lake County SWCD.
15. **Predicting dissolved oxygen concentrations in Lake Trout lakes: Developing new tools for a multiple-stressor world.** *Jeziorski, Adam[1]; Paterson, A.M.[2]; Molot, L.[3], Boegman, L.[4]; Smol, J.P.[1]* [1]Dept. Biology, Queen's University; [2]Dorset Environmental Science Centre – OMOE; [3]York University; [4]Depart. Civil Engineering, Queen's University
16. **Biological monitoring efforts in Minnesota's Lake of the Woods Watershed rivers and streams.** *Lueck, April.* Minnesota Pollution Control Agency.
17. **Long term monitoring in Minnesota lakes-Interactions between Bythotrephes longimanus and native zooplankton communities.** *Hirsch, Jodie K.* Minnesota Department of Natural Resources.

16:20 – 16:40 CLOSING REMARKS – MIKE GOFFIN, CO-CHAIR IRLWWB

Forum Sponsors – 2014

The organizing committee would like to thank our 2014 sponsor's for assisting with the 10th Annual International Lake of the Woods Water Quality Forum. This event would not be possible without the assistance of the following groups:

- Lake of the Woods Water Sustainability Foundation
- International Joint Commission
- Minnesota Pollution Control Agency
- Lake of the Woods District Property Owners Association
- Voyageurs National Park
- Rainy River Community College
- St. Cloud State University
- Dorset Environmental Science Centre (OMOE)
- Rainy Lake Conservancy
- North American Lake Management Society
- The City of Kenora
- The Municipal Township of Sioux Narrows-Nestor Falls
- Consulate General of Canada – Minneapolis

Organizing Committee – 2014

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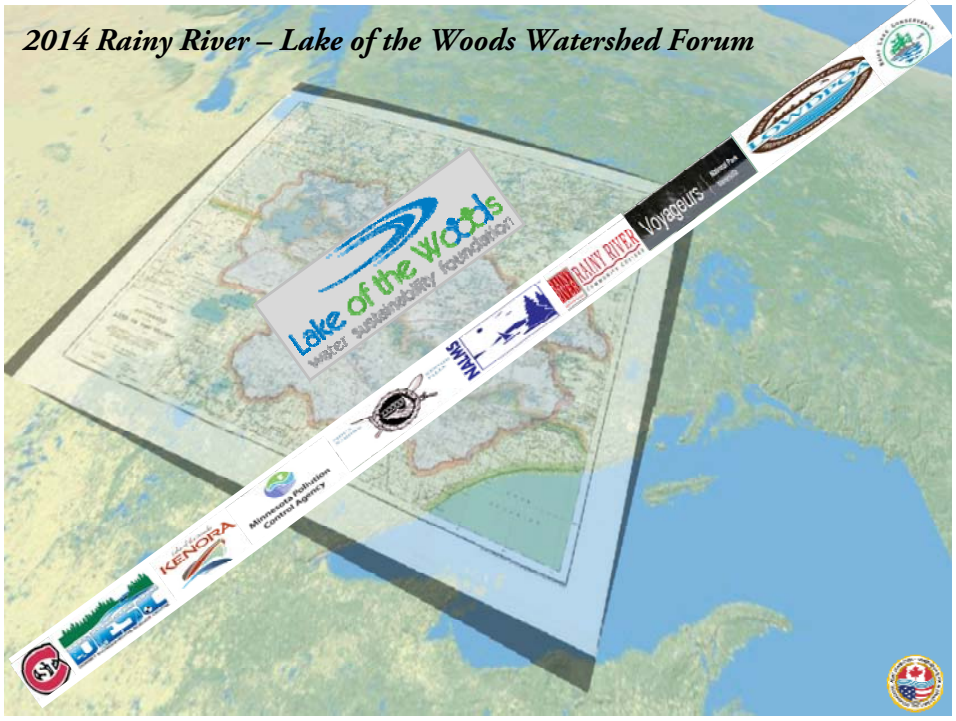
Presentation Abstracts

International Joint Commission Welcome and Update

Commissioner Rich Moy

International Joint Commission, US-Section



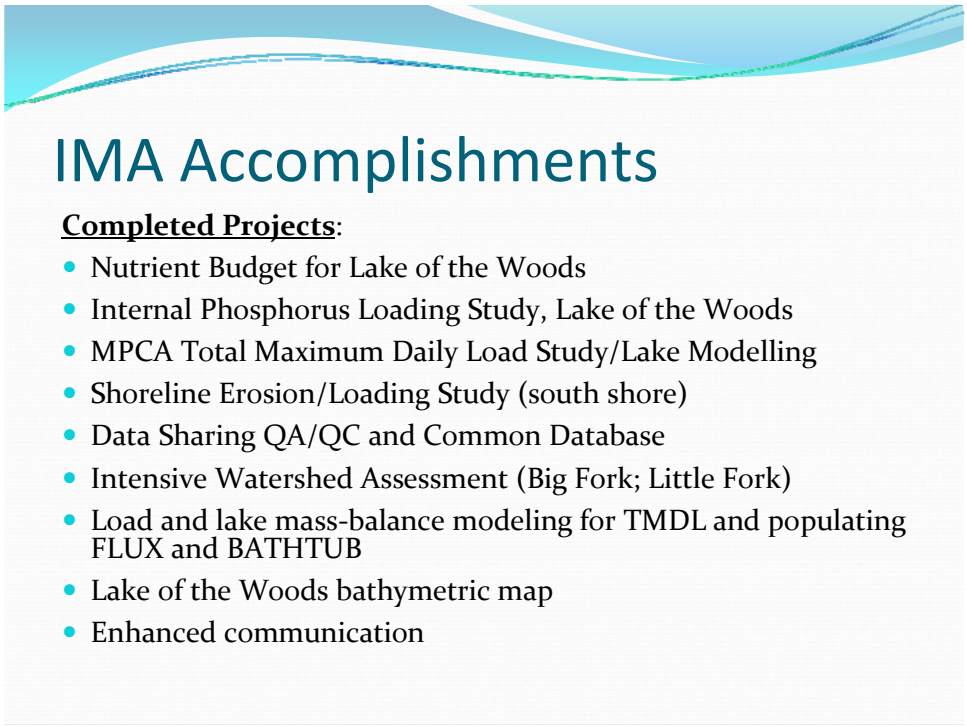
Abstract

Commissioner Rich Moy presented an update on International Watershed Initiative and the International Rainy-Lake of the Woods Watershed Board, established in April 2013. The boards directive, function and progress to date was summarized along with other IJC initiatives in the bi-national basin

International Multi-Agency Working Arrangement (IMA) Update

Trina Rawn

IMA Workgroup Member; Ontario Ministry of Environment



Abstract

An update on progress, activities and work plan priorities of the IMA was presented, noting the development of an updated five year workplan and the completion of significant projects including nutrient budgets as part of the Minnesota TMDL work, and the development of load and mass balance models for the Lake of the Woods and development of watershed hydraulic models for the basin. A summary of ongoing work that is currently funded was presented including: HSPF Basin Model Phase II – hydrology, nutrient load, contaminants; Minnesota –load based watershed monitoring, Ontario – tributary monitoring (concentrations); Historical Nutrient Loading Project – thermal modelling; Sediment Release Rate by Temperature study; Remote Sensing of Algae Blooms/Citizen Monitoring; Geospatial planning and implementation of data harmonization; Development of land use maps for LOW using Landsat imagery; and Determining phosphorus concentrations in sediment column. Priority "wish list" of unfunded projects were presented, including: annual maintenance of Wheeler's Point Gage; development of a Historical Wind Data Set; mapping of Invasive Species Distribution and Abundance; implementation of a Core Monitoring/Tiered Monitoring program; and Development of a Geospatial Platform (with IJC) and Maintenance of a Load and Mass-balance Database.

IMA TAC GIS Subcommittee Update

Sellers, Todd

Lake of the Woods Water Sustainability Foundation, Box 112, Kenora, ON Canada P9N 3X1

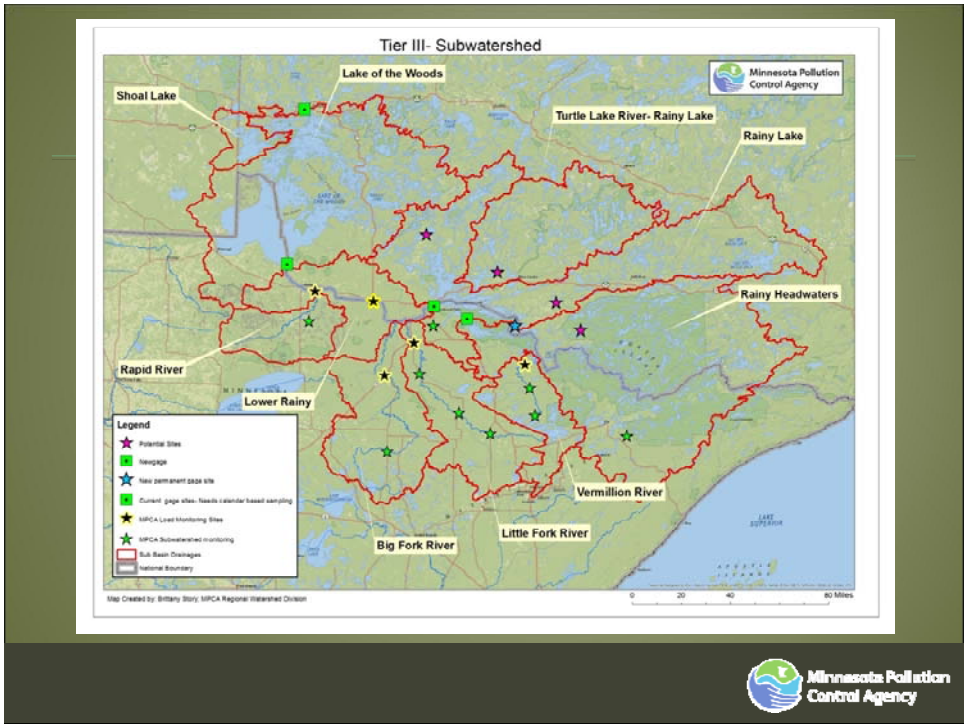
Abstract

GIS and data management has been identified by the IMA as a high priority. The harmonized hydrographic data initiative of the IJC provides us in our basin with a platform and key opportunity. The GIS and data management subcommittee of the IMA TAC is developing a GIS strategic plan and has identified potential pilot projects to begin developing a shared understanding of the IMA activities in the basin. A progress update is presented along with example projects.

IMA Monitoring Update

Baratono, Nolan

Minnesota Pollution Control Agency



Abstract

The International Multi-Agency Arrangement Technical Advisory Committee determined that a comprehensive monitoring approach was needed for the Rainy-Lake of the Woods Watershed. A monitoring subcommittee was formed in 2011. The Subcommittee determined that the monitoring program would need to provide data for the following subject areas:

- Nutrient Enrichment and Harmful Algal Blooms
- Aquatic Invasive Species (AIS)
- Surface and Groundwater Contamination
- Climate Change
- Hydrology

The Subcommittee further specified that the program should allow for seamless coverage from the Subregion/Basin scale down to the subwatershed scale, be statistically sound and accommodate new subject areas and special studies as necessary.

This presentation provides an overview of a tiered monitoring approach for the Rainy-LOW Watershed. This four-tiered approach allows for basin scale (Tier I), sub-basin scale (Tier II, Hydrologic Unit Code (HUC) 8s), subwatershed scale (Tier III, HUC 12s and smaller) and special studies (Tier IV) which may encompass the subwatershed, watershed and basin scale. The framework for the program allows agencies to:

- Expand or decrease monitoring as budgets dictate

- Provide data that are useful at the subwatershed, watershed and basin scale as necessary
- Determine cumulative effects
- Determine how effective projects are in meeting goals

Tier I, II and III sites are or will be established at flow gage sites throughout the basin. Most of the gage infrastructure is in place for Tier I and II sites. Many of the Tier III gages are in place for the Minnesota portion of the Watershed.

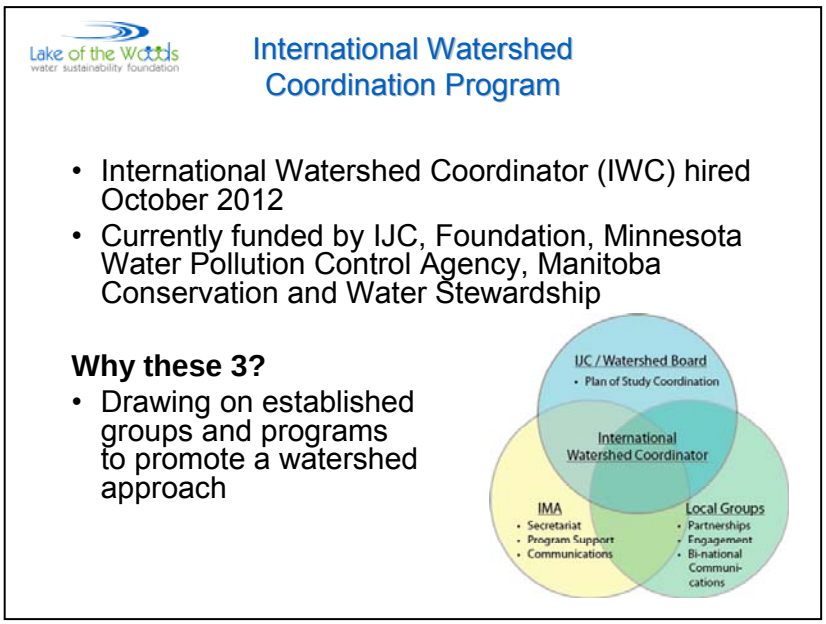
Field data collected along with chemical samples collected at these watershed pour-point sites will provide data specific to the watershed above the site and when coupled with storm event monitoring and flow data will provide nutrient, sediment and contaminate loads to the watershed below the site. Additional parameters may be collected at the sites (such as AIS or metals) as needed. With full implementation of Tier I, II and III agencies will have a network in place that will provide an early warning of problems or changes in individual watersheds and identify the subwatersheds needing protection or restoration activities.

The Tier IV Special Studies would be designed as needed to address protection or restoration needs.

International Watershed Coordinator Program Update

Saunders, Kelli

Lake of the Woods Water Sustainability Foundation, Box 112, Kenora, ON Canada P9N 3X1



Abstract

In October 2012, the International Watershed Coordination (IWC) Program was launched for the Rainy-Lake of the Woods Watershed, moving collaboration on watershed science and management a few more steps forward. The program has been developed as a partnership between the Lake of the Woods Water Sustainability Foundation, the International Joint Commission, Manitoba Conservation and Water Stewardship and the Minnesota Pollution Control Agency-Koochiching Soil and Water Conservation District. The program is managed by an International Watershed Coordinator (IWC) and provides coordination throughout the watershed on three main projects:

- The new International Joint Commission (IJC) Rainy-Lake of the Woods Watershed Board's Water Quality Plan of Study
- Secretariat support to the International Multi-Agency Work Group (IMA)
- Networking support to local civic engagement entities

The goal of the IWC Program is ensure that communication amongst the many entities working in the basin is strong, that common goals begin to form around watershed management, that support is provided to those doing research and that the research is communicated as joint management strategies are developed and that partnerships are strengthened across the border. Highlight projects currently underway as part of this program include the identification of research gaps regarding our common knowledge about nutrients and harmful algal blooms, aquatic invasive species, surface and groundwater contamination and impacts from hydrologic regulation and climate change (i.e. the IJC's Plan of Study); development of a watershed-wide contact database, and development of a locally driven civic engagement website.

With so many agencies and organizations at work in the watershed, it was recognized that there is a need for one coordinated approach to future management and to joint, consistent messaging—this new IWC program will fill these needs.

SOBR UP: Lake of the Woods and Rainy River Watershed, State of the Basin Report – 2nd Edition 2014

Clark, Bev

Lake of the Woods Water Sustainability Foundation

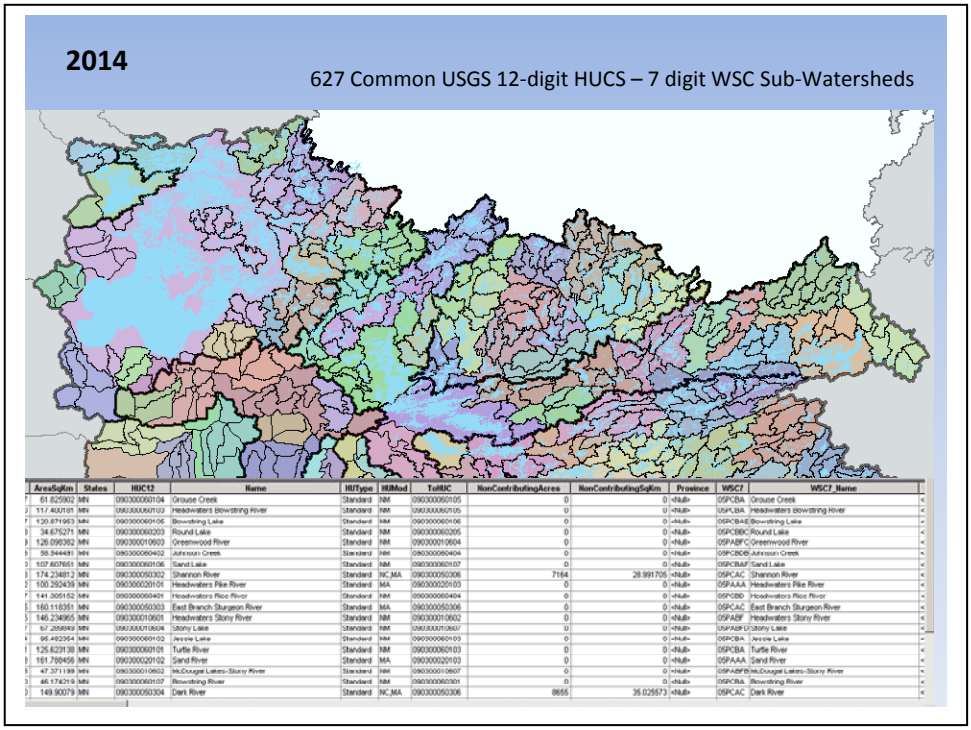
Abstract

The first State of the Basin Report (SOBR) was published in 2009 to synthesize the growing body of knowledge regarding the Lake of the Woods watershed. Research initiatives and monitoring in the watershed had increased in recent years due to concerns about algal blooms and followed many grass roots initiatives to support science in the watershed. The International Water Quality Forum was responsible for generating much of this momentum. In the 5 years since the first edition of the SOBR was published there has been continued and increased efforts to fill gaps in the understanding of key processes in the watershed. Nutrient loading, nutrient flux, algal bloom dynamics, ecosystem responses to water level control and the effects of multiple stressor impacts such as climate change are a few examples. These findings which have helped to provide tools that can answer difficult questions are of sufficient importance that a second edition of the SOBR was required. The 2nd (2014) edition is nearing completion, with funding from the IJC's International Watershed Initiative and the Lake of the Woods Water Sustainability Foundation and technical support from the IMA. It will expand the scope of the original document by providing more information for areas upstream of the Rainy River and provide support for the development of the IJC Water Quality Plan of Study for the watershed which is currently underway.

Moving Towards a Unified Geospatial Framework

Laitta, Mike

Physical Science Advisor/Geospatial Coordinator, International Joint Commission of Canada and the United States.



Abstract

An overview of the Hydrographic Data Harmonization initiative coordinated by the IJC was presented, noting that it is the foundational infrastructure for the IJC's International Watershed Initiative. The focus in on building a shared geographic framework to provide seamless and interoperable geospatial data to provide a perspective and context for planning and initiatives; operational support for IJC Boards and Study Groups across the transboundary, and support decisions based on strong situational awareness. An update on progress from 2008 to 2014 was presented, culminating with the completion of the Rainy-Lake of the Woods basin harmonization to the level of 627 Common USGS 12-digit HUCS – 7 digit WSC Sub-Watersheds. This harmonized hydrologic framework can not be leveraged for modeling at a variety of scales and for operation data overlay. Work is progressing on development of a geospatial strategic plan for the International Multi-Agency Arrangement, leveraging the harmonized framework, to provide sound and timely advice to the IMA Technical Advisory Committee with respect to geospatial information, geospatial data and science planning.

IJC International Rainy-Lake of the Woods Watershed Board Update

Goffin, Mike

Co-Chair IRLWWB, Environment Canada

Abstract

Mike Goffin, Canadian Co-Chair of the International Rainy-Lake of the Woods Watershed Board (IRLWWB) provided an overview of International Watershed Initiative Boards and an update on the formation, mandate, membership and progress of the IRLWWB during its first year. A summary of activities was presented, including public meetings, establishment of the Community Advisory Group and Industry Advisory Group, development of the board's workplan, development of terms of reference for a water quality plan of study, and progress on the Rainy-Namakan Rule curve studies. Priorities and next steps for the board were presented, including to:

- Identify any gaps in water quality and/or aquatic ecosystem health objectives
- Select, determine, establish, and report on water quality / aquatic ecosystem health alert levels
- Review Water Quality Plan of Study
- Continue monitoring water levels and flows conditions
- Rule Curve Studies and Evaluation
- Prepare annual report to the International Joint Commission
- Develop approach for tracking and reporting on environmental issues in watershed
- Hold public meeting(s) in August 2014

IJC Lake of the Woods Water Quality Plan of Study Update / Workshop Reporting

Brigham, Mark and Pilon, Paul

Co-Chairs, WQPOS

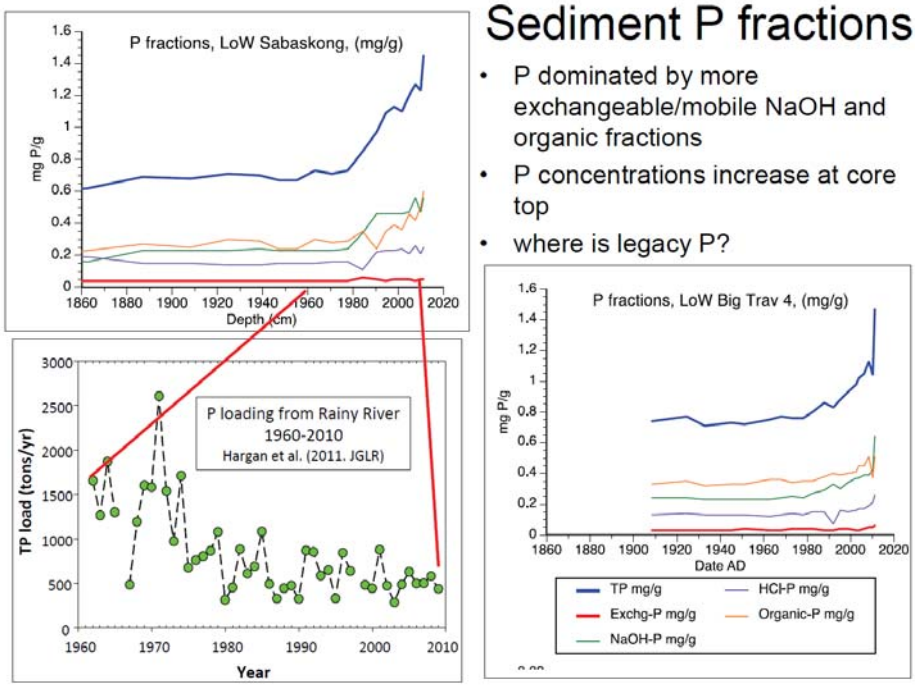
Abstract

A workshop was held on March 11, to provide input to the development and refinement on a first cut draft of a Lake of the Woods Basin Water Quality Plan of Study. A summary of workshop sessions was presented.

A historical phosphorus budget for Lake of the Woods: Biogeochemical and diatom records in the southern basin

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

[1]*St. Croix Watershed Research Station, Science Museum of Minnesota, Marine on St. Croix, MN 55047*
[2]*Center for Water and the Environment, Natural Resources Research Institute, University of Minnesota Duluth, 1900 East Camp Street, Ely, MN 55731*
[3]*Large Lakes Observatory & Department of Geological Sciences, 10 University Dr., Duluth, MN 55812*
[4]*Dorset Environmental Science Centre, Ontario Ministry of the Environment, 1026 Bellwood Acres Road, P.O. Box 39, Dorset, ON, P0A 1E0*
[5]*Minnesota Pollution Control Agency, 909 Riverside Drive, International Falls, MN 56649*



Abstract

A historical phosphorus budget is being constructed for Lake of the Woods (LoW) that will be an important tool for resource managers to address water quality and cyanobacterial blooms that currently impact the lake. Sediment cores (piston cores, ~1 m long) collected from from throughout the southern basin in Big Traverse (2 cores), Little Traverse, Sabaskong, Muskeg, Buffalo Bay, and Big Narrows are the focus of intensive analytical efforts including radioisotopic dating, geochemistry (LOI, phosphorus, silica), diatom communities, and fossil pigments. We've previously reported on sediment mapping of the southern basin, gross sediment composition (typically >80% inorganic by dry weight), and sedimentation rates that have increased two-fold between pre-1900 and modern times in the lake (with greater increases in Big Traverse Bay). Three additional analyses are nearly complete and provide the next key pieces of evidence for determining the nutrient loading and ecological history of the lake. Diatoms preserved in sediment cores provide historical snapshots of a major algal group and are also used to estimate historical water column concentrations of total phosphorus. Analysis of diatom communities suggests all sites in LoW have long been dominated by *Aulacoseira islandica*, but diatom communities deposited since the 1990s show increasing abundance of eutrophic indicator species such as *Cyclostephanos dubius*, *Stephanodiscus minutulus*, and *Stephanodiscus parvus*. The application of inference models to estimate historical levels of total phosphorus shows slight

trends toward increased levels of water column total phosphorus based on changing diatom communities preserved in more recent sediments. Biogenic silica (a measure of historical diatom productivity) and phosphorus fractions in the sediment cores were also analyzed. Sediment phosphorus shows little historical change in concentration of sediment P, although there is slightly increased flux or accumulation of P upcore. However, the accumulation rate of P does not track the monitored trends of decreased loading from the Rainy River over the last 30 years suggesting that P is readily cycled in LoW and that loss of P from the lake through burial in the sediments is less efficient than in other lake types.

Rainy River/Lake of the Woods Hydrology and Water Quality Modeling Process and Uses

Blackburn, Julie A[1]. and Love, Jason T.[2]

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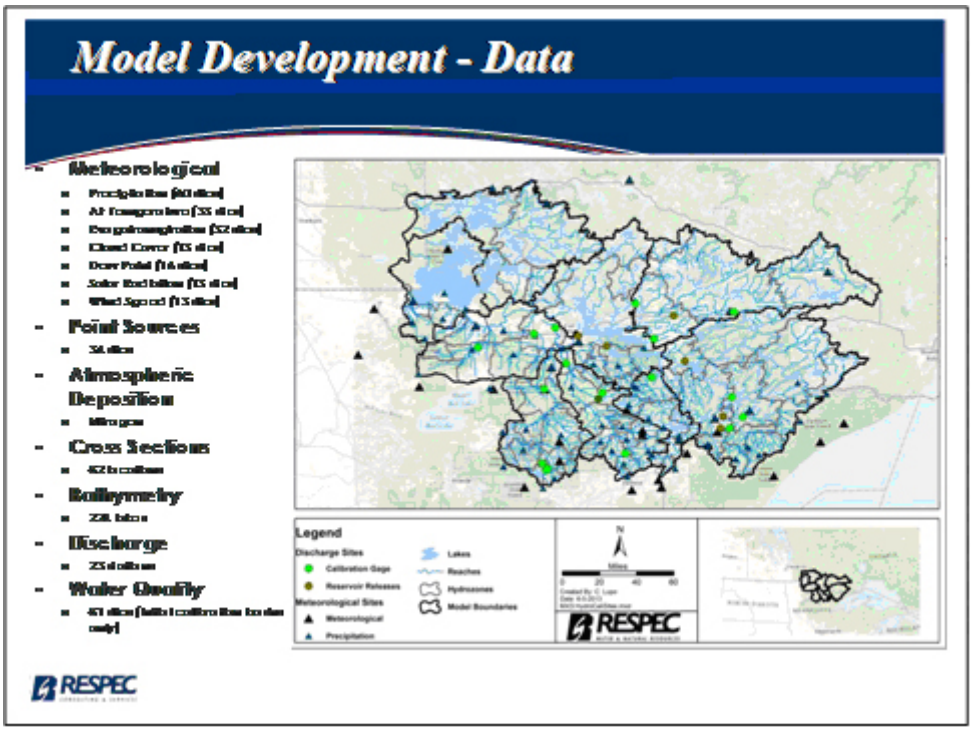


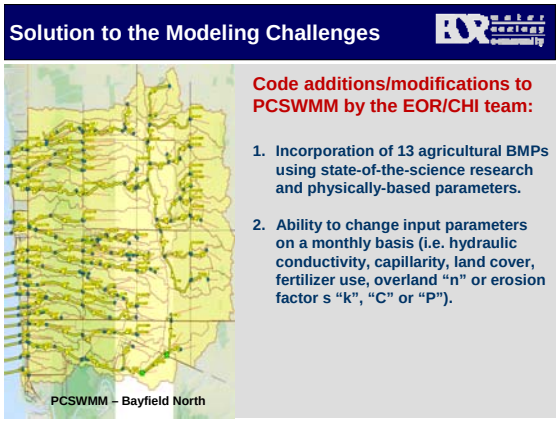
Abstract

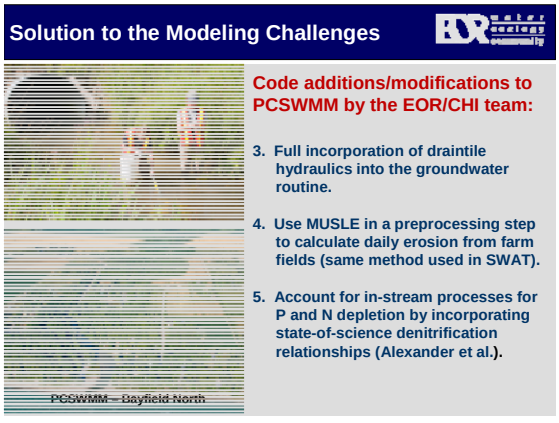
HSPF is being used to develop model applications that simulate watershed runoff and water quality for the Rainy River/Lake of the Woods Watershed. **HSPF** is a tool used by the MPCA in their approach to watershed monitoring, assessment, TMDL development, and identification of restoration and protection strategies. The model applications cover over 25,000 square miles and integrate a wide variety of datasets, including meteorological, land cover, soils, flow and waterquality monitoring, and point-source data. Hydrologic calibration of the entire model area is complete, and water-quality calibration of three of the major watersheds in Minnesota (i.e., Big Fork River, Little Fork River, and Lake of the Woods) is complete; the remainder will be completed in 2014 and 2015. The model applications will facilitate prioritizing management actions in the watershed. The types of scenarios that can be run include land use changes, capture of pollutant loads, and changes in efficiencies based on land management practices. The results of a simulated management scenario in the watershed will demonstrate the applicability of the **HSPF** model applications to the Rainy River/Lake of the Woods Watershed as a whole.

All I need is a model that can do everything – The southeast Lake Huron modeling experience and its potential application to Lake of the Woods

Olivier, Cecilio and Fleming, Ryan

Emmons & Olivier Resources Inc., 651 Hale Ave. N., Oakdale, MN 55128 USA





Abstract

A partnership of government and landowners along the highly recreational southeast shores of Lake Huron, funded the creation of a new Rural Storm Water Management Model (RSWMM) for a pilot area totaling 500 Km2. The model required the ability to accurately simulate current and future Hydrologic, Hydraulic and water quality conditions, and assess TSS, P and N loads reduction due to agricultural and urban BMP implementation. No currently existing model can fully meet these stated goals. Therefore, a custom-made model needed to be developed requiring a strong knowledge of the effectiveness of agricultural practices and a great dose of creativity and technical innovation.

PCSWMM (EPA SWMM engine) is being used as a base model and additional water quality routines and code is being added to improve the water quality functionality in rural areas. Specifically, MUSLE algorithms of the SWAT model and in-stream components of the SPARROW model are incorporated into the existing runoff and hydraulics modes in PCSWMM. Physically-based and non-physically based agricultural BMPs are also being added. Seasonality in parameterization, so important to accurately represent agricultural settings in cold-climate areas (i.e. variable soil infiltration, erosion or nutrient application depending on the time of year), has been integrated into the PCSWMM code. Physical, chemical and biological processes associated to P and N in streams, are also simulated.

Overall, the RSWMM provides a unique tool to examine both hydrology and water quality in agricultural and urban areas contributing to Lake Huron. Given the similarities between Lake Huron and Lake of the Woods watersheds (i.e. fair amount of agricultural land use in the Canadian side of LOTW's drainage area, high amounts of SRP in the lake and tributaries, and uncertainty of the winter/spring pollutant runoff pulses), the RSWMM could also be used as a state-of-the-science watershed assessment and decision making tool for Lake of the Woods.

The first international StreamStats project: Rainy River and Lake of the Woods watershed (A progress report)

Steeves, Pete[1]; Laitta, Michael[2]

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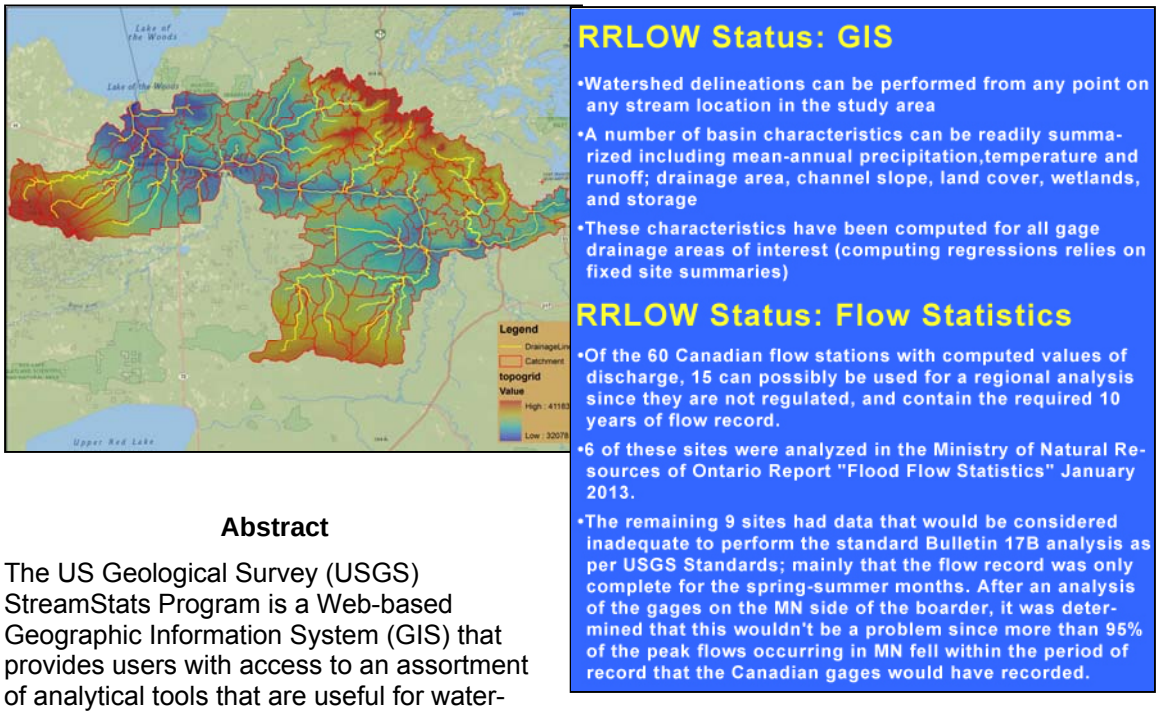
[2]International Joint Commission, Washington, DC



Abstract

The US Geological Survey (USGS) StreamStats Program is a Web-based Geographic Information System (GIS) that provides users with access to an assortment of analytical tools that are useful for water-resources planning and management, and for engineering design applications, such as the design of bridges (http://water.usgs.gov/osw/streamstats/). StreamStats allows users to easily obtain streamflow statistics, drainage-basin characteristics, and other information for user-selected sites on streams. StreamStats users can choose locations of interest from an interactive map and obtain information for these locations.

The first International StreamStats Project in the Rainy River and Lake of the Woods (RRLOW) Watershed is currently in development. Significant progress has been made with the goal of having a site up by the end of 2014. As of this abstract submittal (Jan. 2014), the GIS preprocessing has been completed for both watershed delineations (from any point on the stream network) and basin characteristic computations for a number of characteristics that should prove to be significant for peak flows (including drainage area, annual precipitation, annual runoff, storage, and channel slope). Regression equations are now being developed with the use of USGS, International Joint Commission (IJC), and Environment Canada stream gage networks. With this being the first of its kind, there remain a few outstanding issues to work out regarding gage-database coordination, web-site hosting, and publication.

The RRLOW StreamStats project will represent a significant milestone when completed. It involves the cooperation of federal, state, and provincial agencies in both the USA and Canada, with oversight by the IJC and the RRLOW River Board. It is built upon an unprecedented “harmonization” effort of GIS layers, including hydrography and watershed boundaries. When this project is completed, this harmonized data will be available on the new web site, and will highlight the data-analysis capabilities of StreamStats in a transboundary setting.

Mercury trends in four lakes in Voyageurs National Park, northern Minnesota, 2000-2012

Brigham, Mark E.[1]; Sandheinrich, Mark B.[2]; Maki, Ryan P.[3]; Krabbenhoft, David P.[4]

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[2]University of Wisconsin - La Crosse, 1725 State Street, La Crosse, WI 54601
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Abstract

We present a case study comparing methylmercury in lake water and small yellow perch for four undeveloped lakes in Voyageurs National Park (northern Minnesota) to wet atmospheric deposition of mercury, sulfate, and hydrogen ion in northern Minnesota. Mercury, sulfate, and hydrogen ion all potentially affect the mercury cycle in lakes, and annual wet-deposition rates of each of these pollutants decreased from 1998−2012 at nearby National Atmospheric Deposition Program precipitation monitoring sites (average percent changes of −33, −48, and −66 %, respectively). Consistent with trends in the atmospheric pollutants, two of four lakes (Ryan and Peary) show declines in epilimnetic aqueous methylmercury (average percent change = −46% decrease from 2000−2012) and mercury in small yellow perch (average = −34%). Counter to trends in the atmospheric pollutants, aqueous methylmercury increased by 83% in a third lake (Brown Lake), and mercury in small yellow perch increased by 82%. The trends reported above were determined by linear regression of the parameter of interest (annual wet-deposition rate; or log-transformed concentrations) versus time in years, and are significant (p<0.05). The fourth lake (Shoepack Lake) had two disturbances in its watershed during the study period (forest fire; changes in shoreline inundation due to beaver activity); this lake lacked overall trends in both aqueous methylmercury and mercury in yellow perch. The diverging responses among the study lakes exemplify the complexity of ecosystem responses to decreased loads of atmospheric pollutants.

Potential environmental impacts of the Twin Metals Mine

Baker, Lawrence A.

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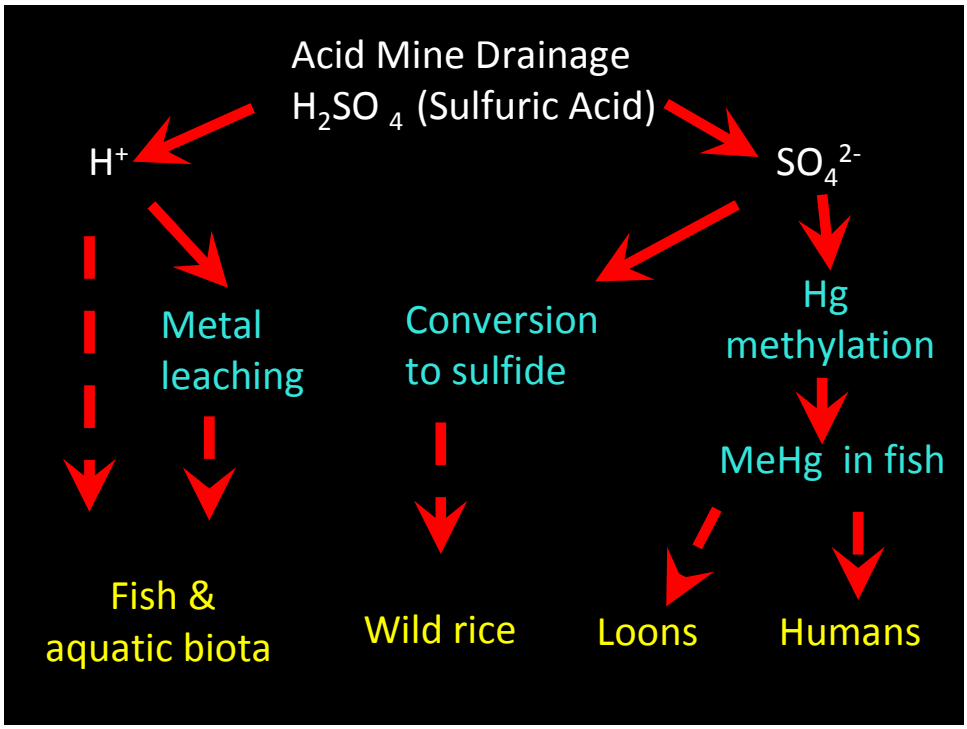

Abstract

The proposed Twin Metals Mine would be located near Birch Lake on the Kawishiwi River near Ely. If constructed, it would remove up to 730 million tons of copper ore over period of two decades. Since copper ore contains only ~ 0.5% copper, nearly all of this material would end up in as mine tailings. The mine would be underground. Depending on the planning scenario, tailings would be stored in some combination of existing pits, surface impoundments, and the mine shaft itself.

The Kawishiwi River is designated an “outstanding water” that flows out of the BWCAW through Birch Lake and then re-enters the BWCAW and flows into Ontario's Quetico Provincial Park. Several protected research sites are located in the watershed, and the watershed is protected by an 1854 Treaty for Native Americans.

Waters in this area are highly sensitive to acidic mine drainage (AMD) and river is already affected by bacterial contamination from septic systems. There is also widespread mercury contamination in the area – more than 300 waters in Lake and St. Louis Counties have mercury advisories for fish contamination.

One likely impact of the Twin Metals Mine would be production of acidic mine drainage (AMD). This is particularly important because

Minnesota has a 10 mg/L sulfate standard for wild rice waters, of which there are more than 200 in Lake and St. Louis Counties. It would take very small amounts of AMD to cause sulfate levels in receiving waters to exceed 10 mg/L.

Sulfate from AMD would also likely affect the biogeochemical cycling of mercury and phosphorus. Numerous studies have shown that sulfate stimulates mercury methylation, which in turn increases mercury levels in fish. Sulfate also affects the cycling of phosphorus, causing release of P from sediments, at least initially. Long term effects of sulfate on P cycling as not well understood. Leached AMD from the Twin Metals Mine might also affect domestic drinking water wells that are used by nearly all residents in the vicinity of the proposed mine and half of all residents in Lake County.

Finally, if large tailings ponds were to be built, there would be serious potential threat from dam failure. Globally, the risk level for failure of tailings dams is about 0.1% per year, based on the historical record. Because tailings dam failures are often triggered by heavy rainfall, the likelihood of failures may increase, unless they are designed to accommodate much higher precipitation events. If a tailings dam failure were to occur, the distribution of sediments, acidic waters, and metals would likely contaminate the Kawishiwi River for tens of kilometers. The initial flush would quickly result in death of fish and other biota downstream, but the effect would be of short duration. On the other hand, damage caused by metal-laden sediments would likely persist for years.

Potential Risks of Underground Nickel/Copper Mines in the Kawishiwi Watershed

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Abstract

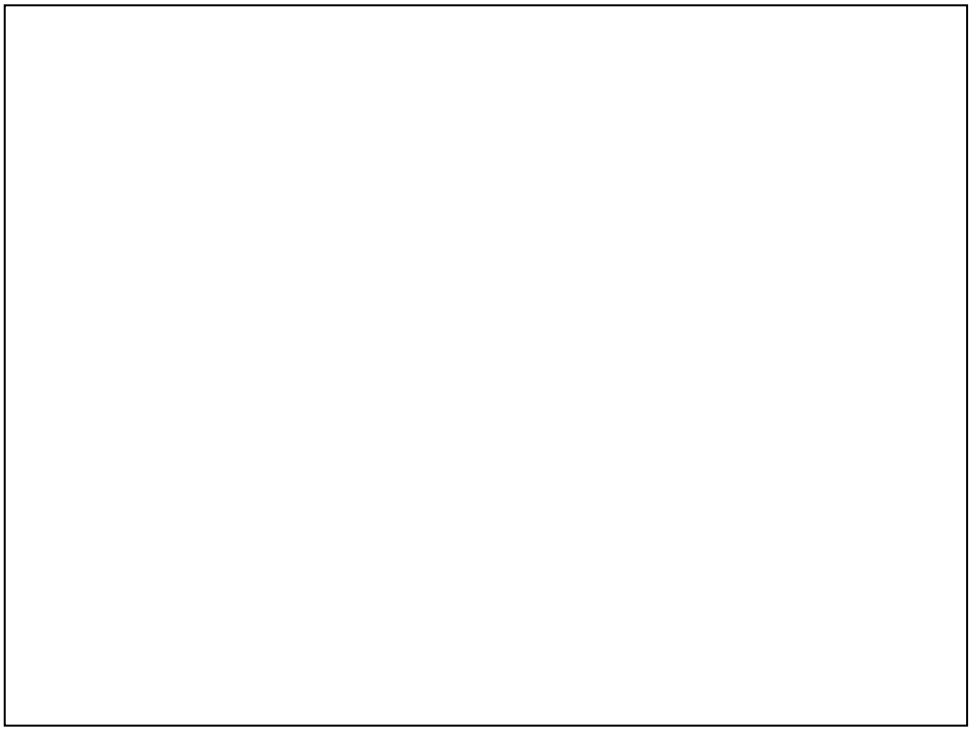
The Kawishiwi watershed may have numerous nickel/copper mines in the future. Several deposits occur within a short distance of the South Kawishiwi River at depths up to 5000 feet. This presentation provides a conceptual flow model for the area and qualitative discussion of the likely hydrologic risks caused by underground sulfide mining. About a third of the average 28 in/y of precipitation becomes river flow, which is a combination of runoff and groundwater discharge. After peaking during spring snowmelt, surface runoff decreases slowly as wetland and small lake storage drains. Groundwater discharge is the primary source of river baseflow. A thin till-formed surficial aquifer is conductive but has low transmissivity. The upper few hundred feet of the bedrock aquifer is fractured and transmits some groundwater with a possibility of higher flow rates near fractures.

Deep underground mines require dewatering, but the matrix permeability in this area is low so generally high dewatering rates should not be expected. Mines encountering fractures, however, may dewater at a rate tens to hundreds of times higher than the base dewatering rate encountered in the surrounding matrix. The extent of the impacts on surface water and wetlands depends on the connectivity between surficial and bedrock aquifers and the extent of fractures in the area. Sulfide at one deposit in the watershed is higher than at the nearby acid mine drainage (AMD) producing Dunka Mine. High and variable acid production and poor buffering capacity suggest the AMD risks are high. Tailings impoundments could leak which, if not quickly contained, will contaminate aquifers with seeps contaminating surface water. They could also fail, which at least 146 impoundments globally have done over the past several decades many due to high rainfall events. Increased sediment transport could increase the movement of mercury through the watershed. The hydrologic risks to the pristine watershed from sulfide mining in the Kawishiwi watershed are high but insufficiently understood for good decision making.

Minnesota's wild rice standards study

Mark Tomasek

Supervisor, Environmental Outcomes Division, Minnesota Pollution Control Agency

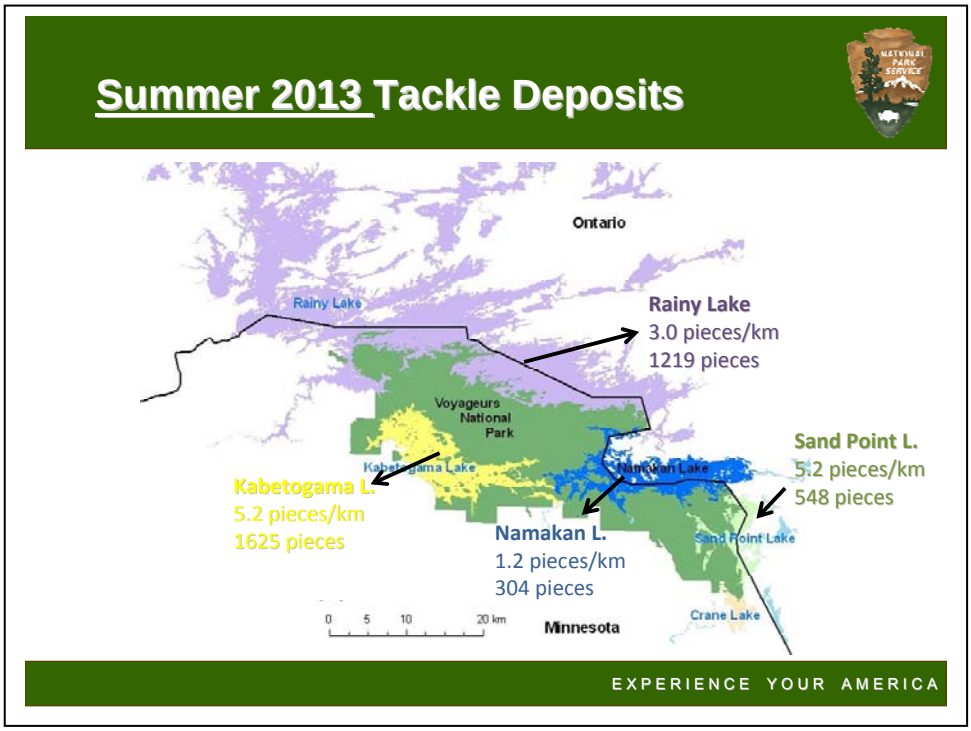


Abstract

Lost and Discarded Fishing Tackle in Voyageurs National Park: Implications for Piscivorous Birds

Warmbold, Jerry[1] and Windels, Steve[2]

[1]University of South Dakota, Vermilion, SD
[2]Voyaguers National Park



Abstract

Fishing is the primary recreational activity for the majority of visitors to Voyageurs National Park (VNP). The amount of fishing tackle lost into lacustrine systems in Minnesota, including lakes within Voyageur National Park (VNP), is astounding. A recent study suggests that approximately 211,000 individual pieces of lead tackle were cumulatively lost in Rainy Lake between 1983 and 2004, an average of nearly 10,000 pieces per year. Ingestion of lead tackle by aquatic bird species, including common loons, gulls, cormorants, and eagles can result death by lead poisoning. Piscivorous birds may also become entangled in fishing line or snagged by hooks from lost or discarded fishing tackle. In the summers of 2012 and 2013, we surveyed sections of shoreline along the large lakes in VNP to estimate accumulation rates of lost and discarded tackle that may collect along shorelines and be encountered by piscivorous birds and other wildlife. We also surveyed nest sites of double-crested cormorants and bald eagles to assess incidence of fishing tackle being brought to nestling birds. Lastly, we summarized known instances of wildlife being entangled or hooked in fishing tackle and the outcome of those events. We will report preliminary results from our study and discuss the implications for risk of injury or mortality to individual birds from encounters with lost or discarded tackle.

Development of an integrated habitat model for Rainy and Namakan Lakes, US-Canada border

Morin, Jean; Bachand, Marianne; Tougas-Tellier, Marie-Andrée; Ouellet, Valérie; Champoux, Olivier; Fortin, Patrice; Martin, Sylvain; Novoa, Julio

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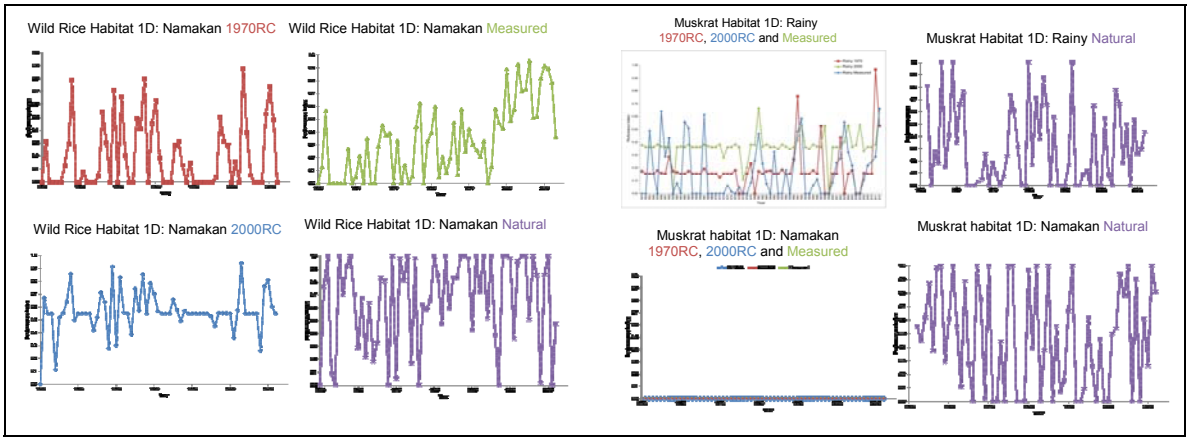

Abstract

Water levels of Rainy and Namakan Lakes have been managed using different rule curves (1970 and 2000 rules curves, most recently) since 1949. The IJC (International Joint Commission) is the binational entity responsible for the transboundary waters; the present rule curves that manage the system will be reviewed in 2015. In order to quantify the effects on the ecosystem of present water level management, we are developing an integrated ecosystem response model using mostly a 2D habitat modelling approach combined with more simple relations with water level changes. Historically, artificial water level regulation of the system has been related to major issues including wild rice reduction in abundance, hybrid cattail invasion, wetlands diversity reduction, loon population reduction, walleye and northern pike population reduction and low muskrat abundance.

A regular computational grid with nodes every 20 m was constructed. Such a dense grid was necessary because of the shoreline complexity and the surface area that covers nearly 3000 km² of lacustrine and riparian habitats. A seamless DEM was built using several types of data and sources: LIDAR, Shoals and Radar data for terrestrial areas, while bathymetric soundings, isodepth contour maps and Shoals data were used in lacustrine areas. Using an historical water level series (quarter-montly mean) for both lakes from 1950 to 2013, we built a physical variables database that comprises water depth for every quarter-month, hydroperiod variables calculated for relevant temporal window such as seasons (nbr of dry-wet cycle, nbr of dry quarter-month etc), and modelled wave action based on observed winds and bottom slope.

Bidimensional habitat models are being developed for submerged plant and wetlands (swamps, shallow and deep marshes) and also for hybrid-cattail and wildrice, as well as for Pike and Walleye reproduction models. Results from some of the vegetation models are used as input variables for northern pike (larvae and young-of-the-year stages models), so that changes in vegetation are taken into account. More simple relations with global water level over each lake are used to assess the direct impact of water level on loon nests and on muskrat winter houses.

Results from the different habitat models are presented in a quantitative manner allowing selection of the best available rule curves in terms of management of water levels. Results show that present rule curves (2000 rule curves) are more efficient than the 1970 rules curves but several problems remain, especially for northern pike, muskrat and wild rice abundance. Some modulations of the rule curves can be proposed for maintaining more "diverse" wetlands and helping wildrice to compete with hybrid cattail.

Improving water level management on the Rainy and Namakan chain of lakes through the identification of potential flood vulnerabilities

Shantz, Mike

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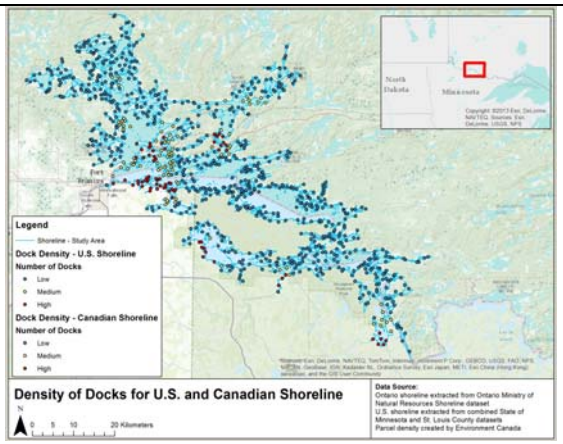
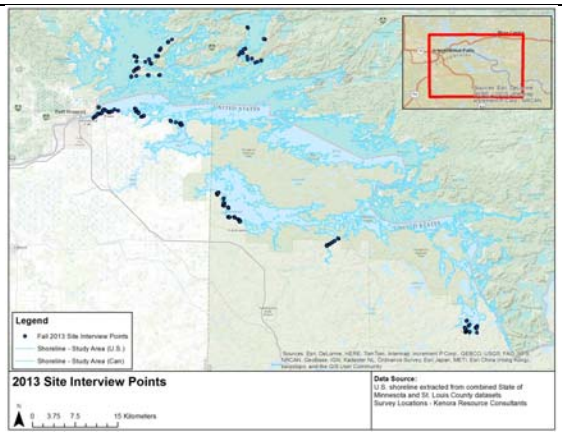


General Screening



Property Owner Surveys

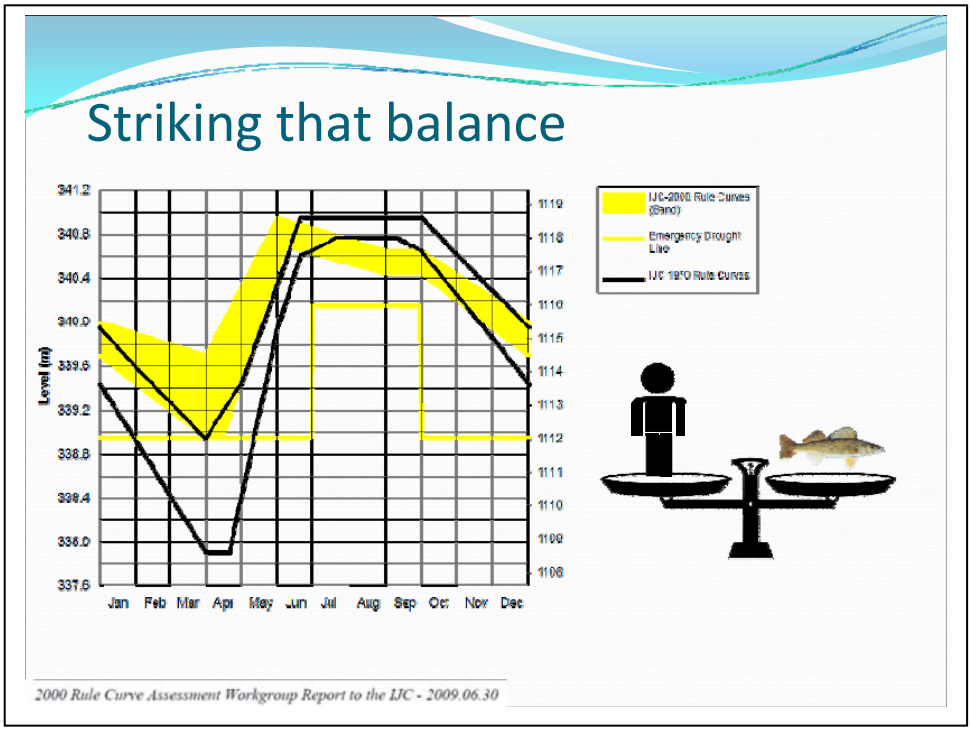
Abstract

Work is underway to identify potential flood vulnerabilities on the Rainy and Namakan Chain of Lakes (Rainy, Namakan, Kabetogama, Sand Point, and Crane) on both sides of the international border. The project is part of a larger effort to compare the performance of the current water level management strategy (the 2000 Rule Curves) and the previous water level management strategy (1970 Rule Curves). The anticipated completion date for the current flood vulnerability assessment is March 2015. To date, considerable progress has been made in consolidating geospatial information relevant to the flood vulnerability assessment including elevation data and building and dock locations. As well, site visits were undertaken in summer and fall 2013 to support field data collection and receive direct input on flooding vulnerabilities from shoreline property owners in the study area. A review and synthesis of the field data is now progressing and highlights from the preliminary results will be discussed. Data gaps and uncertainty will also be identified with particular emphasis on potential opportunities for additional public input as well as specific implications for the rule curve comparison.

Managing water levels in the Namakan Reservoir: effects on walleye spawning habitat

Papenfuss, Jason; Cross, Tim and Paul Venturelli

University of Minnesota, 2003 Upper Buford Circle, Ste. 135, St. Paul, MN 55108



Abstract

The most recent water level management policy (rule-curve) in the Namakan Reservoir was established in 2000 by the International Joint Commission and was intended to strike a balance between benefits to plants and animals in the reservoir and human water needs (e.g., recreation, and navigation). Walleye (*Sander vitreus*) are prevalent in the reservoir, sensitive to water levels, and ecologically, culturally, and economically important, making them an excellent species for studying the effects of rule-curves. To compare the effects of two rule-curves (1970-2000 and 2000-present), I used spatial modeling to estimate water depth and therefore seasonal habitat availability at various sites within the reservoir. The overall objective of the study was to determine if the most recent rule-curve has improved spawning habitat availability for walleye.

The effects of water-level regulation on nutrients and plankton: results from a whole-lake experiment at the Experimental Lakes Area

Paterson, Michael [1]; Findlay, D. [2]; Beaty, K.[3].

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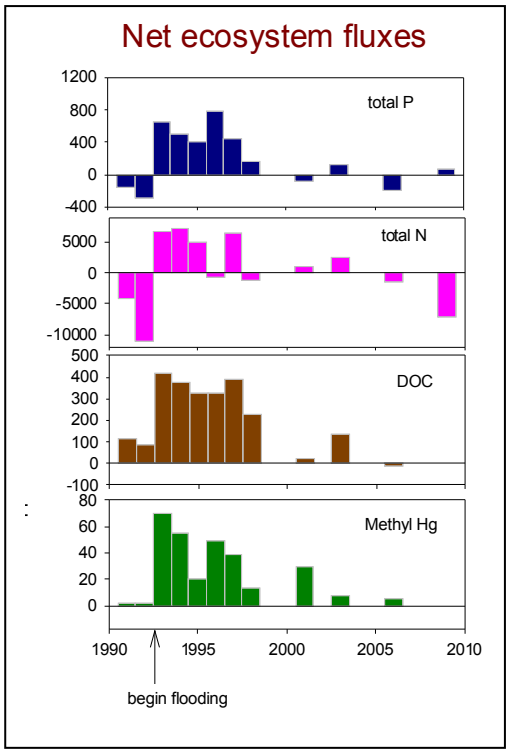
[2]Plankton R Us, 39 Arlburg Cr., Winnipeg, MB R2N 1M1;
[3]Fisheries & Oceans Canada, 501 University Cres. Winnipeg, MB R3T 2N6



Abstract

Dams have been constructed on many inflows to the Lake of the Woods and water levels on the lake itself are regulated at the outflow. New dams may also be constructed on inflowing rivers for micro-hydropower generation or other purposes. Data from a whole-ecosystem experiment on water-level regulation at the Experimental Lakes Area (ELA) will be examined to address 2 questions: 1) how does water-level regulation affect nutrient concentrations and plankton productivity?; and 2) how long do impacts persist after initial dam construction? As part of the ELA Reservoir Project (ELARP), we followed changes in nutrient concentrations, nutrient budgets and plankton productivity in Lake 979 for 2 years prior to (1991-92) and for 17 years after (1993-2010) the construction of a dam at the outflow that raised water levels 1.3m and increased lake volume by 6X. Following construction of the dam, average total phosphorus (P) concentrations increased from approximately 7 ug/L to above 20 ug/L and the lake changed from being a net sink to a net source for P. The lake remained a net source for P for 6 years and elevated P concentrations were observed for >10 years. Densities of phytoplankton and zooplankton increased >10X and these elevated levels persisted for >10 years. The results from this project may represent a worst-case scenario for systems on the Canadian Shield because the flooded area primarily consisted of a peatland bog with large stores of carbon.

The role of citizens in AIS and water quality monitoring and the responsibility of agencies to interpret and act citizen-based findings

Passe, Derrick

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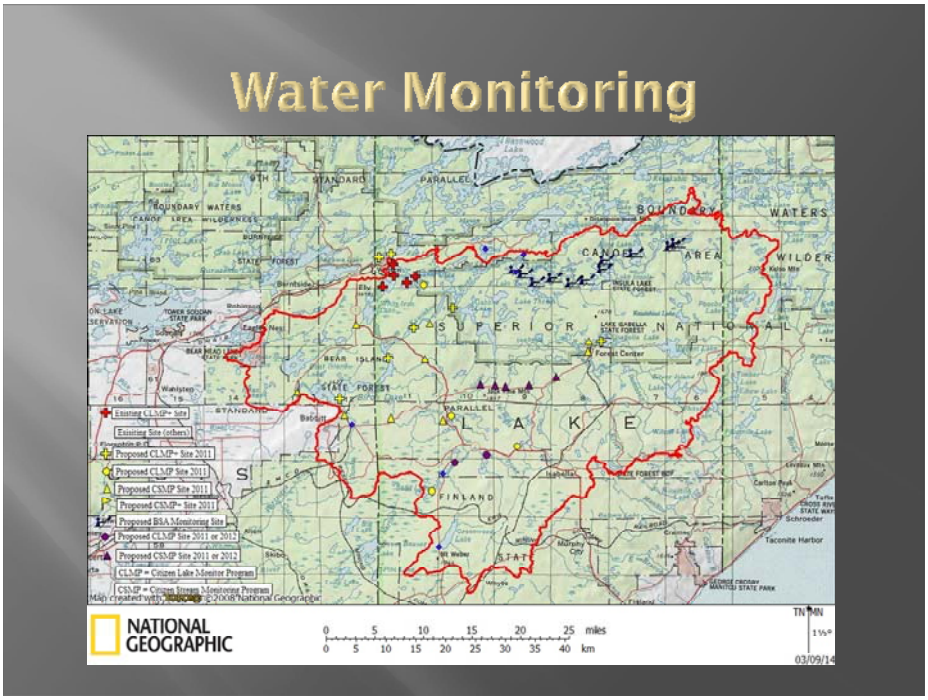

Abstract

The Kawishiwi Watershed is a 1225 square miles watershed located at the headwaters of the Rainy River near Ely, Minnesota. 95% of the watershed is located in the Superior National Forest and a third of it is in the Boundary Waters Canoe area. At the Outlet of the Watershed is a chain of Lakes known as the White Iron Chain of Lakes. In 1993, the White Iron Chain of Lakes Association (WICOLA), a citizen organization began monitoring nutrient levels in the White Iron Chain of Lakes. With technical assistance from MPCA, they continued to monitor these lakes at 5 locations on a monthly basis, measuring pH, temperature, DO, nitrogen, phosphorus and chlorophyl-A. In 2010, WICOLA successfully secured two grants from the Minnesota Pollution Control Agency, totaling over a million dollars, to assess the Water Quality and threats thereto of the entire Kawishiwi Watershed. Under the Kawishiwi Watershed Protection Project, WICOLA and other volunteers sampled and analyzed water quality at more than 10 Lake sites and 11 streams in the Kawishiwi Watershed. In addition to the Water Quality Monitoring, volunteers researched County records for all septic systems within the Watershed, monitored each of their water quality monitoring sites for AIS infestations, determined the extents of AIS infestations and was a node for disseminating water quality information to a largely transient population.

The goal of this Project was to educate watershed users, provide guidance to agencies managing the watershed and determine the current trends of water quality in the Kawishiwi Watershed. The Final Implementation Plan was assembled and reported on all the project components into an Implementation Plan that will be used to manage and protect the watershed for years to come. The monitoring data has been shared with the project partners, but analysis of trends and implementation of the findings is on-going. Adoption of recommendations from the KWPP are currently being integrated into the County Water Plan and MPCA Intensive Watershed Management Process.

Predicting dissolved oxygen concentrations in Lake Trout lakes: Developing new tools for a multiple-stressor world

Jeziorski, A[1], Paterson, A.M.[2],Molot, L.[3], Boegman, L.[4], Smol, J.P.[1]

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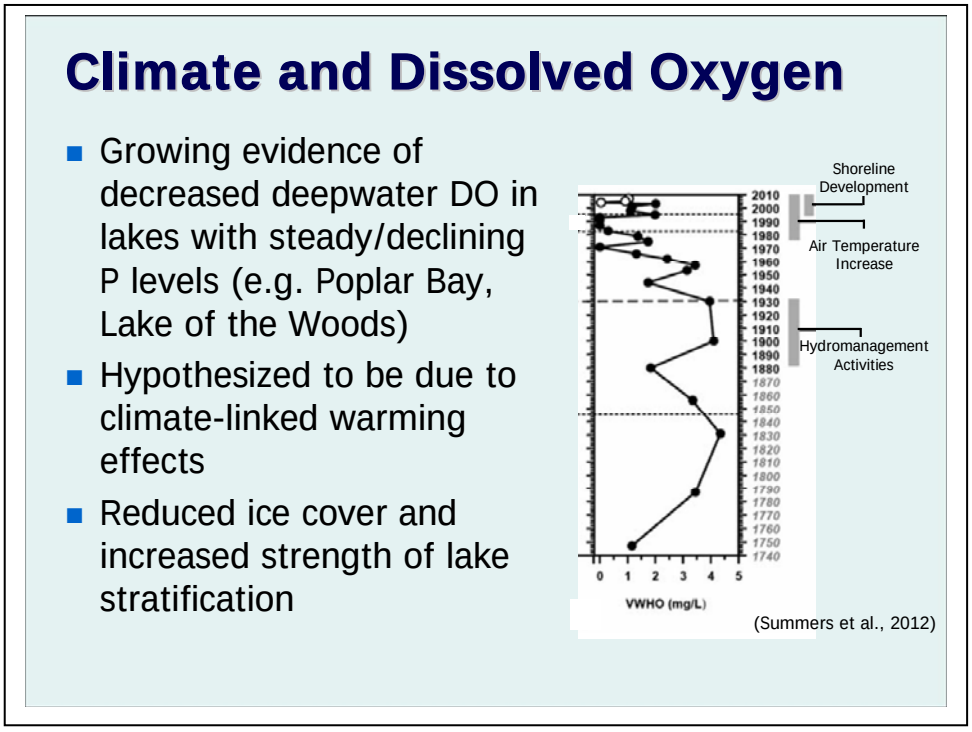
[2]Ontario Ministry of the Environment, Dorset Environmental Science Centre, 1026 Bellwood Acres Road, P.O. Box 39, Dorset, ON Canada, P0A 1E0
[3]Faculty of Environmental Studies, York University, 4700 Keele Street, Toronto, ON, Canada, M3J 1P3
[4]Department of Civil Engineering, Queen's University, 58 University Avenue, Kingston, ON, Canada, K7L 3N6.



Abstract

Canada's lake trout lakes are rare and valuable in both economic and ecological terms. However, lake trout populations are increasingly threatened by multiple environmental stressors (e.g., over-exploitation, competition with introduced species, nutrient loading, and climate warming). There is growing concern that habitat quality in the deep waters of many lake trout lakes is declining due to oxygen depletion. Moreover, new evidence suggests that declines in deepwater oxygen concentrations may occur in lakes where nutrient inputs have not increased, or even where phosphorus inputs or lake nutrient concentrations have decreased over time, creating exceptions to the "increased nutrients, decreased deepwater oxygen paradigm". Managers require a new toolset, one that includes predictive models to forecast shifts in lake trout habitat, and improve our understanding of historical changes in lake trout habitat, in response to multiple stressors.

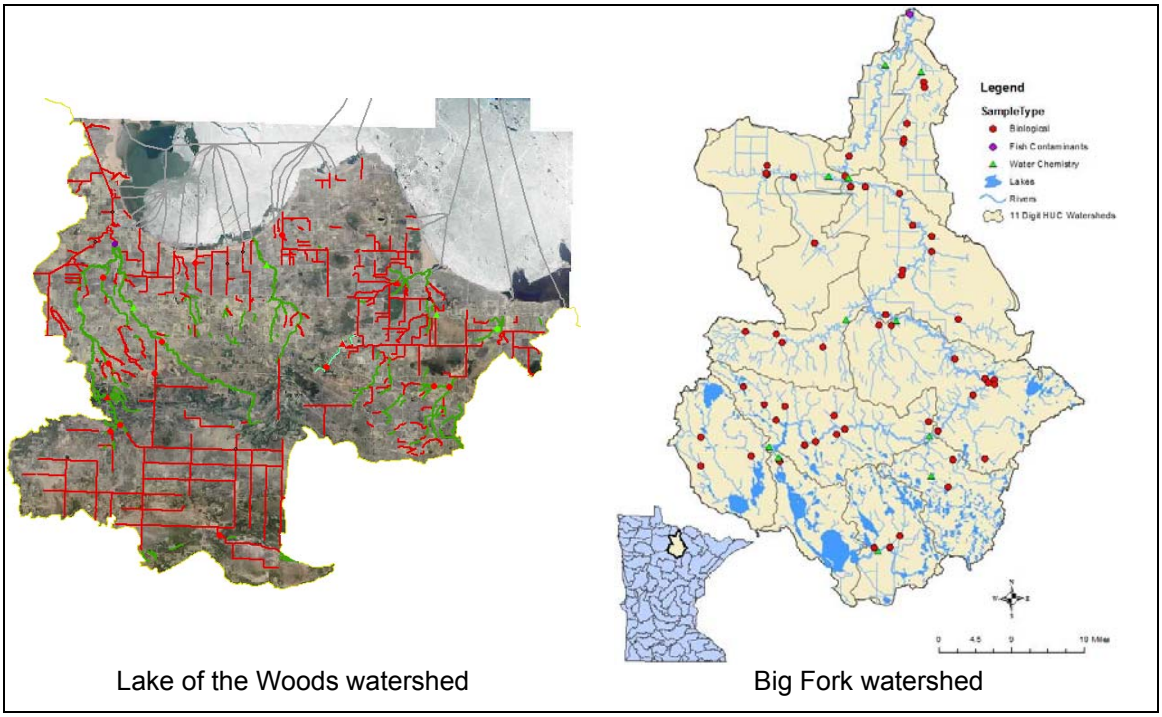
Our focus is upon a set of lakes (including Lake of the Woods) with naturally-reproducing lake trout populations, long-term oxygen data, and fall into at least one of the following categories: there is significant shoreline development pressure or agriculture in the watershed; there have been long-term changes in measured hypolimnetic dissolved oxygen (DO) concentration; they are near or below the provincial guideline of 7 ppm for end-of-summer mean volume-weighted hypolimnetic [DO]; and/or they are of current management concern for water quality or have experienced recent algal blooms.

The project combines three distinct yet complementary techniques that will accurately hindcast, measure and predict past, present, and future hypolimnetic [DO] in the study lakes as a function of multiple drivers including lakewater chemistry, algal blooms and physical structure of the lake (e.g., length of ice cover, extent of thermal stratification). In the summer of 2014, sediment coring will begin in northern bays of the Lake of the Woods, and biological and chemical indicators preserved in the sediments (i.e. paleolimnological approaches) will be examined to develop and refine tools for hindcasting deepwater [DO]. This work will build on recent published findings from Poplar Bay in northern Lake of the Woods, where paleolimnological investigations have found that the onset of substantial warming during the late-1970s triggered marked biological changes among algal and invertebrate communities. The tools and models developed through these analyses will provide managers with a scientifically-defensible approach for managing lake trout habitat in a multiple-stressor world, provide guidance on mitigation strategies, and enable sustainable management.

Biological monitoring efforts in Minnesota's Lake of the Woods Watershed rivers and streams

Lueck, April

Minnesota Pollution Control Agency (MPCA), 7678 College Road, Suite 105, Baxter, MN 56425



Lake of the Woods watershed Big Fork watershed

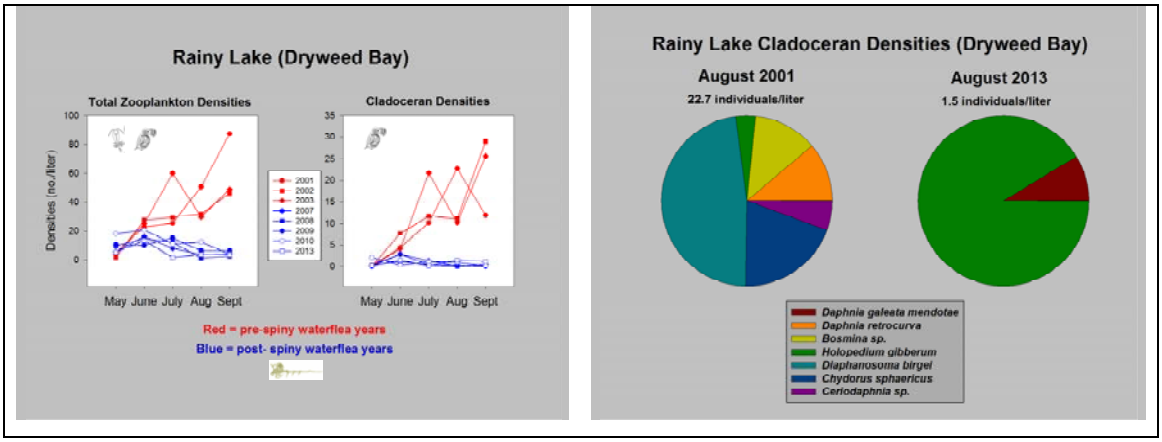
Abstract

In 2012 the Minnesota Pollution Control Agency conducted a biological survey on the streams and rivers in the Lake of the Woods watershed (HUC:09030009). Data collection focused on the fish and aquatic macroinvertebrate communities as well as water chemistry on basic nutrients. The biological data is an important indicator of stream health, and will be used to make assessments in order to locate stream impairments. Currently assessments of this data are underway and will result in a state published report outlining the overall conditions found throughout the Lake of the Woods watershed.

Long term monitoring in Minnesota lakes-Interactions between *Bythotrephes longimanus* and native zooplankton communities

Hirsch, Jodie K.

Minnesota Department of Natural Resources (IMA-AIS Committee Chair) 27841 Forest Lane, Park Rapids, MN 56470



Abstract

Zooplankton communities play key roles in the functioning of lake ecosystems. They occupy an intermediate trophic position in lakes, serving both as efficient phytoplankton grazers as well as primary food sources for larger invertebrates and young-of-the-year fish. Introductions of aquatic invasive species may have impacts on the native zooplankton community, either by direct predation or direct competition. In Minnesota lakes, long-term monitoring is beginning to show that recent infestations of spiny waterfleas and zebra mussels are impacting native zooplankton communities. This presentation will provide an overview of these impacts.

Long-term zooplankton monitoring of lakes in the Rainy River watershed (Lake of the Woods, Rainy and Kabetogama lakes) reveals substantial declines in both zooplankton densities and species richness after recent infestations of spiny waterfleas. Small cladoceran species appear to be significantly impacted, suggesting direct predation by spiny waterfleas. Similar trends are emerging in Mille Lacs Lake, which has recently established populations of both spiny waterfleas (2010) and zebra mussels (2005). Zebra mussels may also be impacting the zooplankton community by direct competition for food. However, impacts from food competition may be slower to develop which emphasizes the critical need for long-term monitoring and robust data sets to help understand potential impacts from aquatic invasive species.

Poster Abstracts

Inland lakes at Voyageurs National Park represent near-pristine conditions in the Environmental Protection Agency's Northern Glaciated Nutrient ecoregion

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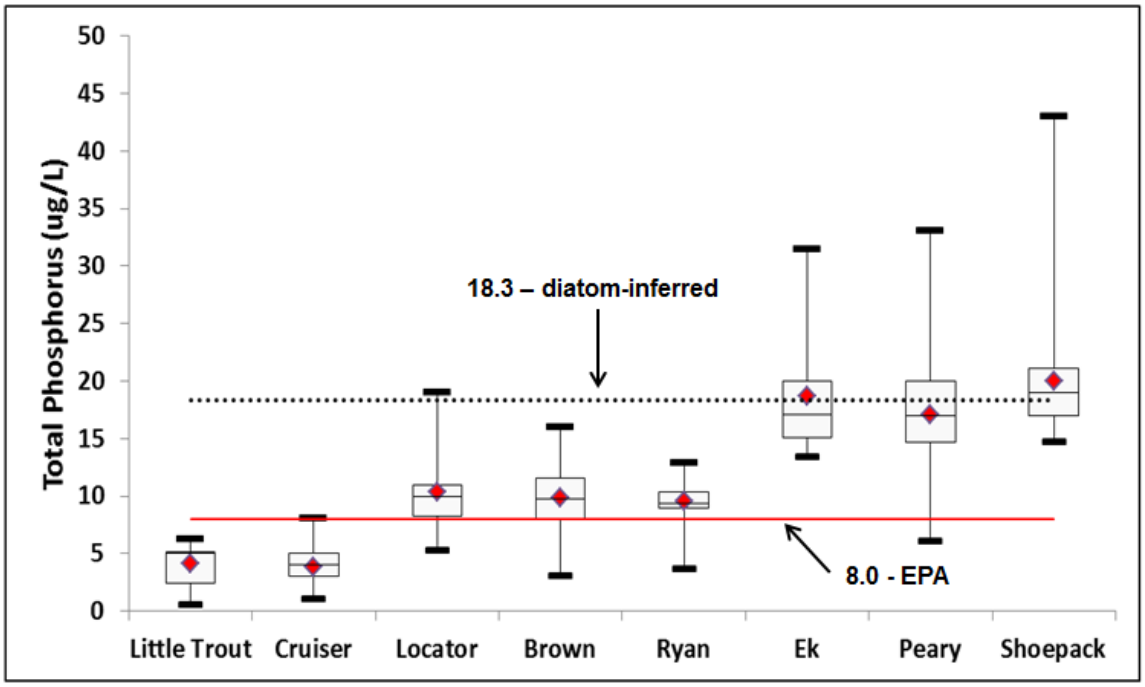

Abstract

The Great Lakes Inventory and Monitoring Network (GLKN) is one of 32 National Park Service monitoring networks throughout the United States, which together include over 270 national park units. The GLKN consists of nine park units, including Voyageurs National Park (VOYA). The inland lake resources of GLKN parks are astounding, numbering in the thousands. VOYA alone contains nearly 300 lakes >1 ha.

GLKN began monitoring water quality in VOYA interior lakes in 2006. Monitoring consists of sampling eight index lakes three times annually during the open water season, and 14 additional lakes on a longer rotation, as funding permits. We selected the index lakes to span gradients of lake type, geographical location, visitor use, lake basin morphometry, and watershed size. Parameters measured include a core suite (profiles of temperature, pH, conductivity, and dissolved oxygen), water clarity, water level, chlorophyll-*a*, dissolved organic carbon, alkalinity, major anions and cations, and nutrients.

Most lakes are mesotrophic, with relatively low nutrient and chlorophyll levels. Nevertheless, several lakes exceed nutrient reference criteria established for the ecoregion by the U.S. Environmental Protection Agency (USEPA). However, when compared with more refined diatom-inferred nutrient reference criteria almost all of the lakes meet or are below the criteria, and represent the "best of what is left" for inland lakes in the Upper Midwest. Furthermore, for three lakes where we have detailed sediment core data, current levels of total phosphorus—the nutrient limiting productivity in VOYA lakes—are not significantly different than diatom-inferred total phosphorus levels dating back to pre-European settlement and the era of extensive logging within the park.

Interactive Web Tools for Climate Data Visualization

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Abstract

The NPS Great Lakes Inventory & Monitoring Network endeavors to have high quality datasets of historical climate observations readily available so that NPS researchers and managers can easily access and understand patterns in the local climate. Working with a contractor, the NPS network has developed a suite of products including annual resource briefs and an interactive website to reduce the difficulty in locating climate data for Voyageurs National Park and other NPS park units in the Great Lakes area. The ClimateAnalyzer.org web portal allow users to quickly create custom charts and graphs from the records of representative climate stations in the US and Canada that reflect the climate of Voyageurs NP and the surrounding area.

Lake of the Woods Soil and Water Conservation District: a look at featured projects

Hirst, Mike

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Abstract

Lake of the Woods Soil and Water Conservation District is a local unit of government that promotes and implements programs to protect natural resources at a local level. The geographical boundaries of the District are the same as the Lake of the Woods County boundary in Minnesota, which includes the US portion of Lake of the Woods and the mouth of the Rainy River. The purpose of the District is to provide for the adoption of sound water quality, proper land use, and soil conservation practices on all lands in the District, to assist with the development of a prosperous agricultural economy, and to foster other community development for the general welfare and security of the people of the District. The SWCD works on many projects in the Rainy River Basin, including implementation and research projects. Highlights of the SWCD include: watershed studies and planning, inventories and water monitoring, environmental education, and on the ground conservation projects. The SWCD bridges the gap between the people that live and work on the landscape and the entities and agencies that manage natural resources within the county.

Brief Bio

A decision support tool using an HSPF watershed model application

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Abstract

A major challenge facing decision makers within watersheds is how to select the best combination of water quality management practices to implement among the many options available that result in the most cost-effective, achievable, and practical management strategy possible. A watershed-scale, decision-support tool was developed for an eastern South Dakota watershed to facilitate prioritizing and placing best management practices (BMPs) to achieve the needed reductions identified by the Total Maximum Daily Load (TMDL). This tool could be adapted to the entire Rainy River/Lake of the Woods Watershed. The decision-support framework of the tool consists of Geographic Information System (GIS) for site selection, an **HSPF**-model application to simulate the transport and fate of pollutants, and a BMP database. The BMP database was developed by assigning costs and reduction efficiencies to commonly applied practices from literature. This decision-support framework will assist in developing custom implementation plans by combining individual and/or suites of BMPs that are simulated and applying the reduction efficiencies to the appropriate source loads represented in the **HSPF** model. The cost effectiveness is calculated by using the total costs and reductions achieved and from the application of the implementation plan. The decision-support tool also includes a costeffectiveness optimization and water-quality trading component.