12th Annual

International Rainy-Lake of the Woods Watershed Forum

March 11 - 12, 2015

Rainy River Community College

International Falls, Minnesota, USA

Table of Contents

Program At A Glance

MARCH 11 – 10:00 AM

10:15 Welcome & Introductions

10:30 Bi-National Updates – Moderator Todd Sellers

1. **International Joint Commission and Plan of Study update.**
   Glenn Benoy. International Joint Commission - Canada
2. **International Rainy-Lake of the Woods Watershed Board update.**
   Scott Jutila. International Rainy-Lake of the Woods Watershed Board
3. **International Multi-Agency Working Agreement (IMA) update.**
   Lori Dowling-Hanson. IMA Working Group member, MN DNR

11:30 Lake of the Woods – Moderator Andrew Paterson

4. **Paleolimnology of the southern basin of Lake of the Woods, Part 1: the sedimentary record.**
   Euan D. Reavie[1], Mark B. Edlund[2], Norman A. Andresen[3], Daniel R. Engstrom[2]. [1]Center for Water and the Environment, U. Minnesota Duluth; [2]St. Croix Watershed Research Station, Sci. Museum of MN; [3]Andresen Consulting
5. **A historical phosphorus budget for Lake of the Woods: legacy loads still affect the southern basin.**
   M.B. Edlund[1], E.D.Reavie[2], S. Schottler1, N. Baratono[4], A.M. Paterson[3], D.R. Engstrom[1]. [1]St. Croix Watershed Research Station, Science Museum of Minnesota;[2]Center for Water and the Environment; U. Minnesota Duluth; [3]Dorset Environmental Science Centre, Ontario Ministry of the Environment; [4]Minnesota Pollution Control Agency
6. **Diffusive phosphorus flux and sediment characteristics in Big Traverse, Lake of the Woods: update on 2014 research.**
   William F. James. University of Wisconsin

12:30 – 13:30 Lunch

7. **Phosphorus sources for the Rainy River / Lake of the Woods watershed.**
   Christopher D. Lupo and Julie A. Blackburn. RESPEC Water & Natural Resources
8. **Lake of the Woods WRAPS Process: from HSPF to local implementation.**
   Jeremiah Jazdzewski[1], Tim Erickson[1], Drew Kessler[1], Mark Deutschman[1], Mike Hirst[2]. [1]Houston Engineering, Inc., [2]Lake of the Woods County Soil and Water Conservation District
9. **Regional lake water quality measurements for Lake of the Woods / Rainy River Basin by satellite remote sensing: capabilities and limitations with current and upcoming satellite systems.**
   Leif G. Olmanson, Patrick L. Brezonik, Jacques C. Finlay, Marvin E. Bauer. Departments of Forest Resources, Civil Engineering, & Ecology, Evolution, and Behavior, University of Minnesota, St. Paul and Minneapolis, MN
10. **Recent and historic phytoplankton and cyanobacteria changes in Lake of the Woods.**
    Hedy J. Kling[1], Sue Watson[2], Claire Reis (Herbert)[3], Michael P. Stainton[4], Gregory McCullough[3]. [1]Algal Taxonomy and Ecology Inc. Winnipeg, MB; [2]*Watershed Hydrology and Ecology Research Division,*Environment Canada Burlington ON; [3]Centre for Earth Observation Science (CEOS) , U. Manitoba, Winnipeg, MB; [4]Fisheries and Oceans Canada, Winnipeg, MB
11. **Modeling the effects of past climate change on boreal lakes.**
    Daniel R. Engstrom[1], Mark B. Edlund[1], James E. Almendinger[1], Xing Fang[2], Joan Elias[3], Ulf Gafvert[3], David VanderMeulen[3]. [1]St. Croix Watershed Research Station, Science Museum of Minnesota; [2]Department of Civil Engineering, Auburn U., Auburn, AL; [3]National Park Service, Great Lakes Inventory & Monitoring Network, Ashland, WI

15:10 Break

15:40 Effects of Artificial Lake Level Management - Rainy-Namakan – Moderator Ryan Maki

12. **Goals and performance of the IJC 2000 Rule Curves for Rainy Lake and Namakan Reservoir.**
    Gail Faveri[1], Larry Kallemeyn[2], Ryan Maki[3], James Bomhof[4]. [1]Environment Canada, Burlington ON; [2]USGS (retired); [3]Voyageurs National Park, International Falls, MN; [4]Lake of the Woods Secretariat, Ottawa, ON.
13. **Hydraulic and eco-hydraulic conditions of critical spawning habitats in the upper Rainy River under the 2000 Rule Curve.**
    J.W. Muirhead and W.K. Annable. Dept. of Civil and Environmental Engineering, University of Waterloo, Waterloo, ON
14. **Rainy River index of biotic integrity.**
    E.R. Timusk[1], Dr. K.E. Smokorowski, Dr. M. Power, W.M. Gardner. [1]Fisheries & Oceans Canada, Sault Ste. Marie, ON
15. **Studies of the upper rainy river food web and variations in spawning critical habitats in relation to flow.**
    Adrienne Smith[1], Karen Smokorowski, Jerome Marty, Evan Timusk, Michael Power. [1]U. Waterloo, Waterloo, ON

17:00 Break (poster display set up and migration to AmericInn)

18:00 – 21:00 Foundation Reception & Poster Session (AmericInn) – See Over

MARCH 11 – EVENING

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

Welcome – Brian Shipley
Consul & Head, Foreign Policy & Diplomacy Service, Consulate General of Canada - Minneapolis

Guest Speaker – John Linc Stine
Commissioner, Minnesota Pollution Control Agency

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

Posters

a. Spread, control and effect of exotic cattails on wild rice in the Rainy Namakan.
John Kabatay[1], Peter Ferguson Lee[2], O'Niell Tedrow[2]. [1]Seine River First Nation Environmental Program, Seine River First Nation, Mine Centre, ON; [2] Dept. of Biology, Lakehead University, Thunder Bay ON

b. Evaluating changes in growth and life history of northern pike (*Esox lucius*) in Rainy Lake, Ontario, Canada.
Patrick J. Kennedy[1], Michael D. Rennie[2]. [1]Dept. of Biological Sciences, University of Manitoba; [2]International Institute for Sustainable Development – ELA (IISD-ELA)

c. Lake Winnipeg Basin Initiative – Phase II update.
L. Rutherford, A. Friesen, I. Griffin, M. Duval, D. Hay. Environment Canada, Lake Winnipeg Basin Office, Winnipeg, MB

d. Can the common loon be used to evaluate water levels rule curves?
Marianne Bachand, Sylvain Martin, Julien Hénault-Richard, Olivier Champoux, Patrice Fortin, Jean Morin. Hydrology and Ecohydraulic Section, Meteorological Service of Canada, Environment Canada, Québec, QC

e. 2D modeling of the impacts of water level regulation on vegetation: the cases of wild rice and cattail.
Marianne Bachand, Sylvain Martin, Julien Hénault-Richard, Olivier Champoux, Patrice Fortin, Jean Morin. Hydrology and Ecohydraulic Section, Meteorological Service of Canada, Environment Canada, Québec, QC

f. Civic Engagement in the North: reaching out to the public in the Big Fork and Little Fork River watersheds
Jolén Simon[1], Mike Kennedy[2]. [1]Koochiching SWCD, International Falls, MN; [2]MPCA, NE Regional Office, Duluth, MN

g. Enhancing binational citizen-based water quality monitoring in the Rainy – Lake of the Woods watershed - a summary of available data and future directions.
Anna M. DeSellas[1], Shannon Martin[2], Laurie Sovell[2], Christie Davies[1], Kelli Saunders[3]. [1] Ontario Ministry of the Environment and Climate Change, Dorset Environmental Science Centre, Dorset, ON; [2] Minnesota Pollution Control Agency, Saint Paul, Minnesota MN; [3] Lake of the Woods Water Sustainability Foundation, Kenora, ON.

h. Developing capacity for source water protection planning in remote northern communities
Leslie Collins. Institute for Watershed Science, Trent University, Peterborough, ON

i. Removal of contaminants of emerging concern in sewage lagoons
Craig Murray. Institute for Watershed Science, Trent University, Peterborough, ON

j. Scenario Application Manager (SAM): an implementation decision support tool
Julie A. Blackburn. RESPEC Water & Natural Resources, Roseville, MN

k. Regulation of 2014 high inflows to Namakan chain of lakes, Rainy Lake and Lake of the Woods
James Bomhof[1] and Gail Faveri[2]. [1]Lake of the Woods Secretariat, Ottawa ON; [2]Environment Canada, Burlington ON

l. Development of a simple model for estimating acid neutralizing capacity in northern USA seepage lakes
Nancy Serediak[1], Randall K Kolka[2], Gordon Putz[3]. [1]Streamline Consulting, Thunder Bay, ON; [2]USDA Forest Service, Northern Research Station; [3]Professor Emeritus of Civil and Environmental Engineering, University of Saskatchewan

m. Suggestions, thoughts and worries in the watershed
Gerald Caple. 387 Gunflint Narrows, Grand Marais, MN 55604

n. Precipitation and payrolls: examining municipal water treatment and fish hatchery data and determining how they have been impacted by the 2000 Rule Curves
Ryan Haines. Kenora Resource Consultants Inc.

o. Evaluating and monitoring impacts of lake level changes on archeological sites within Voyageurs National Park
Andrew LaBounty, Timothy Schilling, Mary Graves, Ashley Barnett. Voyageurs National Park.

MARCH 12

08:10 Welcome & Introductions

08:20 Effects of Artificial Lake Level Management Rainy Namakan (cont'd) – Moderator Ryan Maki

16. **Plenary 1 - Influencing ecological properties using water level management.**
James H. Larson[1*], David F. Staples[2], Ryan P. Maki[3], Jon M. Vallazza[1], Brent C. Knights[1], Kevin E. Peterson[4], Brian R. Gray[1]. [1] U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI; [2] Minnesota Department of Natural Resources, Forest Lake, MN; [3] Voyageurs National Park, International Falls, MN; [4] Minnesota Department of Natural Resources, International Falls, MN

17. **Plenary 2 – Habitat modeling of the Rainy-Namakan lakes, impacts of rule-curves on biota**
Jean Morin, Marianne Bachand, Olivier Champoux, Julien Henault-Richard. Environment Canada

18. **Simulating flooding impacts on the Rainy and Namakan chain of lakes to compare rule curve performance**
Mike Shantz. Environment Canada, Burlington, ON

10:00 – 10:30 Break

19. **Effects of water management regime of Rainy Namakan system on wild rice production**.
O'Niell Tedrow[1], Peter Ferguson Lee[1], John Kabatay[2]. [1]Department of Biology, Lakehead University; [2]Seine River First Nation

20. **Correlating turbidity, depth, and upstream dam releases with wild rice (*Zizania palustris*) production in the Seine River, Northwestern Ontario**.
Stephanie Reid,Peter Ferguson Lee. Department of Biology, Lakehead University, Thunder Bay ON

21. **Northern pike young-of-the-year habitat characteristics in Rainy Lake and Namakan Reservoir**.
Anne Timm, Rod Pierce. USDA Forest Service, Northern Research Station, Baltimore Field Station, Baltimore, MD

22. **Using corrected benchmark elevations and high-resolution bathymetry to address water-level management in Rainy Lake and Namakan Reservoir**.
J.R Ziegeweid[1], R.J.Silliker[2], B.K. Densmore[3]. [1]U.S. Geological Survey Minnesota Water Science Center; Mounds View, MN 55112; [2]Natural Resources Canada; Ottawa, ON, Canada; [3]U.S. Geological Survey Nebraska Water Science Center; Lincoln, NE

23. **Model predictive control strategies for implementing rule curves for the Namakan Reservoir / Rainy Lake watershed**.
Jeffrey C. Kantor. Department of Chemical and Biomolecular Engineering, University of Notre Dame, Notre Dame, IN

12:10 – 13:30 Lunch

24. **Trophic state in Voyageurs National Park lakes before and after implementation of a revised water-level management plan**.
V.G. Christensen[1] and Ryan P. Maki. [1]USGS West Fargo, ND; [2]USNPS

25. **Assessment of the affects of the 2000 Rule Curves on northern pike reproduction in Rainy and Kabetogama lakes, MN**.
Larry Kallemeyn[1], Benjamin Vondra[2], David Staples[2], Ryan Maki[3]. [1]USGS (retired), 1812 Shady Oak Place, Spearfish, SD; [2]MNDNR, [3]USNPS

26. **Beaver lodge site selection in large lake environments**.
Steve K. Windels[1], Joshua B. Smith[2], Jerrold L. Belant[3], Brian E. McLaren[4]. [1]Voyageurs National Park, International Falls, MN ; [2]Voyageurs National Park Association, International Falls, MN; [3]Mississippi State University, Starkville, MS; [4]Lakehead University, Thunder Bay, ON

27. **Estimating the effect of water-level fluctuations on the reproductive success of common loons**.
Steve Windels[1], Steve Gutreuter[2], Ryan Maki[1]. [1]Voyageurs National Park, International Falls, MN; [2]US Geological Survey

14:50 Break

MARCH 12 (CONT'D)

15:20 Other Subjects

28. **Habitat use within a juvenile nursery hole by adult and juvenile lake sturgeon in the Namakan River**. Jim Burchfield, Cameron Trembath, Brian McLaren. Lakehead University, Faculty of Natural Resources Management, Thunder Bay, ON
29. **Conceptual flow and transport model for the Rainy Lakes watershed**
    Tom Myers. Hydrologic Consultant, Reno NV
30. **Land cover classification of the Lake of the Woods / Rainy River basin for 1990 and 2010: integrating Landsat imagery with Lidar and object-based image analysis**
    Leif G. Olmanson, Marvin E. Bauer. Department of Forest Resources and Remote Sensing and Geospatial Analysis Laboratory, University of Minnesota, St. Paul, MN

16:20 Closing Remarks

PROGRAM ADDENDUM – MEETINGS OF RESEARCH WORKING GROUPS

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

MARCH 10

14:30 – 16:30 International Multi-Agency Arrangement Technical Advisory Committee

- Room H-100, Rainy River Community College

16:30 – 18:00 Lake of the Woods Historical Nutrient Budget Study Team

- Room H-100, Rainy River Community College

MARCH 11

08:00 – 10:00 International Multi-Agency Arrangement Working Group

- Room H-100, Rainy River Community College

Forum Sponsors – 2015

The organizing committee would like to thank our 2015 sponsor's for assisting with the 12th Annual International Rainy-Lake of the Woods Watershed Forum. This event would not be possible without the assistance of the following groups:

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

Organizing Committee – 2015

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

Nolan Baratono
Minnesota Pollution Control Agency
P.O. Box 61
International Falls, MN 56649
218-283-2240 | toll free 1-800-657-3864
nolan.baratono@state.mn.us

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

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

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

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

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

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

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

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

Hayley Anderson
Membership Coordinator
Lake of the Woods District Property Owners Association
P.O. Box 1160, Kenora ON P9N 3X7
807-468-8715
hayley.anderson@lowdpoa.com

Presentation Abstracts

International Joint Commission and Plan of Study update.

Glenn Benoy

International Joint Commission – Canada Section

Abstract

An update is presented on the background, extent and status of the Lake of the Woods Basin Water Quality Plan of Study. The presentation discusses the origins and process behind development of the Plan of Study to address priority issues: in the basin. The Plan of Study recommends 32 projects at a cost of approximately $8.4 million over 5 project themes:

- Long-term monitoring
- Nutrient enrichment and harmful algal blooms
- Aquatic invasive species
- Surface and groundwater contamination
- Capacity building

The Plan of Study was presented to the U.S. Department of State and to the Canadian Department of Foreign Affairs and Trade Development in late January. With the PoS under review by Governments, the IJC "stands ready to provide governments with any additional information they might need in responding to the Study Team's recommended Plan of Study".

Brief Bio

Dr. Glenn Benoy is senior water quality and ecosystem adviser with the IJC's Canadian Section. Prior to being appointed as Canadian Co-chair of the study team for the Lake of the Woods Basin Water Quality Plan of Study, Glenn worked on two other major projects for the IJC. First, he was co-author of the IJC's 2014 Lake Erie Ecosystem Priority (LEEP) report that makes recommendations to Canada and the United States on how best to reduce phosphorus loadings to Lake Erie to address water quality issues of harmful algal blooms (HABs) and hypoxia. Second, he leads the IJC's SPARROW water quality modeling project in partnership with the U.S. Geological Survey (USGS) and the National Research Council (NRC) of Canada. A SPARROW model has been developed for the Red-Assiniboine Basin and one is currently under development for the Great Lakes and Winnipeg River basins.

International Rainy-Lake of the Woods Watershed Board update.

Scott Jutila

US-Secretary, International Rainy-Lake of the Woods Watershed Board

Abstract

An update is presented on the background, status and activities of the International Rainy-Lake of the Woods Watershed Board during 2014.

Brief Bio

International Multi-Agency Working Arrangement (IMA) update.

Lori Dowling-Hanson

IMA Workgroup Member – Minnesota Department of Natural Resources

Abstract

An update on the activities and progress of the International Multi-Agency Working Arrangement is presented, covering background, purpose and focus, including expanded geographic watershed focus and new consideration of aquatic invasive species. Project achievements are highlighted including the State of the Basin Report, and many studies in support of the Minnesota TMDL for Lake of the Woods. Development of a tiered monitoring proposal, now included as a foundational project in the IJC's Lake of the Woods Basin Water Quality Plan of Study is highlighted along with the IMAs instrumental role in the development of the Plan of Study.

Brief Bio

Lor is Regional Director, Northeaster Region of Minnesota Department of Natural Resources. She participates as MDNR's representative on the Working Group of the IMA.

Paleolimnology of the southern basin of Lake of the Woods, Part 1: the sedimentary record

Euan D. Reavie*[1], Mark B. Edlund[2], Norman A. Andresen[3], Daniel R. Engstrom[2]

[1]Center for Water and the Environment, Natural Resources Research Institute, University of Minnesota Duluth, 5013 Miller Trunk Highway, Duluth, MN 55811
[2]St. Croix Watershed Research Station, Science Museum of Minnesota, Marine on St. Croix, MN 55047
[3]Andresen Consulting LLC, 5742 Princeton Place, Ypsilanti, MI 48197

Abstract

To quantify the environmental history of the southern basin of Lake of the Woods (Ontario, Manitoba and Minnesota), seven cores were collected for retrospective analyses. Primary goals were to determine pre-European settlement conditions and track the timing and extent of anthropogenic impacts and remediation. Sediments were dated using radio-isotopic methods, and fossil-algal remains, in concert with other stratigraphic indicators (organic and inorganic materials, sedimentation rates, other biological entities), were used to reconstruct a ~150-year history of the lake. Diatom assemblages were assessed from sediment intervals, and inferred trophic conditions in the profiles were derived using a regional diatom-based model for Minnesota lakes. Nutrient reconstructions indicate a period of cultural eutrophication throughout much of the 20th century. Despite a known reduction in anthropogenic nutrient loading to the lake in recent decades, there has been no apparent reversal in eutrophication in the pelagic system. Contemporary observations suggest that blooms of blue-green algae are becoming a greater problem. It appears that legacy nutrient recycling and other environmental drivers are maintaining the current condition of pelagic nutrient enrichment. Sedimentary analyses also indicate that a longer ice-free season and associated physical changes to the lake resulting from warming are probably contributing to the recent reorganization of algal assemblages.

Brief Bio

Euan is a Senior Research Associate in the Natural Resources Research Institute at the University of Minnesota Duluth. His research tends to focus on aquatic indicators of human impacts, algae, paleolimnology and remediation of ballast-mediated invasions from ships in the Great Lakes.

A historical phosphorus budget for Lake of the Woods: legacy loads still affect the southern basin

M.B. Edlund*[1], E.D.Reavie[2], S. Schottler[1], N. Baratono[4], A.M. Paterson[3], D.R. Engstrom[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]Dorset Environmental Science Centre, Ontario Ministry of the Environment, 1026 Bellwood Acres Road, P.O. Box 39, Dorset, ON, P0A 1E0
[4]Minnesota Pollution Control Agency, 909 Riverside Drive, International Falls, MN 56649

Abstract

Using basin-wide paleolimnological analyses, a historical phosphorus (P) budget was constructed for southern Lake of the Woods (LoW). Sediment cores (piston cores, ~1 m long) collected from Big Traverse (2 cores), Little Traverse, Sabaskong, Muskeg, Buffalo Bay, and Big Narrows were analyzed for radioisotopic dating, geochemistry (loss-on-ignition, phosphorus, biogenic silica), diatom communities, and fossil pigments. Fossil pigments and diatom communities provided a record of change in historical algal communities and production, as well as estimates of historical water column total phosphorus (TP) concentration based on diatom inference models. Pigments show a bimodal pattern of increasing pigment concentration since damming that peaks around 1970, followed by decreased concentrations in the 1980s, and then increased concentrations again in the last 15 years. Diatom records suggest increased productivity and increased water column TP upcore, coincident with greater abundance of eutrophic indicator species. Geochemical records from cores were combined using sediment focusing factors to provide whole-basin estimates of the accumulation of bulk sediment, total phosphorus, and phosphorus fractions including refractory and labile forms. Although historical P loading estimates compiled by Hargan et al. (2011; JGLR 37:753) showed that P loading to LoW from the Rainy River has been significantly reduced since the 1960s, sediment phosphorus concentrations and accumulation rates increase upcore at all sites rather than show a significant peak in P accumulation in the 1960s. A substantial proportion of exchangeable and mobile P fractions further suggests that a large pool of mobile sediment P is available for resuspension and exchange. Because of the large active pool of P that is present in Lake of the Woods, four whole basin, mass balance approaches and/or dynamic models were used to explore potential historical P loading scenarios to Lake of the Woods and historical in-lake nutrient dynamics. Key results of the models included, first, that phosphorus loading estimates for Lake of the Woods are estimated to be approximately 646 t P/yr before damming, which is nearly as high as current loading estimates. Second, burial rates of refractory P are increasing in Lake of the Woods compared to pre-damming levels. Third, there is a large pool of labile P that can only be accounted for if historical loading was larger (as documented by Hargan et al. 2011). Fourth, most of the models we tested indicate that the pool of active P was much larger in the past, and at its maximum size in the 1970s. Fifth, the active legacy pool is currently being depleted to support modern levels of productivity in Lake of the Woods. Last, the rate at which the pool is being depleted varies among models, but generally shows the active pool of sediment P as being rapidly depleted since the 1970s.

Brief Bio

Mark Edlund is a senior scientist at the Science Museum of Minnesota's St. Croix Watershed Research Station. In addition to Lake of the Woods, he has worked on other Great Lakes of the world including the Laurentian Great Lakes, Russia's Lake Baikal, and Mongolia's Great Lakes.

Diffusive phosphorus flux and sediment characteristics in Big Traverse, Lake of the Woods: update on 2014 research

William F. James

University of Wisconsin – Stout, Sustainability Sciences Institute – Discovery Center, 123E Jarvis Hall, Menomonie, WI 54751

Abstract

Diffusive phosphorus (P) flux from sediment may contribute to the phosphorus (P) budget of the Lake of the Woods (LOW) and needs to be considered in Total Maximum Daily Load (TMDL) development. Earlier research (James WF. 2012. Estimation of internal phosphorus loading contributions to the Lake of the Woods, Minnesota. MPCA Report) indicated that sediment diffusive P flux, derived from experimental laboratory systems, was moderate under aerobic conditions at 0.2 to 0.6 mg/m^2 d, but much higher under anaerobic conditions at 8.3 to 12.5 mg/m^2 d. Although hypolimnetic hypoxia may occur in LOW, aerobic conditions probably prevail at the sediment-water interface and regulate diffusive P flux most of the time due to frequent wind-generated mixing, since water bodies in the LOW system are generally large and shallow with long effective fetches exposed to prevailing wind rose. The objectives of this research were twofold: expand on previous research to examine 1) seasonal and temperature-related variations in aerobic and anaerobic diffusive P flux and 2) temporal and vertical variations in sediment P pools in Big Traverse Lake. Examination of diffusive P fluxes versus temperature will provide modelers with empirical information that can be used to better estimate internal P loading and predict temperature-related changes in diffusive P flux due to climate change. Additionally, analysis of vertical variations in sediment P pools will provide insight into the extent to which sediment processes are at a tipping point with regards to internal P loading and if higher P concentrations at the sediment surface will translate into diffusive P flux. Overall, this research provides supporting data for Phase II of the Historical Nutrient Budget: Thermal Modeling. Results presented here represent preliminary findings for research conducted in 2014.

Replicate sediment cores collected at a station located in the eastern of basin of Big Traverse Lake (48.92182 -94.72825) in July and late August, 2014, were incubated at 18 C and 25 C, respectively, under aerobic or anaerobic conditions for laboratory determination of diffusive P flux. Under anaerobic conditions, mean rates doubled as a function of incubation temperature from 7.8 mg/m^2 d (1.0 SE) at 18 C to 16.8 mg/m^2 d (2.2 SE) at 25 C. These rates fell within the median to upper 25% quartile compared to anaerobic rates determined for other Minnesota Lakes. Under aerobic conditions, mean rates varied between 0.28 mg/m^2 d (0.07 SE) at 18 C and 0.36 mg/m^2 d (0.06 SE) at 25 C. Although means were not significantly different as a function of temperature under aerobic conditions, they were, nevertheless, moderately high and fell near the median relative to rates measured for other Minnesota Lakes.

The mean total P concentration in the upper 5-cm layer was moderate at ~ 0.80 mg/g. Biologically-labile P (i.e., the sum of the loosely-bound P, iron-bound P, and labile organic P fractions; subject to recycling and diffusive P flux to the overlying water column) accounted for ~ 46% (0.375 mg/g), while biologically-refractory P (i.e., aluminum-bound P, calcium-bound P, and refractory organic P; relatively inert to recycling and subject to burial) represented ~54% (0.433 mg/g) of the sediment total P. Iron-bound P (i.e., P bound to iron oxyhydroxides; active in diffusive P flux under anaerobic and reducing conditions) was the dominant biologically-labile P fraction (~ 58%). The mean concentration was moderate at 0.218 mg/g. Mean labile organic P (i.e., cellular polyphosphates and readily mineralized organic P) and loosely-bound P (i.e., porewater P and P loosely adsorbed to calcite) accounted for ~ 37% (0.140 mg/g) and 5% (0.017 mg/g) of the biologically-labile P fraction, respectively. Calcium-bound P was the dominant biologically-refractory fraction at 57% (0.247 mg/g).

Vertical sediment profiles of total P and biologically-labile P exhibited modest concentration peaks in the upper 5- to 6-cm sediment layer overlying lower concentrations below these sediment depths. This vertical pattern suggested that surface sediment in the eastern region of Big Traverse Lake has accumulated biologically-labile P in excess of diagenesis and burial (i.e., gross P deposition > diagenesis and burial). Surface peaks reflected elevated concentrations of

iron-bound P and labile organic P, suggesting the potential for internal P loading. In contrast, more biologically-inert aluminum-bound and calcium-bound P concentrations were relatively constant with sediment depth over the upper 30-cm sediment profile and did not explain surface layer pattern. Overall, total P and biologically-labile P concentrations were 0.834 mg/g and 0.375 mg/g, respectively, in the upper 1-cm and a mean 0.596 mg/g and 0.179 mg/g, respectively, below the 5-cm depth. Interestingly, biologically-labile P concentrations were approximately constant, while total P concentrations continued to decrease and a slow rate, with increasing sediment depth below 5-cm. The latter pattern coincided, in part, with declining refractory organic P concentration as a function of sediment depth.

Preliminary experimental estimates of diffusive P flux and vertical P profiles from sediment collected in the eastern portion of Big Traverse Lake suggested that sediment is likely a modest source of internal P loading to the LOW system. More information is needed on bottom water dissolved oxygen and redox dynamics as well as water column mixing and exchange in order to better understand the role and magnitude of internal P loading contributions within the context of an overall P budget. Vertical sediment P profiles also suggested that past P accumulation has exceeded diagenesis and burial, resulting in the modest buildup of biologically-labile P that may drive future internal P loading.

Brief Bio

I was a research aquatic biologist with the Engineer Research and Development Center, U.S. Army Corps of Engineers, for 32 y. I managed research at the Eau Galle Aquatic Ecology Laboratory in Wisconsin. I retired from ERDC in 2011 and am now a professor and research aquatic ecologist at the University of Wisconsin – Stout. My research interests are in lake eutrophication and management; sediment phosphorus dynamics, fluxes, and vertical characteristics; internal phosphorus loading and vertical transport; cyanobacteria blooms; alum treatment to control internal P loading

Phosphorus sources for the Rainy River / Lake of the Woods watershed

Christopher D. Lupo*[1] and Julie A. Blackburn[2]

[1]RESPEC Water & Natural Resources, P.O. Box 725, Rapid City, SD 57709; [2]RESPEC Water & Natural Resources, 1935 West County Road B2, Suite 320, Roseville, MN 55113

Abstract

The Rainy/Lake of the Woods Watershed has several water quality impairments, and developing a thorough understanding of the factors that contribute to those impairments is essential before efficient management actions can be proposed. Impairments to streams and waterbodies for the watershed include nutrients, turbidity, dissolved oxygen (DO), and mercury. The Lake of the Woods is impaired for nutrients, and phosphorus has been linked to its more frequent and intense algae blooms. The Minnesota Pollution Control Agency uses the Hydrological Simulation Program-FORTRAN (HSPF) as a primary tool to develop a holistic watershed-scale approach for monitoring, assessment, TMDL development, and identification of restoration and protection strategies. The model is being used to simulate hydrology, total suspended solids (TSS), temperature, DO, biochemical oxygen demand (BOD), nitrogen and phosphorus for the Rainy River/Lake of the Woods Watershed. Because of the scale of the watershed, nine models have been developed that cover over 25,000 square miles and integrate a wide variety of datasets, including meteorological, land cover, soils, flow and water quality monitoring, and point-source data. This presentation will summarize simulated total phosphorus and orthophosphate loads by model application (HUC8 equivalent), individual subwatersheds, and on a per acre basis for simulated land uses. The model will provide insight into the regions and land uses that account for disproportionate loadings and could be targeted to optimize management efforts.

Brief Bio

Mr. Lupo is an environmental engineer with a strong background in hydrology, water resources, and biogeochemical processes. He began working for RESPEC's Water & Natural Resources Division in Rapid City, South Dakota, in October 2012 and develops and calibrates hydrologic and water quality models in a variety of complex ecoregions. He has experience modeling pristine forest and lake-dominated systems in northern Minnesota, as well as heavily cropped, eutrophic systems throughout the Minnesota River and Missouri River Watersheds.

Ms. Blackburn has worked extensively with soil and water conservation districts, watershed districts, and state and federal conservation agencies in the fields of watershed management, drainage management, Total Maximum Daily Load (TMDL) implementation, and resource conservation planning. She has also provided leadership to watershed districts by overseeing all facets of comprehensive watershed management including surface water monitoring and analysis, TMDL studies and implementation plans, stormwater management, public drainage systems, rule development and permitting programs, conservation practice planning and implementation, strategic planning, communications, outreach, and public relations.

Lake of the Woods WRAPS process: from HSPF to local implementation

Jeremiah Jazdzewski*[1], Tim Erickson[1], Drew Kessler[1], Mark Deutschman[1], and Mike Hirst[2]

[1]Houston Engineering, Inc., [2]Lake of the Woods County Soil and Water Conservation District

Abstract

The 81 major watersheds in Minnesota, including Lake of the Woods (LOW), are currently undergoing various stages of the Watershed Restoration and Protection Strategy (WRAPS) and Total Maximum Daily Load (TMDL) process. One of the challenges in this process is how to take large-scale watershed-wide Hydrological Simulation Program Fortran (HSPF) modeling and effectively utilize the results to develop implementation planning that is applicable at the local scale. The future of water quality management in Minnesota is moving towards prioritizing and targeting management strategies to ensure they result in measurable water quality improvements. This presentation will outline the process of how HSPF modeling results within the LOW basin were refined with the help of additional tools, methodologies, and local cooperation, to target implementation strategies required for the WRAPS process that will result in measurable water quality improvements. Ultimately this implementation guidance will both help secure funding and produce measureable results towards WRAPS/TMDL goals.

Brief Bio

Jeremiah Jazdzewski and Tim Erickson are civil engineers at Houston Engineering, Inc. currently working with Mike Hirst at the Lake of the Woods Soil and Water Conservation District to complete their WRAPS and TMDL projects. The project is entering its fourth year and the recent focus has been on utilizing data developed throughout the WRAPS process to determine implementation prioritization and strategies.

Regional lake water quality measurements for Lake of the Woods / Rainy River basin by satellite remote sensing: capabilities and limitations with current and upcoming satellite systems

Leif G. Olmanson*, Patrick L. Brezonik, Jacques C. Finlay, and Marvin E. Bauer

Departments of Forest Resources, Civil Engineering, & Ecology, Evolution, and Behavior, University of Minnesota, St. Paul and Minneapolis, Minnesota, USA 55108

Abstract

This presentation will review advances over the past decade that have enabled use of satellite imagery for regional scale-measurement of lake characteristics, such as clarity, chlorophyll, total suspended solids (TSS), and colored dissolved organic matter (CDOM). For example, in the Midwest U.S.A. historic and recent Landsat water clarity assessments have been conducted on >25,000 lakes to investigate spatial and temporal patterns and explore factors that affect water quality. Due to the spectral characteristics of Landsat assessments of all lakes (>4 ha) have been largely limited to water clarity. European Space Agency (ESA) MERIS imagery with spectral bands that were selected for water has been used to assess chlorophyll for ~900 of Minnesota's large lakes (>150 ha). Improvements of the recently launched Landsat-8 and upcoming ESA Sentinel-2 and 3 satellites will expand our capabilities to assess other optically-related water quality characteristics (e.g., chlorophyll, CDOM, mineral suspended solids (MSS)). Landsat 8 and Sentinel-2 for all lakes and Sentinel-3 for large lakes more often. To explore the potentials and limitations of these systems a field campaign to measure optical water quality characteristics (e.g. chlorophyll, TSS, turbidity, dissolved organic carbon (DOC) and CDOM) and in situ reflectance spectra nearly contemporaneously with imagery from Hyperspectral Imager for the Coastal Ocean (HICO) and Landsat 8 was conducted in the summers of 2013 and 2014. Sites in Minnesota and Wisconsin were selected to obtain a wide range of concentrations of CDOM, chlorophyll, Fe, and MSS, the primary factors that affect reflectance. This presentation will discuss the improved spectral, radiometric, spatial and temporal characteristics of Sentinel and Landsat 8 sensors and use simulated Sentinel and Landsat 8 bands to evaluate improvements in sensing important variables, such as chlorophyll, turbidity, MSS, DOC and CDOM, for comprehensive regional assessments of lake water quality.

Landsat, Sentinel, Water Quality, Regional, HICO, Hyperspectral

Brief Bio

Recent and historic phytoplankton and cyanobacteria changes in Lake of the Woods

Hedy J. Kling*[1], Sue Watson[2], Claire Reis (Herbert)[3], Michael P. Stainton[4], and Gregory McCullough[3]

[1]Algal Taxonomy and Ecology Inc. Winnipeg, Manitoba
[2]*Watershed Hydrology and Ecology Research Division,*Environment Canada Burlington Ontario,
[3]Centre for Earth Observation Science (CEOS) , University of Manitoba, Winnipeg, MB
[4]Fisheries and Oceans Canada, Winnipeg, Manitoba

Abstract

Lake of the Woods (LOW) is a spatially complex, large (4350 km^2) lake located on the boundary between the precambrian shield and the interior plains. The lake can be divided into 6 regions based on spatial environment and differences in hydrodynamic and topographic features, which include a large shallow well mixed southern basin receiving nutrient-enriched glacial till drainage, and deeper stratified northern basins receiving input from both the southern basin and soft water shield drainage. As a result, the phytoplankton and cyanobacteria species are also highly diverse. Data from cores retrieved 2003 indicate that there have been noticeable shifts in community composition and biomass since the early 1900s. This presentation depicts historic and current phytoplankton composition, and shifts in cyanobacteria species distribution in Lake of the Woods, including toxins and updated cyanobacterial taxonomy. Detailed taxonomic analysis shows a diverse community of multiple cyanobacterial species belonging to genera typically known to produce algal toxins, including non nitrogen fixers such *as Microcystis* (*M. novacekii, M. botrys, M.viridis, M. aeruginosa, M. flos-aquae*), *Woronichinia naegeliana, Pseudanabaena (P. rutilus-viridis, P. muscicola, P. limnetica*), *Planktothrix agardhii* (complex), *Limnoraphis birgei* (pseudonym *Lyngbya)*, and important nitrogen fixers such as *Dolichospermum* (pseudonym *Anabaena*) (*D. flos-aquae, D. planktonicum complex, D. crassum, D. lemmermannii, D. fuscum, D. mendotate*), *Aphanizomenon* (including members of the *flos-aquae* complex (*A. flos-aquae, A. klebahnii, A. yezoense*), *A. gracile, A. schindlerii*) and *Cuspidothrix issatchenkoi* and *Gloeotrichia echinulata*. This paper describes and clarifies the morphological taxonomy of the known toxin-producing species of cyanobacteria, identifies the dominant forms and discuss their significance. Further detailed taxonomic research (combining morphological, ecophysiological and genetic information) is badly needed in order to adequately assess risk of toxins in relationship to human perturbation in the different regions of the lake

Brief Bio

Hedy Kling is the principal researcher at Algal Taxonomy and Ecology Inc (ATEinc) for past 17 years and previously (29 years) was the primary algal taxonomist at the Freshwater Institute, Department of Fisheries and Oceans (Central and Arctic Region), Winnipeg, Canada. She is well connected to the Canadian and Global taxonomic and limnological community. Hedy has more than 40 years experience in phytoplankton from a wide variety of Canadian lakes: Including ultra oligotrophic Arctic Canada, mountain and coastal lakes, Canadian shield to eutrophic prairie pot-holes, central Canadian large lakes (Lake Winnipeg, Lake of the Woods), Great Lakes of North America and the Central Great Lakes of Africa. She has specialized in the past 14 years in morphological identification of potentially toxic cyanobacteria and am collaborating with researchers using a polyphasic approach to taxonomy including molecular methods. Hedy has been a member of the International Association of Phytoplankton Taxonomists and Ecologist (IAP) since 1980 and regularly participate in workshops and course in cyanobacteria, general algal taxonomy as the field is rapidly evolving due to advances in genetics. She also has experience in paleolimnology looking at diatoms and non siliceous algal microfossils in cores. Hedy Kling has been author and co-author on more then 60 primary publications, many technical reports and has given many presentations.

Modeling the effects of past climate change on boreal lakes

Daniel R. Engstrom*[1], Mark B. Edlund[1], James E. Almendinger[1], Xing Fang[2], Joan Elias[3], Ulf Gafvert[3], David VanderMeulen[3]

[1]St. Croix Watershed Research Station, Science Museum of Minnesota, 16910 152nd St N, Marine on St. Croix, MN 55047
[2]Department of Civil Engineering, Auburn University, Auburn, AL 36849
[3]National Park Service, Great Lakes Inventory and Monitoring Network, 2800 Lake Shore Drive East, Ashland, WI 54806

Abstract

Climate change may disrupt boreal aquatic ecosystems directly through changes in temperature and precipitation, indirectly through watershed effects, and in concert with man-made stressors to produce longer ice-free seasons, stronger thermal stratification, increased dissolved organic carbon, and more cyanobacterial blooms. Eight lakes spanning a range of surface areas and depths were studied from Voyageurs and Isle Royale National Parks (Minnesota/Michigan, USA). We used retrospective thermal modeling of temperature-depth relationships generated with MINLAKE2012 and compared model output with monitoring and biological changes interpreted from dated sediment cores. Models were developed for each lake spanning 1960–2011. The most common trend was increasing summer shallow-water temperatures across two time periods (1962–1986, 1987–2011), followed by increased frequency and duration of thermal gradients of 2-3° C/m for deep lakes. Sediment core data (diatoms, biogenic silica) showed changes in diatom communities between 1960 and 2010 differed among shallower and deeper lakes and park units, with shallow lake warming affecting the abundance of benthic/tychoplanktonic forms and deep lake changes impacting deep chlorophyll layer communities and species that respond to length of spring mixing.

Brief Bio

Dan Engstrom is the director of the St. Croix Watershed Research Station, the environmental research wing of the Science Museum of Minnesota.

Goals and performance of the IJC 2000 Rule Curves for Rainy Lake and Namakan Reservoir

Gail Faveri*[1], Larry Kallemeyn[2], Ryan Maki[3] and James Bomhof[4]

[1]Environment Canada, Burlington ON; [2]USGS (retired); [3]Voyageurs National Park, International Falls, MN; [4]Lake of the Woods Secretariat, Ottawa, ON.

Abstract

Although Rainy Lake and the lakes of Namakan Reservoir are natural lakes, they were dammed in the early 1900s. Because Rainy and Namakan lakes are international waters, the International Joint Commission (IJC) has regulatory authority and stipulates water-management practices (rule curves) to the private-sector dam operators. Rule curves are bands of allowable high- and low-water levels throughout the year. From 1970-1999, the IJC 1970 Rule Curves were in effect for Rainy and Namakan lakes. The water level fluctuations allowed by the 1970 Rule Curves, especially those for Namakan Reservoir, were shown to have adverse effects on some components of the aquatic ecosystem. During the 1980s, research on effects of water-level management on the aquatic ecosystems of the Rainy Lake and Namakan Reservoir was conducted in order to develop alternatives to the 1970 Rule Curves. During the 1990s, biologists in the basin of Rainy and the Namakan chain of lakes compiled extensive research results which showed adverse effects of the IJC 1970 Rule Curves for Rainy and Namakan lakes on vegetation and wildlife. The results of these studies were used by a committee of U.S. and Canadian representatives from private industry, the public and government agencies to develop a consensus on water management in the Rainy Lake-Namakan Reservoir system. This group submitted recommendations to the IJC in 1993. The IJC, working through its International Rainy Lake Board of Control, evaluated the recommendations and concluded that modifications to the 1970 Rule Curves were justified. The IJC adopted a new set of rule curves for each reservoir in 2000. The IJC 2000 Order also requested an evaluation of the impacts of the rule curve after 15 years to assess whether he 2000 Rule Curves were having their intended effects. Many of the researchers here today are part of the studies underway to evaluate the effects of the 2000 Rule Curves.

This presentation will serve as an introduction to the goals and performance of the 2000 Rule Curves and will include a summary of the divergent hydrology experienced in the basin since 2000.

Brief Bio

Gail Faveri is the Canadian Chair of water levels committee of IR-LWWB and the Canadian member of IRLWCB and LWCB. After completing a Masters of Applied Science in Reservoir Regulation Optimization from the Ecole Poytechnique of Montreal, she worked for over twenty years in the private sector in various water management projects from Nova Scotia to British Columbia, before joining the federal government in 2002.

Hydraulic and eco-hydraulic conditions of critical spawning habitats in the upper Rainy River under the 2000 Rule Curve

J.W. Muirhead and W.K. Annable*

Department of Civil and Environmental Engineering, University of Waterloo, Waterloo, ON N2L 3G1

Abstract

A 22 km reach of Rainy River immediately downstream of International Falls Dam IFD) was investigated during the spring freshet seasons of 2012 and 2013 to characterize hydraulic states and conditions using an acoustic Doppler current profiler (ADCP). The objective of the study was to identify critical spawning habitats of walleye and lake sturgeon spawning from concurrent investigations and determine if hydraulic linkages spatially existed as a function of channel discharge which could be used to comment on the 2000 Rule Curve. Eighty one contemporaneous metrics frequently employed in eco-hydraulic studies were evaluated over the seasonal range in freshet flows (25^{th} to 75^{th} quartile range).

Results of the two-year field investigation identified that the spawning and incubation periods for both walleye and lake sturgeon coincided with spring freshet periods which were strongly influenced by backwater effects from Manitou Rapids and lagged timing of freshets from major tributaries downstream of the study site. The backwater conditions obscured the majority of relationships that are often observed in rivers where normal depth conditions prevail as a function of discharge. Only six metrics demonstrated strong correlations as a function of discharge which were all either direct or indirect expressions of channel bathymetry complexity. Inspection of the channel identified a series of shoals with varying substrate sizes (gravel//boulder/cobble) at different elevations which could be inundated to potentially augment critical spawning habitat opportunities; the remainder of the channel is a relatively featureless uniform U-shaped channel morphology. The number and persistence of additional shoal inundations is a function of seasonal storage above IFD such that sustained flows below IFD can be progressively increased or maintained during the periods of critical spawning and incubation periods.

Brief Bio

Bill is an Associate Professor of Civil & Environmental Engineering at the University of Waterloo. He has been researching the hydraulic, sediment transport and morphological characteristics of rivers for over the past 20 years. A major research thrust has been working closely with aquatic biologists and ecologists investigating the bio-physical linkages of aquatic habitats under a myriad of river morphologies and flow regimes. In addition to theoretical and applied research, he has also been designing, monitoring and supervising the construction of natural channel restoration projects throughout North America totaling over 2,700km of streams and rivers studied and over 180km of river channels rehabilitated spanning a broad scale in watershed scales and geologic settings. Recent research has focused on the sediment transport characteristics of urban river systems and how changes in hydrology affect habitat dynamics.

Rainy River index of biotic integrity

E.R. Timusk*[1], Dr. K.E. Smokorowski, Dr. M. Power and W.M. Gardner

Evan Timusk, Fisheries and Oceans Canada, 1219 Queen St. E., Sault Ste. Marie, ON, Canada, P6A 2E5. 705-941-2663

Abstract

In 2001, the International Joint Commission (IJC) issued an order prescribing the method for regulating the levels of the boundary waters of Rainy and Namakan lakes, consolidating and replacing a number of previous and supplementary orders. The 2000 Rule Curve shifted towards a more natural hydrograph under the assumption it would benefit the aquatic communities of Rainy Lake and Namakan Reservoir. In an attempt to assess the potential impacts of the 2000 Rule Curve on the fish community downstream of International Falls, in August, 2013 an Index of Biotic Integrity (IBI) was estimated for the upper Rainy River (spanning 72 km between International Falls and Long Sault Rapids). The 2002 Rainy River IBI estimation methods were replicated in 2013 to ensure direct result comparability. IBI scores ranged from 60-80 in 2002 and 55-80 in 2013 (60-80 is considered “good” for large rives of this region). Mean IBI scores were 67.7 and 70.3 in 2002 and 2013, respectively, and were not significantly different. However, there were large changes in some of the metrics, including percent riverine species (41% decrease), percent lithophil species (44% decrease), percent insectivores (18 % increase) and percent round suckers (12% increase). Most of these changes were driven by an increase in the abundance of young-of-the–year (YOY) yellow perch. The increase in YOY yellow perch abundance is thought to be an artifact of natural interannual variability and not the result of changes caused by the 2000 Rule Curve. Overall, the 2000 Rule Curve did not appear to have a significant effect, either possitive or negative, on the upper Rainy River fish community.

Brief Bio

Evan Timusk became an Aquatic Science Biologist with DFO’s Great Lakes Laboratory for Fisheries and Aquatic Sciences in Sault Ste. Marie in 2010. Evan received his B.A. in Biology at the University of Maine at Machias in 2007 and his M.Sc. in Integrative Biology at the University of Guelph in 2009. For his M.Sc. thesis Evan studied life history trait evolution in salmonids, specifically focusing on embryonic development rate in brook charr. However, his research interests are broad and include the effects of hydroelectric facilities on downstream aquatic ecosystems, which is currently his primary research focus.

Studies of the upper rainy river food web and variations in spawning critical habitats in relation to flow

Adrienne Smith*[1], Karen Smokorowski, Jerome Marty, Evan Timusk and Michael Power

[1]University of Waterloo, Waterloo, Ontario, Canada, N2L 3G1 (613) 266-7403

Abstract

While the impacts of large hydroelectric dams are now well recognized, there is growing awareness of the pivotal role of the flow regime as a key driver of the ecology of rivers. In 2001, the International Joint Commission (IJC) issued an order prescribing a method for regulating the levels of Rainy and Namakan lakes, as a result, the Rainy River hydrograph is thought to have lost the natural seasonal flow pattern. To date only limited biological monitoring has been conducted on Rainy River. Parallel biological and hydraulic river surveys were performed in 2012 and 2013 directly downstream of the International Falls Dam. Biological surveys involved identification of spawning locations, a complete biological work-up of individuals and a tissue sample collection for stable isotope analysis for three target species, walleye (*Sander vitreus*), lake sturgeon (*Acipenser fulvascens*) and logperch (*Percina caprodes*). Specific objectives were to characterize and catalogue the existing condition and age-class structure of the identified species and where possible, make comparisons with published literature on Lake of the Woods/Rainy River populations prior to the 2000 rule curve change. Using stable isotope analysis we characterized the Rainy River food web and provide a baseline for the assessment of the Rainy River food web, trophic structure and feeding habits of the target species. Finally, we sought to identify and characterize the critical spawning habitat in the upper Rainy River and determine if substrate, water velocity and depth characteristics of the spawning sites were affected by changes in water surface elevation.

Brief Bio

Adrienne has recently completed her MSc thesis at the University of Waterloo in Fisheries Biology. She received her Bachelor's degree from Carleton University in 2010 and an Environmental Technicians diploma from St Lawrence College in 2011.

Plenary 1 - Influencing ecological properties using water level management

James H. Larson*[1*], David F. Staples[2], Ryan P. Maki[3], Jon M. Vallazza[1], Brent C. Knights[1], Kevin E. Peterson[4], Brian R. Gray[1]

[1] U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI
[2] Minnesota Department of Natural Resources, Forest Lake, MN
[3] Voyageurs National Park, International Falls, MN
[4] Minnesota Department of Natural Resources, International Falls, MN

Abstract

Many ecological processes in lakes depend on the regular rise and fall of water levels. In many lakes, water control structures allow for active management of water level fluctuations. Often these are managed for relatively narrow purposes (e.g., hydropower, flood control), but increasingly water level management in lakes and reservoirs is also used to maximize the production of ecosystem services or to accomplish particular conservation goals. Here, we use data from the past twenty-plus years to evaluate the potential for water level management to influence two resource management priorities in the Rainy Lake -Namakan Reservoir system: 1) Minimizing mercury contamination in fish and 2) Increasing the production of important fisheries. Although temporal variation in mercury content of fish (young-of-year Yellow Perch) has been linked to water level fluctuations, our results suggest that associations between water level fluctuations and fish mercury content vary in magnitude among lakes. For example, in Crane Lake, a 1 meter increase in maximum water level from the previous year was associated with a 108 ng (69-147 ng; confidence interval) increase in fish Hg content (per g wet weight), while the same WL change in Kabetogama was associated with only a 5 ng (-31 - 42 ng; confidence interval) increase in fish Hg content. In half the lakes sampled here, effect sizes could not be distinguished from zero. On-going work will identify controls over spatial variation in water level effects on mercury incorporation into the foodweb. In relation to the production of fisheries, previous research has suggested that differences in water level between late summer and early spring may alter the suitability of shoals used by Walleye for spawning. Here we used data from six lakes to estimate this effect. In most lakes, over-winter declines in water level and other metrics did not appear to be strongly related to Walleye or Yellow Perch YOY production. However, increases in Walleye YOY occurred in lakes of the Rainy-Namakan complex following a major change in water level management in 2000, while other lakes in the same region saw declines. Taken together these suggest that changes in water level management may affect Walleye and Yellow Perch YOY. However, mechanisms other than the one we hypothesized (i.e., overwinter declines reducing access to spawning shoals) appear important in some lakes. Additional preliminary analysis on the role of water level fluctuation on year-class strength in several species (Northern Pike, Walleye, Yellow Perch, etc.) within the Rainy-Namakan system is on-going.

Brief Bio

Dr. Larson is from the Great Plains of Kansas, where he attended Southwestern College as an undergraduate before moving to the Great Lakes region and completing a Ph.D. at the University of Notre Dame. His research career has followed a downstream longitudinal gradient. Dr. Larson's graduate work was primarily on the role of land use on the biogeochemistry of small streams. More recently, Dr. Larson's research has moved into food web dynamics within rivermouths of the Great Lakes and studies on ecosystem processes in the nearshore of large lakes. Dr. Larson also studies recruitment constraints on fisheries, the role of food quality in structuring ecosystems and ecotoxicology. Since 2010, Dr. Larson has worked at the U.S. Geological Survey in the Upper Midwest Environmental Sciences Center.

Plenary 2 – Habitat modeling of the Rainy-Namakan lakes, impacts of rule-curves on biota

Jean Morin, Marianne Bachand, Olivier Champoux & Julien Henault-Richard

Meteorological Service of Canada, Environment Canada, 1550 avenue D'Estimauville,
Québec City, Québec, Canada

Abstract

Water levels of Rainy Lake and Namakan Reservoir have been managed using different rule-curves since 1949. The present rule-curves (2000RC) will soon be reviewed by the International Joint Commission which is engaged in several projects on shoreline properties, fisheries, wetlands and socio-economic parameters. The present project integrates a large amount of knowledge from other studies and aims to quantify the effects of historical water level regulation on some key aspects of the ecosystem: wild rice abundance, invasion of hybrid cattail, wetlands diversity reduction, reduction in loon population, decrease of walleye and northern pike population and scarcity of muskrats. Using a combination of simple relations (1D) with water level variations and a more complex 2D habitat modelling approach, we have developed new means to evaluate the system's regulation.

We are developing an Integrated Ecosystem Response Model based on several habitat models concerning critical faunal and floral components of the ecosystem that are sensitive to water level management. The habitat models used quarter-monthly means to analyse long term water levels series representing measured levels, simulated natural levels and simulated levels based on two sets of rule-curves (2000RC and 1970RC) generated by running measured inflows from 1950 to 2012 through hydrologic response models.

We produced several 1D models to evaluate the effect of water level variations on wild rice, common loons and muskrats. Based on literature reviews and available data, we identified periods in which each species is most sensitive to water level variations and the type of variations that would negatively influence these species.

The wild rice survival model (germination and floating stages) suggests that more stable levels during the growing season are favorable to wild rice. However, interannual stability resulting from present regulation promotes more competitive perennial species like cattail. As such, highly variable natural conditions from one year to another are probably more suitable to wild rice in the long term, because even if conditions are poor in some years, more suitable wild rice habitat could be available in good years.

Muskrats are most vulnerable to water level variations during winter when their access to food is limited by ice. The muskrat model suggests that their low abundance in the system could be linked to the important water level decrease during winter which limits muskrat lodge viability. Because they are important consumers of cattails, larger muskrat populations in the system could limit the extent and the expansion of cattail stands.

We evaluated the sensitivity of common loons to water level variations during their breeding season. This model suggests that all rule-curves should produce better conditions for nesting loons than natural control of water levels.

We are also developing a number of spatially explicit 2D models to quantify suitable areas for some taxa: wild rice, cattails, marshes, submerged and emergent plants as well as northern pike and walleye reproduction grounds. For these models, we used a combination of logistic regressions comparing environmental variables (quarter-monthly depth, waves, etc.) in the presence and in the absence of each taxon and other functions accounting for various processes (drying, drowning, vegetation succession, etc.) to predict suitable habitat. Most of the results are still to come, but the submerged plant models show that suitable habitat has remained relatively stable since 1950. The different management rule curves appear to have limited impacts on submerged vegetation habitat other that improving stability in their environmental conditions.

The models developed herein are sensitive to different aspects of long and short term fluctuations in water levels. From the available results, we can already suggest improved water level management for different portions of the annual hydrograph.

Simulating flooding impacts on the Rainy and Namakan chain of lakes to compare rule curve performance

Mike Shantz

Environment Canada, 867 Lakeshore Road,Burlington, Ontario Canada, L7S1A1

Abstract

A simulation tool is currently being developed to estimate potential flooding damages on the Rainy and Namakan Chain of Lakes (Rainy, Namakan, Kabetogama, Sand Point, and Crane) on both sides of the international border. The primary intent is to compare potential flooding damages under two different water level management scenarios including the current 2000 Rule Curves and the previously utilized 1970 Rule Curves. The framework of this flood damage tool will be discussed including the structure of the underlying geodatabase and how the geospatial data is utilized to support the flood damage estimates. Overall results will be provided for the simulations of the 2000 and 1970 Rule Curves. The simulation results will be considered in the context of observed 2014 flooding damages in the basin with particular emphasis on the limitations of this simulation tool in trying to capture all types of flooding damages. The flood damage simulation tool is being designed to allow for future adjustments and improvements as new data and information become available and a few of the priority areas will be outlined including particular aspects of the baseline economic data. As well, opportunities to utilize the tool to quickly and easily simulate impacts under alternate hydrologic scenarios will be discussed.

Brief Bio

Mike Shantz joined the Boundary Waters Issues Unit of Environment Canada in 2004. Since that time, he has supported a range of studies aimed at improving water level planning and management on boundary waters between Canada and the United States, particularly within the Great Lakes basin. This has included support for both the IJC's International Lake Ontario- St. Lawrence River Study and the International Upper Great Lakes Study. More recently, Mike has also been involved in a study looking at flood vulnerability on the Rainy and Namakan chain of lakes. Prior to joining Environment Canada, he completed a Master's degree in Geography at the University of Waterloo with research focused on evaluating hydrological changes associated with wetland restoration efforts.

Effects of water management regime of Rainy Namakan system on wild rice production

O'Niell Tedrow*[1], Peter Ferguson Lee[1], and John Kabatay[2]

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

Abstract

Water level fluctuations on the Seine River can detrimentally affect the production of wild rice. In high water level years, such as 2013, the crop is reduced to virtually nothing and no harvesting occurs. In order to quantify the effects of water levels and water level manipulations on wild rice during its normal phenological development, a series of rafts (3 m x 3 m) were deployed in a protected area of the Seine River. Each raft contained 36 buckets that were planted with wild rice and could be raised or lowered in the water column. The rafts were adjusted in depth during the submerged, floating leaf and aerial stages. Initial depths on the rafts were 40 cm, 60 cm and 80 cm. One set of buckets at the 40 cm depth represented the control treatment and were never adjusted in depth. Once the specific phenological stage was reached, the other three depth treatments were lowered 10 cm every five days until these buckets had been lowered an additional 30 cm. Every two weeks following the final lowering, nine of the buckets were lifted from each raft and the plants still alive were harvested. A final harvest occurred at the end of the season. The plants were transported to the university and the dry weights determined as a measure of plant productivity. The results showed that the most critical depth for wild rice survival and growth was the submerged leaf stage. Lowering of depths during this stage of plant development further reduced plant survival and productivity. The effect of depth increases was further complicated by fluctuations in turbidity. The results suggested that optimum depth management for wild rice would be to maintain depths at low levels with little depth fluctuation until at least the floating leaf stage was attained. The rafts will be again deployed in 2015 to examine this hypothesis in detail.

Brief Bio

O'Niell Tedrow is a Ph.D. student in the Department of Biology at Lakehead University. Mr. Tedrow is also a professor at Vermillion Community College in Ely Minnesota. After completing his undergraduate training in Minnesota, O'Niell completed his M.Sc. degree in aquatic toxicology at Clemson University in South Carolina. He later worked for the EPA in Atlanta Georgia before moving back to Minnesota, working initially with Northern Technical Services in Virginia, Minnesota. O'Niell's Ph.D. thesis is concerned with site specific physical and chemical effects on the survival and growth of wild rice. This includes depth fluctuations as outlined in this presentation as well as the chemical characteristics of sediment supporting wild rice. His Ph.D. supervisor is Dr. P.F. Lee.

Correlating turbidity, depth, and upstream dam releases with wild rice (*Zizania palustris)* production in the Seine River, northwestern Ontario

Stephanie Reid* and Peter Ferguson Lee

Department of Biology, Lakehead University, Thunder Bay ON

Abstract

The cultivation and harvesting of *Zizania palustris* (wild rice) is an imperative part of Indigenous culture since it provides economic security and a source of food. The aquatic grass grows in lakes and river systems across Canada, but is most abundant in Northwestern Ontario. Wild rice plants are very particular and sensitive to a range of ideal chemical, physical, and biological conditions. Ideal plant growth ranges from .60-1.20 meters of water, and in order for chloroplasts to thrive during photosynthesis, effective light penetration depth is needed. While some water circulation is ideal, significant fluctuation in the water levels during the growing season may be detrimental. Impacts to photosynthetic processes may cause poor plant growth and seed production and thus negatively impact yields. This study examined the effects of turbidity increases caused by rainfall events and upstream dam releases on wild rice production during May, June, and July in the Seine River at the Seine River First Nation near Mine Centre, Ontario. Water depth levels and flow data within the Seine River watershed from 2007 to 2014 were correlated with turbidity values from the Seine River First Nation Water Treatment Facility. Flow and water level data for the same time periods were also examined from upstream dams on the Seine River. This study showed that there was a significant correlation between turbidity and flow fluctuations. Future research will determine if there is a corresponding correlation between turbidity and wild rice production by utilizing light recorders placed on experimental rafts which examine the effects of depth increases on wild rice. If wild rice production is declining because of increases in turbidity, it may be possible to develop management strategies that control upstream dam releases to minimize the effects on wild rice.

Brief Bio

Stephanie Reid is a 4th year Honours BSc Water Resource Science w/Specialization in Applied Environmental Water Management student at Lakehead University. Originally from northern Manitoba, Stephanie moved to Thunder Bay to complete her university education. Her plans after graduatin are to obtain full time employment within the water management and sciences discipline. Ms. Reid also works part time in the Lakehead University Environmental Laboratory. Her undergraduate thesis is titled ‘Correlating turbidity, depth, and upstream dam releases with wild rice (*Zizania palustris)* production in the Seine River, Northwestern Ontario’. Her undergraduate thesis is supervised by Dr. P.F. Lee

Northern pike young-of-the-year habitat characteristics in Rainy Lake and Namakan Reservoir

Anne Timm* and Rod Pierce

USDA Forest Service, Northern Research Station, Baltimore Field Station, 5523 Research Park Drive, Suite 350, Baltimore, MD 21228

Abstract

The International Rainy Boards 2000 “Rule Curves” should expand the range of elevations covered by aquatic vegetation that would be available as northern pike nursery habitat in Rainy Lake and Namakan Reservoir as a result of an earlier spring rise. Previous research has documented temperature, depth, presence of submerged aquatic vegetation, and aquatic vegetative cover as characteristics related to young-of-the-year (YOY) northern pike habitat preference. The objective of this study was to identify temperature, depth, and aquatic macrophyte species characteristics associated with highly productive northern pike YOY habitat in Rainy Lake and Namakan Reservoir. This study expanded trap net sampling for YOY northern pike in Rainy, Kabetogama, and Namakan Lakes to 16 bays in 2012 and 21 bays in 2013. Aquatic plant surveys were conducted at each trap net location that collected presence, percent cover, and stem density data. Our study fit negative binomial poisson, zero-inflated poisson, zero-inflated negative binomial, and negative binomial hurdle models using the FMM procedure for finite mixture models to determine significant variables related to YOY pike counts. Best fit models with the lowest AIC criteria identified temperature and aquatic plant stem density as significant variables positively related to northern pike YOY count. Best fit models also identified the presence of *Sagittaria* spp. and *Schoenoplectus tabernaemontani* emergent plants and the presence of *Ceratophyllum demersum*, *Utricularia macrorhiza,* and *Elodea canadensis* submergent plants as significant variables positively related to northern pike YOY count.

Brief Bio

Dr. Anne Timm is a Research Aquatic Ecologist with the USDA Forest Service, Northern Research Station, Baltimore Field Station, Baltimore, Maryland, where she manages a research program that focuses on effects of land use and management activities on aquatic habitats and aquatic species populations.

Using corrected benchmark elevations and high-resolution bathymetry to address water-level management in Rainy Lake and Namakan Reservoir

J.R Ziegeweid*[1], R.J.Silliker[2], and B.K. Densmore[3]

[1]*U.S. Geological Survey Minnesota Water Science Center; 2280 Woodale Dr, Mounds View, MN 55112*
[2]*Natural Resources Canada; 615 Booth Street, 04Ath Floor, Room 418D, Ottawa, ON, Canada K1A 0E9*
[3]*U.S. Geological Survey Nebraska Water Science Center; 5231 S. 19th St, Lincoln, NE 68512*

Abstract

Water levels in Rainy Lake and Namakan Reservoir are regulated according to rule curves developed by the International Joint Commission to satisfy a number of legally-recognized water uses. However, during periods of substantial inflow, water levels at upper and lower ends of Namakan Reservoir may differ by as much as 30 centimeters, confounding efforts to stay within the rule curves and satisfy all legally-recognized water uses. In a previous study, HEC-RAS models were constructed to describe the movement of water through Namakan Reservoir, but models could not be calibrated because streamgages in the reservoir were set to several different vertical datums that could not be reconciled mathematically. In 2014, the International Joint Commission funded a two-part joint study between the U.S. Geological Survey, Environment Canada, Natural Resources Canada, and Water Survey of Canada to improve understanding of water elevations in Rainy Lake and Namakan Reservoir. First, 28-74 hours of simultaneous elevation data were collected for 17 benchmarks in the Rainy Lake and Namakan Reservoir watersheds using static Global Navigation Satellite System receivers. A single geoid model was used to improve relative accuracies of measured benchmark elevations and provide the elevations in a uniform vertical datum. The International Joint Commission can use new elevation data in the evaluation of the 2000 Rule Curves, and elevation data may be used to calibrate previously-developed HEC-RAS models of the narrows that connect the five lakes of Namakan Reservoir. Second, 20-meter grid bathymetry data were collected for 14 shallow (0-3 meter depth) areas in Rainy and Namakan Lakes using high-resolution single-beam sonar. Bathymetry data were combined with new elevation data to enhance a digital elevation model developed by Environment Canada. In addition, bathymetry data may be used in several habitat-modeling studies of wetlands, aquatic plant communities, fish spawning areas, and fish nursery habitats being conducted in support of the evaluation of the 2000 Rule Curves by Environment Canada, U.S. Department of Agriculture Forest Service, University of Minnesota, Ontario Ministry of Natural Resources, and the Minnesota Department of Natural Resources.

Brief Bio

Jeff Ziegeweid is a Hydrologist for the USGS Minnesota Water Science Center, where he has worked since 2008. His work focuses on understanding how biological communities respond to changes in hydrology. Jeff received his bachelor's degree from the University of Wisconsin-La Crosse in 2004, with majors in Biology (Aquatic Science Concentration) and Chemistry and a minor in Mathematics. Jeff received his master's degree in Forestry and Natural Resources (with a Fisheries Emphasis) from the University of Georgia in 2006.

Model predictive control strategies for implementing rule curves for the Namakan Reservoir / Rainy Lake Watershed

Jeffrey C. Kantor

Department of Chemical and Biomolecular Engineering, University of Notre Dame, 182 Fitzpatrick Hall, University of Notre Dame, Notre Dame, IN 46556

Abstract

This presentation describes preliminary results of modeling and simulation studies exploring improvements in lake level control for the Rainy Lake - Namakan Reservoir system that would be possible with an advanced and integrated control strategy.

The 2000 change in rule curves for Namakan and Rainy Lakes, if implemented as written, necessarily changes the annual distribution of outflows to Rainy River. As shown on the accompanying figure, the 'imputed' changes in flows on Rainy River are a flow reduction during the winter months of approximately 30 cubic feet per second, and an increase from late April to late June in amounts ranging from 50 cubic feet per second to over 100 cubic feet per second. These changes are primarily a consequence of the reduced surge capacity due to the rule curve changes, and secondarily to the relative timing of the rule curves Rainy and Namakan Lakes.

Lake level and river flow data were extracted from the the HYDAT database to test whether the 'imputed changes' to the seasonal flow on Rainy River can be observed in the historical data. The correlation of Rainy Lake level to Rainy River flow was compared for the periods from 1970-2000 and 2000-2010. As shown in the accompanying figure, the periods of high water/high flow are more frequent in the 2000-2010 period than 1970-2000. The difference between the two periods is in qualitative agreement with the 'imputed' changes in river flow predicted from the 2000 rule curve change. The data demonstrates, during periods of high flow, than an increase of 100 cubic meters/sec in flow on Rainy River increase the Rainy Lake level by approximately 0.4 meters.

The statistical significance of this change is verified using an empirical stage-frequency diagram for the flow on upper Rainy River. The K-S Kolmogorov–Smirnov) statistic verifies the statistical significance of this change. Local precipitation data for the same periods are not substantially different by the same statistic. This provides strong empirical evidence that the change in seasonal flows caused by the 2000 rule curve change induced high water events on Rainy Lake because of the unique discharge characteristics of upper Rainy River.

For purpose of estimating the net inflow to Rainy Lake, a Kalman tracking filter was constructed to estimate inflows from historical lake level measurements and flow measurements on Rainy River from the HYDAT database. The serendipitous occurrence of redundant lake measurements in the HYDAT database provided a statistical model of the level measurement errors which, in turn, was used to tune the tracking filter to produce maximum liklihood estimates (details available here: http://nbviewer.ipython.org/github/jckantor/Rainy-Lake-Hydrology/blob/master/Estimating_Rainy_Lake_Inflows_1970-2010.ipynb).

Daily estimated inflows to Rainy Lake were computed for the periods 1971-1999 and 2000-2010. The central three quintiles of seasonal flows were then computed and shown in the accompanying figure. As shown, the distribution of Rainy Lake inflows are markedly higher in periods from April through June, and lower in the periods from August through March.

Finally, the median differences in Rainy Lake level between the two periods are shown is compared with 'imputed difference' in Rainy Lake inflows to the 2000 rule curve change. The correlation of observed change in Rainy Lake inflow to the 'imputed' change due to the rule curve change is clearly evident.

Further empirical work compared the empirical distribution of Rainy Lake levels for the 1970-2000 and 2000-2010 periods. As shown by monthly plots of the empirical cumulative distribution of Rainy Lake level, April and June exhibit statistically significant increases in the occurrence of high water levels.

The next stage of this work will develop and simulate the performance of advanced control strategies to control lake levels subject to current rule curves. Model predictive control is a strategy that uses available measurements of Rainy Lake and Namakan Lake levels, a tracking filter to measure ungaged inlet flows, a model of the two reservoir system, and a prediction horizon to estimate an optimal control trajectory. In this instance the control variables are the daily configurations of the dams located at International Falls and at Kettle Falls. Real-time feedback control is achieved by daily updates of the optimal control trajectory in response to new measurements.

Brief Bio

Jeffrey C. Kantor is Professor of Chemical and Biomolecular Engineering at the University of Notre Dame. His research interests are in the application of control theory to a range of engineering applications including the integrated finance and control of process operations and network analysis. His teaching interests are in Chemical Engineering, and the ESTEEM program at Notre Dame.

Dr. Kantor has served the University in a variety of senior roles including Director of the Center for Research Computing, concurrent service as Vice President and Dean of the Graduate School from 2001 to 2006, Vice President and Associate Provost with responsibilities for academic budgets, science and engineering concerns from 1996-2001, Chair of the Department of Chemical Engineering, and other administrative and committee assignments.

Dr. Kantor has served in a variety of civic and institutional roles. Dr. Kantor chaired the Board of Directors of the not-for-profit Madison Center, the largest mental health service provider in Indiana with over 1,000 employees. He has served as member of the Board of Directors for Innovation Park at Notre Dame, for Medical Education Foundation of South Bend, and for Cytometry for Life. In December 2001, Dr. Kantor was appointed by the late Indiana Governor Frank O'Bannon to the steering committee of the state's 21st Century Research and Technology Fund Board. He also served on the board of St. Joseph's County Chamber of Commerce, an at-large director for the Indiana Health Industry Forum, and the CACHE Corporation.

A member of the Notre Dame faculty since 1981, Dr. Kantor is a professor of chemical engineering and specializes in the dynamics and control of nonlinear chemical systems, multivariable robust control, and nonlinear state estimation. Most recently, his work has focused on issues in fault detection, the control of discrete manufacturing systems, and the integrated design. Dr. Kantor's research has been supported by the National Science Foundation, the Department of Energy and a number of industrial sponsors. He was the recipient of a National Science Foundation Presidential Young Investigator Award in 1985 and of the Camille and Henry Dreyfus Foundation Teacher-Scholar Award in 1986.

Trophic state in Voyageurs National Park lakes before and after implementation of a revised water-level management plan

V.G. Christensen*[1] and Ryan P. Maki[2]

[1]USGS, 820 6th Street East, West Fargo, ND 58078; [2]Voyageurs National Park, International Falls, MN 56649

Abstract

We compiled Secchi depth, total phosphorus (TP), and chlorophyll a (Chla) data from Voyageurs National Park lakes and compared datasets before and after a new water-level management plan was implemented in January 2000. Average Secchi depth transparency improved (from 1.9 to 2.1 m, p=0.020) between 1977-99 and 2000-11 in Kabetogama Lake for August samples only and remained unchanged in Rainy, Namakan, and Sand Point Lakes, and Black Bay in Rainy Lake. Average open-water season Chla concentration decreased in Black Bay (from an average of 13 to 6.0 □g/L, p=0.001) and Kabetogama Lake (from 9.9 to 6.2 □g/L, p=0.006) between 1977-99 and 2000-11. Trophic state index decreased significantly in Black Bay from 59 to 51 (p=0.006) and in Kabetogama Lake from 57 to 50 (p=0.006) between 1977-99 and 2000-11. Trophic state indices based on Chla indicated that after 2000, Sand Point, Namakan, and Rainy Lakes remained oligotrophic, whereas eutrophication has decreased in Kabetogama Lake and Black Bay. Nutrient inputs from inflows and internal sources are still sufficient to produce annual cyanobacterial blooms and may inhibit designated water uses. However, trophic state has decreased for Kabetogama Lake and Black Bay and there has been no decline in lake ecosystem health since the implementation of the revised water-level management plan.

Brief Bio

Victoria Christensen has been a hydrologist with the USGS for 20 years. She began her career in Kansas studying sediment and water-quality in reservoirs. She began working in the large lakes in Voyageurs when she moved north in 2002. She has completed a variety projects in Voyageurs, including the studies of nutrient loading, trophic state, bottom sediment, algal blooms, and drivers of fish mercury.

Assessment of the affects of the 2000 Rule Curves on northern pike reproduction in Rainy and Kabetogama lakes, MN

Larry Kallemeyn*[1], Benjamin Vondra[2], David Staples[2], Ryan Maki[3]

[1]USGS retired), 1812 Shady Oak Place, Spearfish, SD 57783; 605-559-0158; [2]MNDNR, [3]USNPS

Abstract

The IJC's 2001 Consolidated Order contained the provision that "This order shall be subject to review 15 years following adoption of the Commission's Supplementary Order of 5 January 2000, or as otherwise determined by the Commission". The review shall, at a minimum, consider monitoring information collected by the natural resource agencies and others during the interim that may indicate the effect of the changes contained in the 2000 Supplementary Order. One aspect of those monitoring programs has been the standardized seining conducted annually since 1983 on Rainy Lake and 1981 on Kabetogama Lake by Voyageurs National Park and Minnesota Department of Natural Resources personnel. This program provides information that can be used to evaluate relationships between environmental conditions and recruitment and growth of young-of-the-year (YOY) fish, including both the primary predators such as northern pike, and several prey species. For northern pike, earlier analyses based on alternative sampling methods suggested that a summer drawdown and an earlier spring rise such as those included in the 2000 rule curves, particularly for Namakan Reservoir, would expand the range of elevations covered by emergent aquatic vegetation that would be available for spawning habitat, thus improving spawning conditions. In this analysis, seine catches of YOY northern pike and hydrological and climatic conditions from pre-2000 (1970 Rule Curves) post-2000 are compared to assess whether the altered hydrological regime has resulted in the hypothesized benefits.

Brief Bio

Mr. Kallemeyn was employed from 1980 to 2007 in International Falls, MN, initially as the aquatic research biologist for Voyageurs National Park and then from 1993 on as the only permanent employee of the USGS's International Falls Biological Station, which was attached to the Columbia Environmental Research Center in Columbia, MO. His work experience primarily involved fish communities in boreal forest lakes and reservoirs (Saskatchewan., MN, Isle Royale National Park) and the Missouri River (SD). His work in the national parks was primarily directed toward the identification and prediction of effects of factors such as reservoir management regimes, invasive species, environmental contaminants, and fisheries management practices on the health and viability of the park ecosystems.

Beaver lodge site selection in large lake environments

Steve K. Windels*[1], Joshua B. Smith[2], Jerrold L. Belant[3], Brian E. McLaren[4]

[1]Voyageurs National Park, International Falls, MN 56649; [2]Voyageurs National Park Association, International Falls, MN 56649; [3]Mississippi State University, Starkville, MS 39762; [4]Lakehead University, Thunder Bay, ON P7B 5E1

Abstract

Beavers are keystone species whose foraging and construction activities can significantly affect vegetation communities (both terrestrial and aquatic) in the vicinity of their lodge. These same activities also contribute nutrients and coarse woody debris to lakes and wetlands. As opposed to the classic beaver pond system, beavers in large lake systems typically do not maintain a dam but construct lodges along the lakeshore. Beavers likely select lodge sites based on forage availability as well as abiotic factors such as the amount of wind/wave action, substrate type, and water depth sufficient to ensure safe underwater access to the winter food caches. In some managed lakes, beavers also must contend with decreasing water levels during the main period of lodge occupancy (winter). We analyzed field-based and remotely-sensed data from 54 beaver lodges from two lakes in Voyageurs National Park to identify factors affecting beaver lodge site selection in large lakes at both the macro- and microhabitat scales. At the macrohabitat scale, water depth at 0m and 10m from the lodge entrance appeared to be the most influential factors affecting lodge site selection, with the amount of wave action (fetch) and substrate type also appearing in the best models. Beavers also showed stronger selection for water depth in the lake that experienced a large overwinter water level drawdown. At the microhabitat scale, water depth, substrate type and vegetation were the most important factors. Our results have implications for predicting beaver habitat suitability in large lakes that are common throughout the Canadian Shield, and understanding the ecological effects of artificial water level management.

Brief Bio

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

Steve Windels*[1], Steve Gutreuter[2], and Ryan Maki[1]

[1]Voyageurs National Park, International Falls, MN 56649; [2]US Geological Survey

Abstract

Waterbirds are sensitive to the effects of fluctuating water levels, as this can affect habitat for foraging, nesting, and predator avoidance. The common loon (*Gavia immer*) is an iconic and conspicuous species in boreal lake systems and serves as top predator in many aquatic food webs. Here we summarize the results of two separate studies related to the effects of water level management on loon reproductive success in the region. We intensively monitored loon nesting behavior and nest success for 278 nests in 2004-2006 in the Rainy-Namakan system. As predicted, both the timing and magnitude of water level change during the nesting period influenced the probability of nest success and nest flooding. The implementation of the 2000 Rule Curves significantly increased loon productivity on the Namakan Reservoir, despite dramatic increases in nest losses from predation and other factors since an earlier study in the 1980s. This increase occurred primarily as a result of the change in the timing of peak water levels in Namakan, which allowed more loons to renest after initial nest failures. We also examined loon reproductive success over a 30 year span in 103 lakes across northern Minnesota in relation to water level fluctuations during the 60-day nesting period. On average, a 100-cm rise in water levels during the nesting period reduced productivity by 50%, likely due to nest flooding, while a 100-cm drop reduced productivity by 20%, due to nest stranding. Model results also reinforced that implementation of the 2000 Rule Curves increased loon productivity on the Namakan Reservoir by 45%.

Brief Bio

Habitat use within a juvenile nursery hole by adult and juvenile lake sturgeon in the Namakan River

Jim Burchfield*, Cameron Trembath, Brian McLaren

Lakehead University, Faculty of Natural Resources Management, 955 Oliver Road, Thunder Bay, Ontario, P7B 5E1

Abstract

This study follows eight juvenile lake sturgeon and multiple adult lake sturgeon implanted with acoustic tags in a Vemco VPS array in Bill Lake, a 25 metre deep hole that is part of the main stem of the Namakan River, an unmanaged river system upstream of the Namakan Reservoir. Movements were tracked during throughout the 2010 year with some gaps during the mid-winter. Substrate data were collected using a low-cost side-imaging sonar system in 2014. The tagged juveniles appeared to vary in their behaviour slightly, but spent much of their time over harder substrates exhibiting behaviours consistent with foraging. Patch residence time was highest for juveniles during the summer months, with juveniles becoming more active and moving to shallower water during the period following iceup. Adult fish were observed incidentally, as they had been tagged as part of an earlier, longer term study. Nonetheless, one adult spent the majority of the study period in Bill Lake, and overwintered there. In contrast to the changes in activity observed in the juveniles, the adult spent much of the summer foraging on the shallower, softer substrates near the downstream end of the hole, and then moved to deep water and became relatively inactive during the winter months.

Brief Bio

Mr. Burchfield is a Ph.D. student in the Faculty of Natural Resources Management at Lakehead University. His project focuses on habitat use by lake sturgeon in the Namakan River/Reservoir system, a major tributary to the Rainy Lake watershed. The lake sturgeon within the Namakan River are a culturally valuable species at risk, which represent a shared stock between Ontario and Minnesota.

Conceptual flow and transport model for the Rainy Lakes watershed

Tom Myers

Hydrologic Consultant, Reno NV

Abstract

Diverse geology, land cover, and lakes affect how anthropogenic activities affect water quality throughout watershed draining to the Rainy Lake and Voyageurs National Park (VNP). Total flow averages 6.75 million acre-feet/year from 14,900 square miles. Flows are highest and most variable during early summer due to snowmelt and lowest during late winter when much of the watershed is frozen. Baseflow, primarily groundwater discharge, from the watershed as a proportion of total runoff varies from about 0.65 to 0.79 of an average 9.5 to 12.3 inches/year. Groundwater flows through two aquifers – a crystalline rock bedrock aquifer varying from granite to volcanics and a less than 100-foot thick glacial till or sand/gravel surficial aquifer – which generally have low storage capacity and allow for rapid interflow of infiltration. Glaciation has scoured most bedrock removing most fractures even in the upper portion of the bedrock. Extreme low flows can be a very small proportion of baseflow because the thin aquifers drain quickly.

Substantial sulfide-ore mineral deposits in the headwaters of the watersheds that drain toward VNP may be developed and become potential contaminant sources, affecting water quality throughout the watershed. Potential contaminants could be diluted by flow or removed in the lakes prior to reaching VNP. However, the watershed has very poor buffering capacity meaning that acid mine drainage (AMD) which reaches surface water draining to the park will make it to the park. AMD could increase the methylation of mercury and contribute to the existing mercury problems. Large spills could flow directly through to the park under the proper hydrologic conditions. Since 2000, the new operating rules have caused reservoir levels and flow rates to vary more naturally, a change that has generally been positive. However, a major contaminant influx that coincides with low flows could have a significant effect on ecosystems because it would be diluted much less. Updated operating rules should consider the effect that flow changes will have on the assimilation capacity of the lakes and flexibility in the rules to allow more releases to dilute significant contaminant loads.

Brief Bio

Tom Myers is a hydrologic consultant who researches and consults on water resources and hydrogeology issues including mining and energy development, groundwater modeling, contaminant transport, and water rights. His clients include conservation groups and local governments. Tom has been working mine dewatering and contamination issues since 1993. He has M.S. and Ph.D. in Hydrology/Hydrogeology from the University of Nevada, Reno.

Land cover classification of the Lake of the Woods / Rainy River basin for 1990 and 2010: integrating Landsat imagery with Lidar and object-based image analysis

Leif G. Olmanson* and Marvin E. Bauer

Department of Forest Resources and Remote Sensing and Geospatial Analysis Laboratory, University of Minnesota, St. Paul, Minnesota 55108

Abstract

With a perceived increase in the frequency and intensity of cyanobacterial algal blooms in Lake of the Woods (LOW), there has been an increased effort to collect information about the nature of algal blooms, nutrient concentrations and sources of nutrients to the LOW. As part of this effort, land cover maps and land cover change maps for the ~1990 and ~2010 time periods of the LOW/Rainy River Basin are being created for inputs to hydrologic models and analyses of land cover and land cover change.

The LOW/Rainy River Basin covers around 70,000 km^2 and requires four paths of Landsat imagery (26, 27, 28 and 29). The recent availability of lidar data throughout Minnesota which covers around 45 percent of the basin has opened up new opportunities for improved land cover classification and mapping. Although the lidar data will be the most beneficial for the Minnesota portion of the 2010 classification, accuracy for each time period and for the entire basin are expected to improve for some land cover classes due to better identification of training data in the Landsat imagery. To utilize information such as multispectral data and indices from Landsat imagery, lidar point cloud data and derived topographic indices we are utilizing object-based image analysis (OBIA) implemented in eCognition software with random forest classification. By using objects instead of pixels we are able to utilize Landsat multispectral and lidar derived data along with spatial and contextual information of objects such as shape, size and texture to distinguish different land cover types. While OBIA has become the standard procedure for classification of high resolution imagery we have found that it works equally well with 30-meter Landsat imagery.

To classify the land cover for the LOW/Rainy River Basin we used multitemporal Landsat imagery from spring and summer. Similar vegetation phenology of images available for paths 28 and 29 allowed for them to be classified together while phenology mismatches of available imagery for paths 26 and 27 required independent classification. DEMs were used to derive slope, compound topographic index (CTI) and dissection while the point cloud data were used to create biomass and vegetation height layers. We used eCognition to segment the imagery and extract the spectral and derived spatial and contextual information for each object. Decision tree classification using random forest enabled taking advantage of the unique differences in these data and determination of the most significant data features for distinguishing among cover types.

The presentation will describe the methods and current results of the ongoing land cover classification for the LOW/Rainy River Basin, including the features found to be most significant for image classification, accuracy of the classification with and without lidar, and comparison to previous Landsat pixel level classifications will be discussed.

Brief Bio

Poster Abstracts

Spread, control and effect of exotic cattails on wild rice in the Rainy Namakan

John Kabatay*[1], Peter Ferguson Lee[2] and O'Niell Tedrow[2]

[1]Seine River First Nation Environmental Program, Seine River First Nation, P.O. Box 124, Mine Centre, ON, P0W 1H0;
[2] Department of Biology, Lakehead University, Thunder Bay ON

Abstract

A recent concern in the Rainy-Namakan system has been the invasion of wild rice stands in Northwestern Ontario by the exotic perennial narrow leaf cattail (*Typha angustifolia* or the hybrid, *Typha glauca = T. latifolia x T. angustifolia).* The problem with this species (and the hybrid) is that unlike the native *T. latifolia.* it can tolerate depths normally occupied by wild rice. These exotic cattails are able to form dense monospecific stands and thus essentially extirpate a wild rice area. In 2012, field surveys conducted by the Seine River First Nation showed dramatic increases in exotic cattails with corresponding declines in wild rice acreages on its traditional harvesting areas on the Seine River and Rainy Lake. Preliminary analyses of air photos suggested that over 70 ha of cattails now occupied Rat River Bay on Rainy Lake. The literature suggests that cutting cattail culms during the growing season can kill the plants due to loss of photosynthetic production and transport of sugars to the rhizomes. Additionally it has been suggested that if the stems are cut below the surface, then transport of oxygen for respiration is interrupted during the winter. In the summer of 2013, a custom made underwater cutting-bar was attached to an airboat belonging to the Seine River First Nation. The cutting bar was able to be lowered into the water column as far as the sediment:water interface. Experimental plots of cattails were cut with the apparatus on Rat River Bay during the growing season. Observations during the fall showed that the cattail shoots had not reached the surface. A quantitative assessment of effects on both cattails and wild rice as well as further cutting strategies are planned for 2015,

Brief Bio

Mr. John Kabatay has been a councillor for Seine River First Nation for over 15 years and is project manager for wild rice studies associated with this project. Councillor Kabatay is in charge of all special environmental projects at SRFN and has been instrumental in completing the Seine River Environmental Contaminants Projects in 2011 -2013 and a variety of ongoing projects dealing with mine remediation and wild rice developments. He has particular expertise in organizing and co-ordinating large scale sampling projects using First Nation personnel.

Evaluating changes in growth and life history of northern pike (*Esox lucius*) in Rainy Lake, Ontario, Canada

Patrick J. Kennedy*[1] and Michael D. Rennie[2]

[1]Department of Biological Sciences, University of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2
[2]International Institute for Sustainable Development – ELA (IISD-ELA)

Abstract

Rainy Lake supports a commercial, subsistence, and popular recreational and consumptive trophy fishery for northern pike (*Esox lucius*). However, Rainy Lake has undergone a variety of stressors over the past century (changes in water regulation policies, exploitation, invasive species) that may impact the growth and life history of this economically important species. This study investigates changes in a number of life history characteristics (abundance, growth, size and age) of northern pike in Rainy Lake, and contrasts those characteristics with other northern pike populations in the region. A variety of aging structures were obtained from the Ontario Ministry of Natural Resources and Forestry to characterize the growth history of the fishery, and how changes in growth rates corresponded with stressors over time in this system. These data will be contrasted with information from the Experimental Lakes Area and provincial databases to provide context for the role of prey community structure on northern pike life histories. Subsamples of aging structures will be analyzed for stable isotopes to evaluate potential changes in the prey base for northern pike. An initial review of the literature and preliminary analysis reveals that recent Fall Walleye Index Netting (FWIN) catch rates are lower than the long-term mean for index netting (1965-97). Recent Ontario government reports have also shown that there have been a good representation of size and age classes for northern pike, suggesting a healthy and sustainable population. Our study aims to help further understand the driving mechanisms behind northern pike growth and recruitment, which will provide insight for discussions on management decisions for the species in the future.

Keywords: Northern pike, life history characteristics, aging structures, stable isotopes, recruitment

Brief Bio

Patrick Kennedy is a graduate student at the University of Manitoba investigating variation in fish growth associated ecosystem stress. He has been working in aquatic ecology for two years as both an undergraduate research assistant at Illinois State University and an aquatic field technician at the Illinois River Biological Station.

Lake Winnipeg Basin Initiative – Phase II update

L. Rutherford*, A. Friesen, I. Griffin, M. Duval, D. Hay.

Environment Canada, Lake Winnipeg Basin Office, 123 Main Street, Suite 150, Winnipeg, MB R3C 4W2

Abstract

The Lake Winnipeg watershed covers over one million square kilometers, encompassing parts of two countries, four provinces and four states. Lake Winnipeg has the largest land drainage to surface area ratio (40:1 sq kms) of any of the great lakes of the world, increasing the potential of pollutant loading from human activities in the watershed.

The water quality in Lake Winnipeg has been deteriorating for several years putting the health of the lake at serious risk. The chief concern is an increasing amount of nutrients, primarily phosphorus and nitrogen, from multiple sources. More than 50% of the nutrient loading to Lake Winnipeg originates from beyond Manitoba's borders; the Red River is the largest source, followed by the Winnipeg River system.

In August 2012, the Lake Winnipeg Basin Initiative (LWBI) Phase II was launched by the Government of Canada with a 5-year (2012-2017), $18 million investment. LWBI Phase II focusses on engaging citizens, scientists and domestic and international partners in actions to restore the ecological health of Lake Winnipeg and reduce domestic and transboundary nutrient pollution. This poster provides an update of Environment Canada science, stewardship and transboundary partnership activities in the first two years of LWBI Phase II.

Brief Bio

Can the common loon be used to evaluate water levels rule curves?

Marianne Bachand*, Sylvain Martin, Julien Hénault-Richard, Olivier Champoux, Patrice Fortin, Jean Morin

Hydrology and Ecohydraulic Section, Meteorological Service of Canada, Environment Canada, 801 - 1550, avenue d'Estimauville, Québec (Québec), Canada, G1J 0C3

Abstract

Rainy Lake (RL) and Namakan Reservoir (NR) are large water bodies sitting between Ontario and Minnesota. The International Joint Commission manages the transboundary waters and has guided water level variations (WLV) of the lakes with rule curves (RC) implemented in 1970 and 2000. We developed a simple model for the common loon nesting success in relation with water level changes only, which is used to evaluate the impact of RCs on the species reproduction. The model produces a performance indicator (PI) based on the probability that loons face suitable habitat conditions for nesting according to WLV. Loons build their nests near the shoreline and tolerate (PI=1) limited WLV (±0.15m). A WLV over 0.40m during the nesting period results in eggs mortality while a significant WL decrease (≥0.80m) forces loons to abandon their nest (PI=0). PIs of loons facing intermediate WLV were calculated with linear interpolations. From 1950 to 2013, the mean loon nesting PIs would have increased two fold under the 1970RC in RL compared to PIs calculated under simulated "natural conditions". In NR the mean PI would have been similar under the 1970RC or the "natural conditions". The 2000RC would have doubled PIs in NR while mean PIs in RL remained stable. As such, RCs improved loon nesting habitat conditions in both lakes compared to "natural conditions". Although RCs promoted favourable conditions for loons, water level regulations are impacting other species in these lakes. For example, more habitat models are needed to thoroughly evaluate the impacts of the RCs on northern pikes, muskrats and wild rice.

Brief Bio

Marianne Bachand is currently working as a postdoc in ecosystem modeling at Environment Canada. She holds a Bachelor degree in Biology from the Université de Sherbrooke (2001-2004) where she also completed a Master's degree in Environment in 2008. During her master she evaluated the impacts of tapir on vegetation dynamic in the Brazilian Atlantic forest. She later obtained a Ph.D. in plants biology at Université Laval. In her thesis she investigated the effects of white-tailed deer on the diversity of balsam fir stands on Anticosti Island. She has also contributed to research projects on the energy invested in flight by turkey vultures in Costa Rica, on genetic resistance to pests of goat Creole in Guadeloupe and characterizing pollinators of a *Heliconia* species in Brazil.

2D modeling of the impacts of water level regulation on vegetation: the cases of wild rice and cattail

Marianne Bachand*, Sylvain Martin, Julien Hénault-Richard, Olivier Champoux, Patrice Fortin, Jean Morin

Hydrology and Ecohydraulic Section, Meteorological Service of Canada, Environment Canada, 801 - 1550, avenue d'Estimauville, Québec (Québec), Canada, G1J 0C3

Abstract

Water levels of Rainy and Namakan Lakes have been regulated using different rule curves (RC) since 1949. The International Joint Commission (IJC) is the binational entity responsible for the transboundary waters. The IJC has guided the water level variations of the lakes with RC implemented in 1970 and 2000. The RC used to regulate the system will be reviewed in 2015.

To quantify the effects of past, present and future water level regulation on the ecosystem; we developed what we call an integrated ecosystem response model in 2 Dimensions (IERM2D), a modelling system that uses a common grid, physical variables to support a large number of interrelated habitat models. Bidimensional habitat models have been developed for a number of taxa and habitat type: submerged plants, swamps with emergent vegetation, hybrid-cattail, wild rice, as well as for pike and walleye spawning and nursery habitat. These models allow quantifying the performance of the different habitat models based on simulated water level series representing expected water level according to different regulation rules (1970RC, 2000RC and natural) and the measured (observations) water level series since 1950. Here, we are presenting results obtained from cattail and wild rice habitat models.

The IERM2D is constructed from a regular computational grid of the Rainy-Namakan system was constructed with nodes every 20 m for a total of 1 624 886 nodes. A seamless Digital Elevation Model (DEM) fitting the grid was built using several types of data and sources (ex: LIDAR, Shoals, bathymetric soundings, etc.). We built a physical variables database that comprises various physical variables at every node for every quarter-month (ex: water depth, slope, number of dry-wet cycle, etc).

Results show that the 2000RC produces more suitable habitats than the 1970RC but several problems persist, especially for wild rice habitat. Some modulations of the RC can be proposed to maintain more "diverse" wetlands and promote wild rice competitive potential against the hybrid cattails invasion. Hybrid cattails have been favoured by the diminution of interannual water level variation resulting from regulated water levels. Results from some of these vegetation models are now used as input variables for other biological models developed in the Rainy-Namakan system, such northern pike spawning and nursery habitat. These physical and biotical models enable a quantitative assessment of the effects of water level management on ecosystem components. This will help improving the RC for 2017 and allow us to propose restoration methods for the different ecosystem components.

Brief Bio

Marianne Bachand is currently working as a postdoc in ecosystem modeling at Environment Canada. She holds a Bachelor degree in Biology from the Université de Sherbrooke (2001-2004) where she also completed a Master's degree in Environment in 2008. During her master she evaluated the impacts of tapir on vegetation dynamic in the Brazilian Atlantic forest. She later obtained a Ph.D. in plants biology at Université Laval. In her thesis she investigated the effects of white-tailed deer on the diversity of balsam fir stands on Anticosti Island. She has also contributed to research projects on the energy invested in flight by turkey vultures in Costa Rica, on genetic resistance to pests of goat Creole in Guadeloupe and characterizing pollinators of a *Heliconia* species in Brazil.

Civic Engagement in the north: reaching out to the public in the Big Fork and Little Fork River watersheds

Jolén Simon*[1] and Mike Kennedy[2]

[1]Koochiching SWCD, 715 4th Street, International Falls, MN 56649
[2]MPCA, NE Regional Office, 525 Lake Ave. S., STE 400, Duluth, MN 55802

Abstract

In 2013, the Koochiching SWCD received a grant from the Minnesota Pollution Control Agency to execute civic engagement in both the Big Fork and Little Fork River Watersheds as part of the MPCA's Watershed Restoration and Protection Strategy (WRAPS). The purpose of this project is for Koochiching SWCD to participate, lead, and coordinate the planning of restoration projects and to develop an effective civic engagement plan for those interested and/or concerned about the environmental conditions found in the Little and Big Fork River Watersheds.

As this 2-year grant comes to an end, the results show an increase in awareness and participation throughout the Rainy-Lake of the Woods Basin between agencies and the public. It has also strengthened many partnerships between Koochiching SWCD and organizations such as the Lake of the Woods SWCD, Lake of the Woods Sustainability Foundation, Itasca SWCD, North St. Louis SWCD, local lake associations, businesses, and units of government. This work will build a foundation for implementing projects on the ground in each watershed over the next 5 years.

Brief Bio

Koochiching Soil & Water Conservation District (SWCD) is a local agency that provides access to natural resource management and conservation services. In cooperation with local, state, and federal agencies, the SWCD provides technical, financial, and educational assistance to address natural resource concerns for all taxpayers and land users within the borders of Koochiching County. The District strives to conserve and protect the soil and water resources by assisting land users in being good stewards of the land and its natural resources.

Enhancing binational citizen-based water quality monitoring in the Rainy – Lake of the Woods watershed - a summary of available data and future directions

Anna M. DeSellas[1], Shannon Martin[2], Laurie Sovell[2], Christie Davies[1] and Kelli Saunders*[3]

[1] Ontario Ministry of the Environment and Climate Change, Dorset Environmental Science Centre, 1026 Bellwood Acres Rd., Dorset, Ontario P0A 1E0, (705) 766-2150, anna.desellas@ontario.ca.
[2] Minnesota Pollution Control Agency, 520 Lafayette Rd., Saint Paul, Minnesota 55155, (651) 757-2874, shannon.martin@state.mn.us (Shannon Martin); (651) 757-2750, laurie.sovell@state.mn.us (Laurie Sovell).
[3] Lake of the Woods Water Sustainability Foundation, Box 112, Kenora, Ontario P9N 3X1, (807) 548-8002, ksaunders@lowwsf.com.

Abstract

There are three volunteer-based, water quality monitoring programs in the Rainy – Lake of the Woods Watershed: The Ontario Ministry of the Environment and Climate Change (MOECC)'s Lake Partner Program (LPP), the Minnesota Pollution Control Agency (MPCA)'s Citizen Lake Monitoring Program (CLMP), and the MPCA's Citizen Stream Monitoring Program (CSMP). The LPP was established in 1996 in partnership with the Federation of Ontario Cottagers' Associations, and engages citizens to gather long-term water quality data (clarity and total phosphorus) on hundreds of Ontario lakes each year, as well as fosters stewardship and promotes awareness of water quality matters within Ontario's cottaging communities. The MPCA's CLMP and CSMP were established in 1973 and 1998, respectively. Through the CLMP and CSMP, volunteers measure the clarity of lakes and streams, collecting valuable data that are routinely used by the MPCA for statistical time trend analyses and water quality assessments. We summarize the watershed-wide, citizen-collected water quality data from these three programs, and examine gaps in current monitoring as a potential starting point for program expansion. This summary sets the stage for agency discussions to expand citizen science and enhance the collection of long-term water quality data in the entire watershed.

Brief Bio

Developing capacity for source water protection planning in remote northern communities

Leslie Collins

Institute for Watershed Science, Trent University, Peterborough, ON

Abstract

Delivery of safe, potable water to remote northern communities is challenging, with limited resources for infrastructure and training, and technological challenges caused by climate extremes. Protection of drinking water sources is a cost efficient mechanism to reduce the requirements for costly treatment options. However there is limited capacity within remote northern communities to develop and implement Source Water Protection (SWP) plans. Through support to The Institute for Watershed Science (IWS) at Trent University from a 5 year RBC Blue Water Project Grant in 2009 the IWS developed training materials for SWP in remote communities in the Northwest Territories and the Yukon. Many of the issues experienced in these regions are also applicable to other remote communities throughout Canada. This training emphasizes community based SWP planning as a tool for providing safe drinking water. This presentation outlines our approach to providing SWP training for remote communities.

Brief Bio

Leslie holds a Bachelor of Science (Specialist in Biology) and Master of Science Degree in Zoology from the University of Toronto. She has worked at the Institute for Watershed Science at Trent University for 14 years as a biologist and training coordinator. As well as coordinating and teaching for professional training courses and workshops, Leslie has worked on Institute projects that assessed the development of ecological indicators for biological integrity related to riverine flow regimes in regulated river systems and the science knowledge gaps for source water protection in Ontario. Over the last 5 years Leslie has been involved with colleagues on a project to develop and deliver educational training materials for source water protection in Yukon and the Northwest Territories. She has also been involved with projects on lagoon systems and wastewater treatment plants to study the effectiveness of these systems for the breakdown of conventional contaminants and contaminants of emerging concern.

Removal of contaminants of emerging concern in sewage lagoons

Craig Murray

Institute for Watershed Science, Trent University, Peterborough, ON

Abstract

Many contaminants of emerging concern, including pharmaceuticals and personal care products (PPCPs) and endocrine disrupting chemicals enter the environment through discharges from wastewater treatment plants (WWTPs). In small municipalities, sewage lagoons are often the only systems used to treat wastewater. We are evaluating whether sewage lagoon serving small municipalities in Ontario are effective at removing these contaminants. The sewage lagoon serving the village of Lakefield in Ontario was monitored to determine removals of selected PPCPs and a natural estrogen (i.e. estrone) by deploying passive samplers at three points in the lagoon. The highest concentration of a pharmaceutical was for ibuprofen in untreated wastewater during the fall monitoring period (i.e. 60 ng/L). Similarly, concentrations of three personal care products (triclosan, HHCB and AHTN) were highest during fall season, at 30, 1677 and 109 ng/L, respectively. Removals were generally highest in the summer (i.e. >70%) relative to removals in the fall and winter. The concentrations of gemfibrozil increased in the wastewater as it passed through the sewage lagoon, which was attributed to de-conjugation of metabolites, and carbamazepine was persistent in the lagoon. This small sewage lagoon was as effective at removing PPCPs as many conventional WWTPs. Work is continuing the monitor removals of these contaminants in the Lakefield lagoon and in two other sewage lagoons operating in small Ontario municipalities.

Brief Bio

Craig holds a Bachelors of Applied Arts in Applied Geography from Ryerson University, a Master of Science in hydrology from The Watershed Ecosystems Graduate Program at Trent University. Craig is a Hydrologist at The Institute for Watershed Science and has over 13 years of experience conducting hydrological research. He has managed and conducted research projects on the impacts of forest harvesting on water resources related to the hydrologic impacts of forest clear cut harvesting on groundwater resources in Northern Ontario and has co-authored a report for the Canadian Forest Service reviewing the key research issues related to the forest-water interface and our current state of knowledge to address these issues. Other projects include examining the strategic research needs related to source water protection regarding agricultural tile drainage, non-point source pollution, and urbanization. More recently Craig has conducted research in association with Fleming College on hydrologic modelling studying the effectiveness of natural wetlands for treating sewage in Canada's far north. Craig has worked for the last 5 years developing and delivering educational materials for communities in the Yukon and Northwest Territories on the protection of drinking water resources. Craig is currently involved in research on wastewater treatment in lagoon systems and wastewater treatment plants and on the fate of contaminants of emerging concern in wastewater effluent.

Scenario Application Manager (SAM): an implementation decision support tool

Julie A. Blackburn

RESPEC Water & Natural Resources, 1935 West County Road B2, Suite 320, Roseville, MN 55113

Abstract

A major challenge facing watershed decision makers is selecting the best combination of water quality management practices to implement that optimize cost-effective, achievable, and practical management strategies. The Scenario Application Manager (SAM) is a watershedscale, decision-support tool originally developed for the Central Big Sioux River Watershed in South Dakota, and then piloted in the Yellow Medicine Watershed on behalf of the Minnesota Pollution Control Agency (MPCA). The decision-support framework of SAM consists of a Geographic Information System (GIS) for site selection, an Hydrologic Simulation Program – Fortran (HSPF) model application to simulate nutrient fate and transport, and a Best Management Practice (BMP) database. The BMP database was developed by assigning costs and reduction efficiencies to common, locally applied practices based on literature research. SAM will assist in developing custom implementation plans by combining individual and/or suites of BMPs and simulating the expected reductions to the appropriate source loads represented in the HSPF model. SAM also includes a cost-effectiveness component for which cost effectiveness is calculated by using the total costs and reductions achieved from the application of the implementation plan. The combination of the graphical interface, a stateaccepted watershed model, practical BMPs, and cost optimization bridges a gap between watershed characterization by water resource engineers and the water resource managers who ultimately develop implementation and nutrient reduction plans. This tool could be adapted for the Rainy River/Lake of the Woods Watershed to facilitate the development of protection plans as well as prioritization and placement of BMPs to achieve nutrient or sediment reductions

Brief Bio

Ms. Blackburn has worked extensively with soil and water conservation districts, watershed districts, and state and federal conservation agencies in the fields of watershed management, drainage management, Total Maximum Daily Load (TMDL) implementation, and resource conservation planning. She has also provided leadership to watershed districts by overseeing all facets of comprehensive watershed management including surface water monitoring and analysis, TMDL studies and implementation plans, stormwater management, public drainage systems, rule development and permitting programs, conservation practice planning and implementation, strategic planning, communications, outreach, and public relations.

Regulation of 2014 high inflows to Namakan Chain of Lakes, Rainy Lake and Lake of the Woods

James Bomhof*[1] and Gail Faveri[2]

[1]Lake of the Woods Secretariat, 373 Sussex Road, Block E, Ottawa ON K1A 0H3
[2]Environment Canada, 867 Lakeshore Road, P.O. Box 5050, Burlington ON L7R 4A6

Abstract

The nested watersheds of the Namakan Chain of Lakes, Rainy Lake and Lake of the Woods span multiple jurisdictions and various boards play a role in the watershed's regulation. The outlet structures of Namakan and Rainy Lake are operated to keep lake levels between time-dependent pre-determined elevations stipulated by the International Joint Commission (IJC) via the International Rainy - Lake of the Woods Watershed Board (IR-LWWB), and are commonly referred to as the IJC Rule Curves. The outlet structure of LOW is operated at the direction of the Lake of the Woods Control Board (LWCB) during normal conditions and whose decisions are subject to approval by the International Lake of the Woods Control Board (ILWCB) during extreme conditions (high or low). These three boards were all involved in regulation decisions during the 2014 high water events.

At the end of the winter of 2014, the snow water equivalent was high across the whole watershed and cold temperatures persisted late into the spring season. Expecting high inflows, the IR-LWWB instructed dam operators on the Namakan Chain of Lakes and Rainy Lake to target the lower portion of the IJC Rule Curves. The LWCB also drew down the Lake of the Woods to below normal lake levels. The spring freshet was largely complete by the end of May and lake levels across the basin were in the normal range. However, despite the forecast of a dry spring, June rainfall was unusually high in the watershed, breaking many historical records and resulting in the inevitable flooding. Water levels were the highest since 1968 on the Namakan Chain of Lakes, and since 1950 on Rainy Lake and Lake of the Woods. Analyses have shown that following the 1970 or the 2000 rule curves result in practically the same final lake levels because the outflow capacity is reduced at lower lake levels. Water levels rise faster but reach practically the same peak level. This presentation or poster will show the statistics of the hydrological conditions not only in the Lake of the Woods watershed but also in the English River system to the northeast and downstream on the Winnipeg River. No one wanted the inflows of water that came in 2014, yet they will come again, if not higher!

During years of extreme hydrology, such as 2014, physical limitations of the outlet structures, along with the need to balance both upstream and downstream impacts, limit the extent to which regulation boards and their regulation decisions can control water levels. Despite the major role of wet conditions in the high water events of 2014, regulation boards did play an active role in minimizing impacts of high water to users within the basin. The engineering advisors and support teams notified officials of likely future water levels and when conditions would return to normal. A WATFLOOD hydrological model was critical in determining the impacts of forecast rainfall on the inflows to the various lakes in the basin and what effect the inflows would have on water levels. The watershed board spokespeople disseminated information over the radio and through the internet to reach the maximum amount of people possible, warning of higher water levels when required. These actions aided in minimizing the impact of the inevitable high water to users in the basin.

Brief Bio

James Bomhof is a water resources analyst with the Lake of the Woods Control Board Secretariat. He holds a Masters of Applied Science in Civil Engineering from the University of Ottawa, where he researched the characterization of ungauged river locations in Canada.

Development of a simple model for estimating acid neutralizing capacity in northern USA seepage lakes

Nancy Serediak*[1], Randall K Kolka[2], Gordon Putz[3]

[1]Streamline Consulting, Thunder Bay, ON; [2]USDA Forest Service, Northern Research Station; [3]Professor Emeritus of Civil and Environmental Engineering, University of Saskatchewan

Abstract

Quantifying acid neutralizing capacity (ANC) in freshwater lakes aids in management decisions regarding critical loading limits for the most sensitive systems, *i.e.*, poorly buffered seepage lakes. The challenge of predicting ANC in what are often very small lakes stems from a lack of data required to calibrate dynamic mass balance models. Integration of data from multiple monitoring sources can improve modelling efforts in predicting ANC in data sparse areas. Available in-lake data from seepage lakes in the northeastern USA (Minnesota and Wisconsin), in combination with public domain monitoring data, were used to develop pattern matches to in-lake ANC based on area weighted charge balances. Charge balance combinations that incorporated 1) a variable *vs* fixed water year, and 2) acid pulses from saturated soils following dry periods fit empirical data best. All trajectory matches were evaluated using maximum likelihood methods; the charge balance combinations that best fit available data were then used as x-values in simple linear regression. Likelihood results from the linear regression model that made the most ecological sense had an R^2adj =0.49 between observed *vs* expected values, with slope =1. Our results suggest that northern seepage lakes that rely on internal ANC production for buffering are vulnerable to acidification not only from direct deposition, but also from watershed runoff inputs when 1) wetlands are present in the watershed, and 2) dry periods during the ice-free season are followed by precipitation sufficient to generate flow.

Brief Bio

Nancy has recently returned to self-employment with Streamline Consulting, following time served in grad school. As of May 2014, she is no longer eligible for the free student registration and couldn't be happier with paying full price.

Suggestions, thoughts and worries in the watershed

Gerald Caple

387 Gunflint Narrows, Grand Marais, MN 55604

Abstract

Some of the parameters that effect the LoW-Rainy Lake watershed will be discussed as they relate to the modification of the equation: "*Pollutant Load=water volume x pollutant concentration"(Freshwater Society and MPCA).* Trees and their shade will be discussed in terms of their thermal effects and watershed properties. Cabins, roads and other deforested roads areas also affect the thermal conditions of the watershed when taken collectively. Other discussion items will include nutrient sources and methods for reducing nutrient loadings. Ideas on new studies that could lead to a suite of methods for reducing internal nutrient loads in watershed lakes. Other suggestions will be made, with the emphasis on implementation. "*Implementation has too often been delayed while perfect data are sought, but immediate action can be very effective". (Science, Vol 346 Issue 6208, pg 421, 2014).*

Brief Bio

High School, Int'l Falls, Mn, BA St. Olaf College, PhD Florida State University(Organic chemistry). Oregon State University, Northern Arizona University, Pittsburg State University (Department Chair), University of South Dakota (after retirement, 4 yrs as a temporary faculty member. Final rank attained University Professor of Chemistry (PSU). Much of my research has centered around environmental problems. I synthesized new compounds to prevent water evaporation from surfaces. This then lead to studies of the water ice interface as ice nucleation and its role in atmospheric processes. This in turn led to ice nucleating bacteria and the synthesis of polymers that prevented bacterial growth. I have worked with conducting polymers as sensors of biomolecules. While at Pittsburg State I worked with the EPA on an excess chlorinated hydrocarbon problem in drinking water.

I have also worked with biologists to develop integrated undergraduate laboratory work, with many of the experiments having environmental implications. Upon retirement I began monitoring and focusing on lakes and lake problems. My last paper (2013), on which I am a co-author, is on sensitive trace copper ion detection.

Precipitation and payrolls: examining municipal water treatment and fish hatchery data and determining how they have been impacted by the 2000 Rule Curves

Ryan Haines

Kenora Resource Consultants Inc., Site 155 Comp 14 RR#1, Kenora, ON P9N 3W7

Abstract

During the winter of 2014/15, Kenora Resource Consultants Inc. received the contract for a study to assess whether municipal water treatment and fish hatchery operations on Rainy River have been affected by the 2000 Rule Curves for Rainy Lake and Namakan Reservoir. Interviews with operators and preliminary data analyses indicate that increased payroll costs are the largest impact to the municipal water treatment plants associated with turbidity levels. The increased payroll is due to the necessity of manually adjusting the chemicals required as turbidity levels fluctuate. Ongoing data analyses focuses on the potential causes of the rapid changes in turbidity, with exploration of the potential diluting effect of higher flows from Rainy Lake when mixed with the more turbid waters from the other inflows to Rainy River. The role that the 2000 Rule Curves may be playing in this relationship will then be examined.

Brief Bio

Ryan Haines is a biologist and project manager with Kenora Resource Consultants Inc. Ryan has been involved in natural resource and environmental projects in northwestern Ontario and Manitoba for the past fourteen years.

Evaluating and monitoring impacts of lake level changes on archeological sites within Voyageurs National Park

Andrew LaBounty*, Timothy Schilling, Mary Graves, Ashley Barnett

Voyageurs National Park

Abstract

In 2013, the IJC commissioned the National Park Service to study how lake level changes may affect archeological sites in the Namakan and Rainy Reservoirs within Voyageurs National Park (VNP). Staff from VNP and the Midwest Archeological Center undertook this investigation. Their study involved two components: modeling the response of different landforms to lake level patterns and ground truthing the model. Based on their models, they identify *mean residence time* as the critical variable between lake level management practices. Mean residence time is a measure of potential erosion between different rule curves that describes which curve would have the least negative consequences for archeological sites within the park. A spatial analysis of archeological site locations is also used to identify which archeological sites may be affected by different management practices.

Brief Bio

Andrew LaBounty is an archeologist at Voyageurs National Park and co-author on the cultural resources component of the IJC study on the Namakan and Rainy Reservoirs. He holds degrees in archeology and geography (GIS), and has worked in the National Park Service for seven years.