March 8-9, 2006
Rainy River Community College
International Falls, Minnesota, USA

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Sponsored by

Lake of the Woods District Property Owners Association

Minnesota Pollution Control Agency

North American Lake Management Society

Ontario Ministry of the Environment

Rainy River Community College (RRCC)

Rainy River Basin Water Resources Center

Lake of the Woods Water Sustainability Foundation

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Dorset Environmental Science Centre	Dorset	ON	Canada
Environment Canada	Burlington	ON	Canada
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Experimental Lakes Area, Fisheries & Oceans Canada	Winnipeg	MB	Canada
Faculty of Forestry & Forest Environ.	Thunder Bay	ON	Canada
Falls High School	International Falls	MN	US
International Joint Commission	Ottawa	ON	Canada
Koochiching County Soil and Water Conservation District	International Falls	MN	US
Lake of the Woods Control Board	Gatineau	QC	Canada
Lake of the Woods District Property Owners Association	Clearwater Bay	ON	Canada
Lake of the Woods Soils and Water Conservation District	Baudette	MN	US
Lake of the Woods SWCD	Baudette	MN	
Lake of the Woods Water Sustainability Foundation	Kenora	ON	Canada
LoW District Property Owners Assoc.	Kenora	ON	Canada
Ministry of the Environment	Kenora	ON	Canada
Minnesota Department of Natural Resources - Waters	Bemidji	MN	US
Minnesota Pollution Control Agency	Duluth	MN	US
Minnesota Pollution Control Agency	St. Paul	MN	US
Natural Resources Research Institute, U of MN - Duluth	Ely	MN	US
Ontario Ministry of Natural Resources	Kenora	ON	Canada
Ontario Ministry of the Environment	Thunder Bay	ON	Canada
Paleoecological Environmental Assessment & Research Lab.	Kingston	ON	Canada
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Rainy Lake Conservancy	New Brighton	MN	US
Rainy River Community College	International Falls	MN	US
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Science Museum of Minnesota - St. Croix W'shed Research Stn	Marine on St. Croix	MN	US
Superior National Forest	Aurora	MN	US
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United States Geological Survey	Mounds View	MN	US
United States Geological Survey	International Falls	MN	US
University of Manitoba - Department of Zoology	Winnipeg	MB	Canada
University of Minnesota	St. Paul	MN	US
USDA Forest Service - Northern Research Station	Grand Rapids	MN	US
Voyageurs National Park	International Falls	MN	US

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2006 Forum Overview

The third, annual, Lake of the Woods water quality forum was held at the Rainy River Community College on March 8-9 2006. The forum was well attended by over 90 scientists, researchers, academics, educators, and other resource stakeholders who participated to present information or to hear about recent research findings that are relevant to Lake of the Woods and its watershed. The forum hosted 16 presentations and 7 posters covering a diverse range of topics from water quality to historical research in the watershed.

In these proceedings we present a set of technical or expanded abstracts that summarize the findings of each presenter. Full presentations are available online at: http://rainybasinwater.org

At the end of the first day, two keynote speakers addressed emerging issues. To address this topic the organizing committee selected two speakers; one to present a science topic and the other to provide more political insight. The science topic was presented by Dr. Mark Seeley who gave an interesting view into the empirical aspects of climate change. Gord Miller, the Environmental Commissioner of Ontario, presented a political view towards the environmental challenges that we will face in coming years and how these will impact our legacy in the Lake of the Woods area.

On the second day, three separate workshops and one technical session were held to discuss issues and provide a platform for technical transfer between workshop participants. The outcomes of these workshops are presented here in the section following the technical abstracts.

The Lake of the Woods Water Quality Forum has been instrumental in moving critical science forward as it pertains to the Lake of the Woods and its watershed. Opportunities to share scientific findings specific to an internationally shared resource are often tactically difficult to develop. However, a unique willingness to share information and donate effort to this forum by a number of skilled and insightful people has guaranteed success for this and future forums. Many thanks to all who participated.

Water Quality Forum Schedule of Events

March 8, 2006

Introduction - Dr. Wayne Merrell, Provost, Rainy River Community College

Presentations

1. Sellers
2. Saunders
3. Kallemeyn
4. Wickman
5. Anderson
6. Maki
7. Reavie
8. Hirst
9. Mosindy & Bev Clark
10. Prepas
11. Kotak
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13. Macdonald
14. Hann

Emerging Issues Keynote addresses

Climate trends in Minnesota: Some implications – Dr. Mark Seeley, University of Minnesota, Dept of Soil, Water, and Climate

Leaving Our Legacy: Water Quality Challenges in the 21st Century – Gord Miller, Environmental Commissioner of Ontario

Lake of the Woods Water Sustainability Foundation Reception

Keynote Speaker: Allen Olson, International Joint Commission, US Section Commissioner

March 9, 2006

Water Quality Forum Workshops

Working Groups:

1. Nutrients/Algae
2. Volunteer Coordination
3. Equipment Calibration
4. Mercury

1. LAKE OF THE WOODS WATER SUSTAINABILITY FOUNDATION – UPDATE AND FUTURE DIRECTION

***Todd Sellers**, Executive Director, Lake of the Woods Water Sustainability Foundation*

The Lake of the Woods Water Sustainability Foundation (LOWWSF) is a charity dedicated to the understanding, enhancement, and protection of the health and sustainability of the water quality of the Lake of the Woods basin. This presentation provides an update on the activities and achievements of the LOWWSF, since its initial launch at the 2005 water quality forum. The objectives of the Foundation are to develop a water quality sustainability plan for the Lake of the Woods and to encourage and provide financial support for water quality research.

During the past year, the LOWWSF has been incorporated and registered as charitable organization in Canada. USA registration is being explored. A board of directors and stakeholder steering committee has been established, representing a broad base of community stakeholders in Canada and the USA. The Foundation has been active in raising stakeholder awareness and support for its objectives with community stakeholders around the basin in Canada and the USA, municipalities & townships, scientists, government agencies, politicians, and the International Joint Commission. Support is emerging for the development of a basin sustainability plan amongst community stakeholders, resource management agencies, and politicians.

The LOWWSF has begun initial fundraising and has hired a full time Executive Director to coordinate the activities of the Foundation. Key priorities for 2006 include: identification of research needs for funding, contribution to a *State of the Basin* report, and continuing to work towards the development of the water sustainability plan for the Lake of the Woods.

2. DOCKTALK: HELPING SHORELINE PROPERTY OWNERS TO BECOME ENVIRONMENTAL STEWARDS

Kelli Saunders, *Environmental Program Coordinator,*
Lake of the Woods District Property Owners' Association

During the summer of 2005, Lake of the Woods District Property Owners' Association (LOWDPOA) was one of five cottage/lake associations in Ontario chosen to deliver an innovative new lake stewardship program, sponsored by the Federation of Ontario Cottagers' Association (FOCA) and funded through the Ontario Trillium Foundation. Through this program, one-on-one site visits were paid to interested property owners to discuss environmental stewardship opportunities and to help them understand the potential impact they may have on their lake. The primary topics addressed during these visits were shoreline naturalization, septic system maintenance, household and landscaping practices to encourage pollution prevention, enhancement of wildlife habitat and reducing threats from invasive species. Over the course of the summer, 100 property owners were visited in areas that included Sioux Narrows, Minaki, Clearwater Bay, Kenora and many areas in between. In addition, six community events/workshops were held throughout the region at which resource management experts in the community and our Docktalk staff spoke to participants about these topics.

The resulting data from surveys conducted at each visit have proven to be very interesting and, while many of the participants were not LOWDPOA members, there appeared to be a considerable amount of concern for the environment and a keen interest in understanding how to lessen the impact a cottager/landowner can have on the health of the water around us.

The presentation will provide information on the program itself, its goals and the results from the 2005 surveys. As was proven this past summer, Docktalk was an excellent opportunity for participants to discuss issues of concern on their property or on their lake in general. In addition, valuable literature on many topics relevant to our area was made available through partnerships the LOWDPOA formed with local resource agencies and businesses. Based on this success, LOWDPOA, with the continued support of FOCA, plans to offer the Docktalk program once again in the summer of 2006.

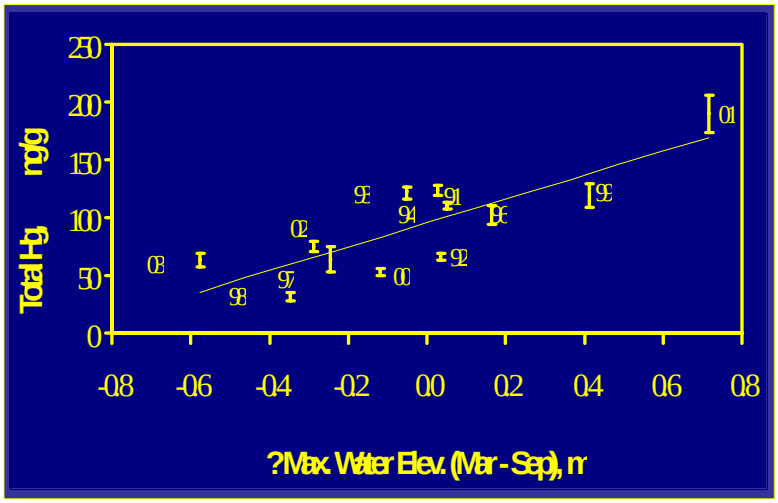
3. RELATIONSHIP BETWEEN MERCURY ACCUMULATION IN YOUNG-OF-THE-YEAR YELLOW PERCH AND WATER-LEVEL FLUCTUATIONS

John A. Sorensen, **Larry W. Kallemeyn**#, and Michael Sydor**

**Environmental Physics Laboratory, University of Minnesota-Duluth, 10 University Drive, Duluth, MN 55812 (Jsorense@D.umn.edu)*
 # USGS-Columbia Environmental Research Laboratory-International Falls Biological Station, 3131 Highway 53, International Falls, MN 56649
(Larry_Kallemeyn@usgs.gov)

A three-year (2001-2003) monitoring effort of 14 northeastern Minnesota lakes was conducted to document relationships between water-level fluctuations and mercury bioaccumulation in young-of-the-year (YOY) yellow perch (*Perca flavescens*) collected in the fall of each at fixed locations. Six of those lakes are located within or adjacent to Voyageurs National Park and are influenced by dams on the outlets of Rainy and Namakan lakes. One site on Sand Point Lake coincides with a location that has nine years of previous monitoring suitable for addressing the same issue over a longer time frame. Mean mercury concentrations in YOY yellow perch at each sampling location varied significantly from year to year. For the 12-year monitoring site on Sand Point Lake, values ranged from 38 ng gww^{-1} in 1998 to 200 ng gww^{-1} in 2001. For the 14 lake-study, annual mean concentrations ranged by nearly a factor of 2, on average, for each lake over the three years of record. One likely factor responsible for these wide variations is that annual water-level fluctuations are strongly correlated with mercury levels in YOY yellow perch for both data sets.

Relationship between total mercury concentrations in YOY yellow perch from Sand Point Lake and the change in the maximum water elevation relative to the previous year for the March to September period, 1991-2003. Bars represent standard errors.

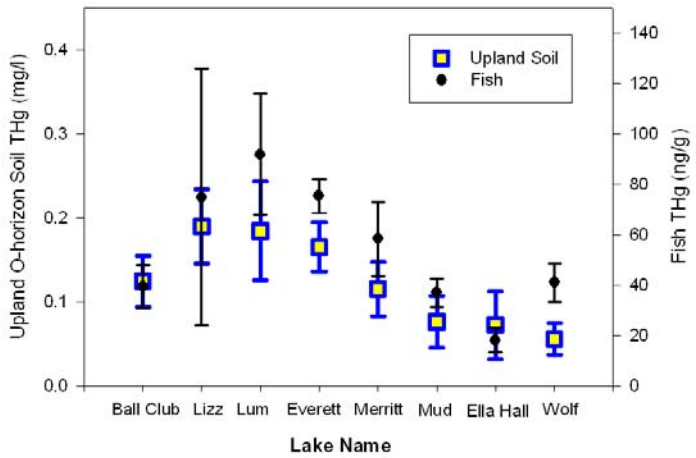


4. INFLUENCE OF PRESCRIBED FOREST FIRE ON THE RE-MOBILIZATION OF MERCURY IN THE BOUNDARY WATERS CANOE AREA WILDERNESS

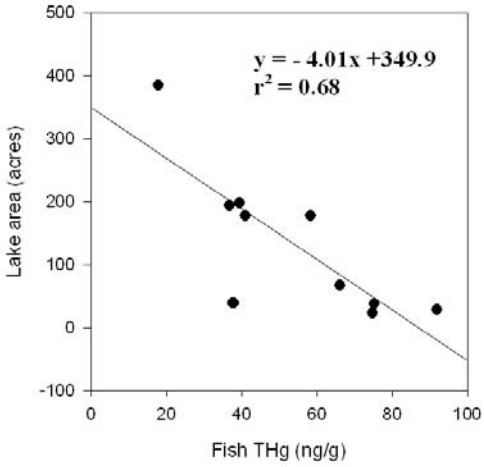
Trent Wickman[1], *Jason Butcher*[1], *Randy Kolka*[2], *Mark Gabriel*[3], *and Kenneth Gebhardt*[1]
[1]*USDA Forest Service Superior National Forest* [2]*USDA Forest Service North Central Research Station* [3]*The University of Minnesota*

In an effort to elucidate the impact of forest fires on Hg re-mobilization, the North Central Research Station and the Superior National Forest established a plan to monitor Hg changes in various environmental media during prescribed forest fire operations in the Boundary Waters Canoe Area Wilderness (BWCAW) of the Superior National Forest. A prescribed fire burning program was developed in response to a major blowdown event that occurred in July, 1999. About 75,000 of the 1.1 million acres of the BWCAW will be burned as strategic patches in the blowdown area over a 5 to 7 year period to reduce fuel loads, providing a rare opportunity to study Hg in a wilderness that is dominated by lakes and wetlands and also relatively unaffected by human activities. In this study, soil, water, fish, and throughfall chemistry information is gathered before and after burns in lakes that are both inside and outside of watersheds where prescribed burn activities are taking place. The goal of the study is to determine if there is an affect on fish Hg concentration from fire, and if so, to suggest mitigation strategies.

Currently in the project's early stages, we have begun to observe important characteristics in the natural variation of total mercury (THg) within fish, lake water, upland soil, and throughfall at the studied lakes. We have found statistically significant ($p<0.001$) differences in fish and upland soil (O-horizon) THg for several lakes. This natural variation has, more than likely, lent an observed positive relationship ($r = 0.70$, $p = 0.01$) between upland soil and fish THg. We are also investigating factors causing the time series variation of lake water THg by way of regression modeling, which may further enable us to isolate forest fire impacts on Hg re-mobilization. Fire impact evaluation is limited, however, initial data suggests THg enhancement in throughfall and wet deposition following the onset of local forest fire.



* Plots display mean and standard deviation



* Plot displays mean for fish THg

Figures: Relationships between THg in fish, upland soil, and lake area.

5. EFFECT OF HISTORICAL LOGGING ON GEOMORPHOLOGY, HYDROLOGY, AND WATER QUALITY IN THE LITTLE FORK RIVER WATERSHED

***Jesse Anderson**, Nolan Baratono, Andrew Streitz, Joe Magner, and E. Sandy Verry**
Minnesota Pollution Control Agency
** Ellen River Partners, Grand Rapids, Minnesota*

Many streams in Northeastern Minnesota run through former glacial lake beds and have comparatively high natural background levels of silt and clay. Superimposed on natural conditions are impacts associated with historical logging of the original hardwood and coniferous forests, which took place from the late nineteenth century to the 1930's. Highlighting a case study in the remote 1,800 mi^2 Little Fork River watershed, we hypothesize via a weight of evidence approach that historical logging had a significant impact on the stream's present water quality and geomorphic state. The river is currently impaired for turbidity, and the impairment is primarily due to excessive suspended sediment concentrations originating from stream bank erosion. Stream destabilization was likely due to two main mechanisms- 1. Increased water yield following timber harvest. 2. Use of the stream channel to transport logs during the spring floods, which destabilized the banks and separated the river from its historic floodplain. Significant increases in the Q1.5 ('bankfull') discharge, independent of precipitation patterns, were documented following historical logging. Based on an analysis of U.S. Geological Survey streamflow data, bankfull flows were 9,120 cubic feet per second from 1937-1969, and dropped to 6,580 cubic feet per second from 1970-2002 as the watershed recovered hydrologically and the forest regenerated. Today, most pre-settlement wetlands are intact in the Little Fork River watershed, and land is primarily managed for timber harvest. Regional curves were developed for several watersheds in northeast Minnesota. Water yield, as measured by normalized bankfull discharge, was found to vary widely- in one case doubling in adjacent major watersheds. This is likely due to variations in watershed storage, and the influence of surficial geology and vegetation. Several proposed next steps for the upcoming impaired waters study are identified.

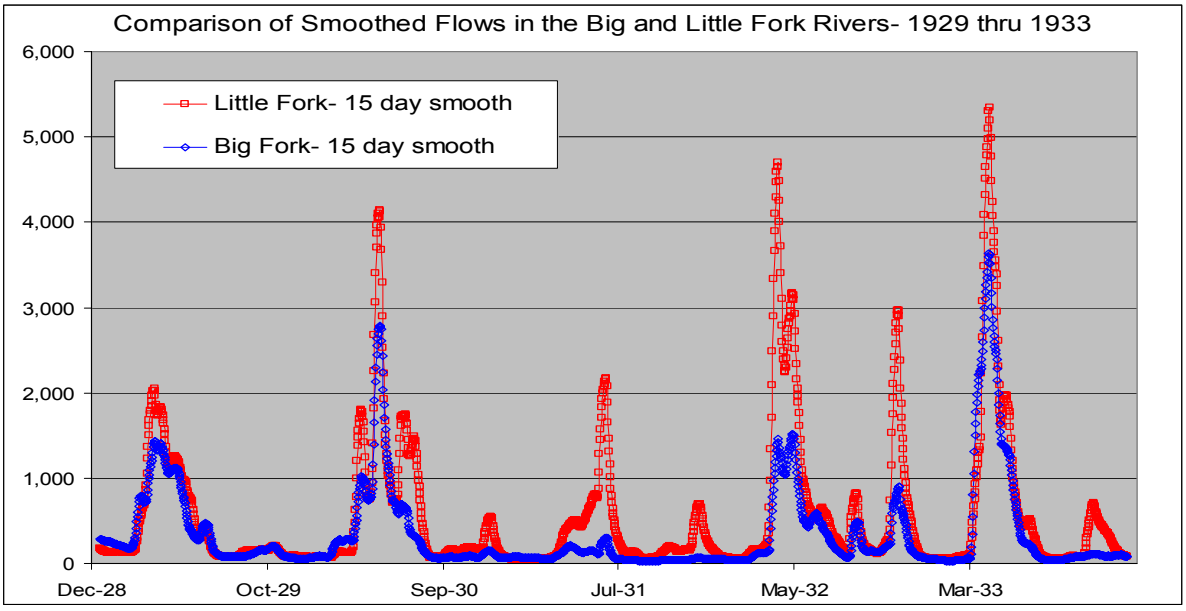
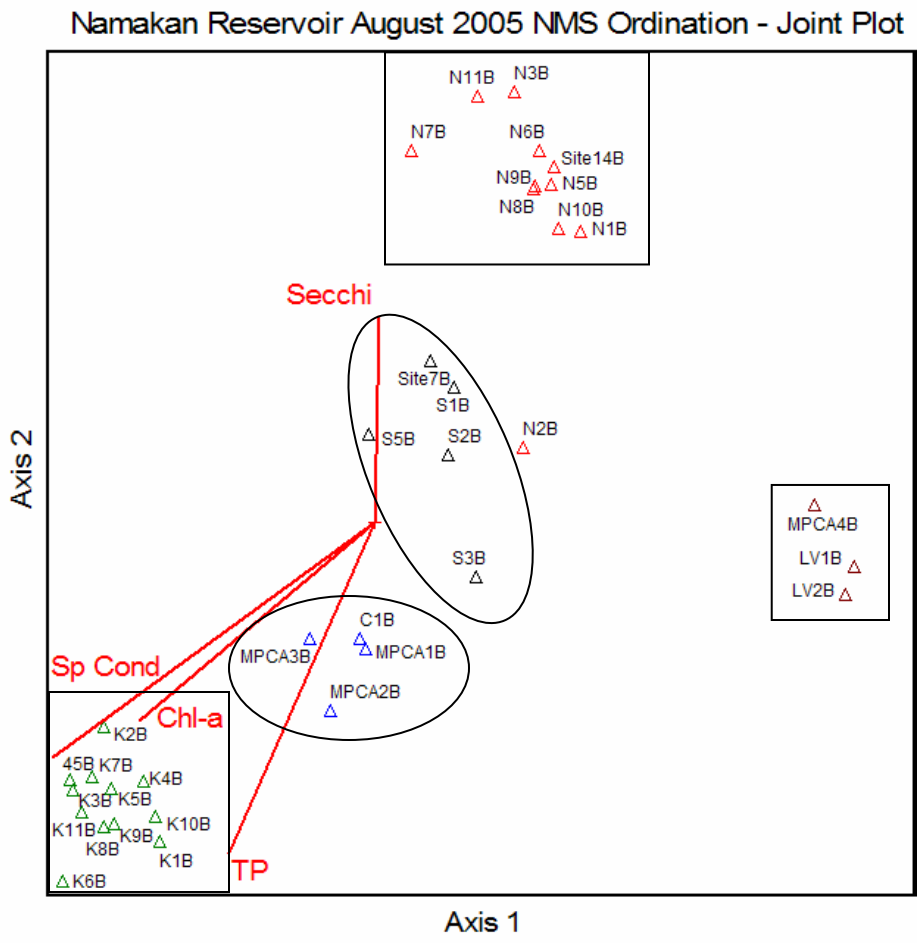


Figure. 15 Day Moving Average Streamflows (cubic feet / second) at US Geological Survey Streamflow Gauging Stations- Little Fork and Big Fork Rivers, 1929 – 1933.

6. SPATIAL VARIATION IN THE WATER QUALITY OF THE NAMAKAN RESERVOIR

***Maki, R.P.**, Kallemeyn, L.W., and C. Holbeck.*

Water quality characteristics of the Namakan Reservoir, Minnesota/Ontario, were investigated for spatial variation in summer 2005. Resource managers at Voyageurs National Park coordinated a volunteer effort to conduct the investigation, during which a team of 20-30 volunteers sampled 37 sites in June and August. Sampling was conducted in each of the five major lake basins within the Namakan Reservoir. Samples were collected for total phosphorus, total dissolved solids (TDS), and chlorophyll-*a*. Secchi disk depth was determined and depth profiles of temperature, dissolved oxygen, pH, and specific conductivity were measured. Nonmetric multidimensional scaling (NMS) ordination was used to investigate the relationship between the water quality of the sample sites (PC-ORD V 4.25). Results of a Multi-Response Permutation Procedure (PC-ORD V 4.25) showed that the five lakes of the Namakan Reservoir differed in water quality characteristics ($p < 0.01$). The **figure** below shows the result of the NMS ordination for the August data; sampled sites from each of the Namakan Reservoir's five lakes are indicated by color (Namakan – red, Sand Point – gray, Little Vermilion – brown, Crane – blue, and Kabetogama – green). Variation in specific conductivity (which was highly correlated with TDS), secchi depth, chlorophyll-*a*, and total phosphorus (August only) were most correlated with the spatial pattern of water quality.



7. PALEOECOLOGICAL IMPLICATIONS ON THE SOUTHEAST LAKE OF THE WOODS TMDL

Euan D. Reavie, *Center for Water and the Environment, Natural Resources Research Institute, University of Minnesota Duluth, 1900 E. Camp St., Ely, MN 55731; Phone 218-365-7243; ereavie@nrri.umn.edu*

Williams Creek, from its headwaters to Zippel Bay, was put on the TMDL list for low oxygen affecting aquatic life. Erosion, sediment deposition and elevated nutrient loading have been identified as common issues throughout the watershed, likely resulting from anthropogenic stressors including agriculture and hydrologic modifications. Paleolimnology was employed in Zippel Bay and its tributaries to characterize long-term nutrient loading and sedimentation rates since European settlement of the region. The figure below illustrates the process of sediment core collection, diatom microfossil analysis and stratigraphic interpretation. Isotope analyses of three sediment cores indicated notable shifts in sedimentation rates in response to human activities, and the application of a new diatom-based nutrient model to fossil diatom assemblages indicated that phosphorus levels have approximately doubled over the last 150 years. These results suggest that there is a higher than natural frequency of low oxygen events resulting from algal blooms. This study has important implications on the Southeast Lake of the Woods TMDL, as it quantifies the extent of limnological impacts and validates the need for remediation.

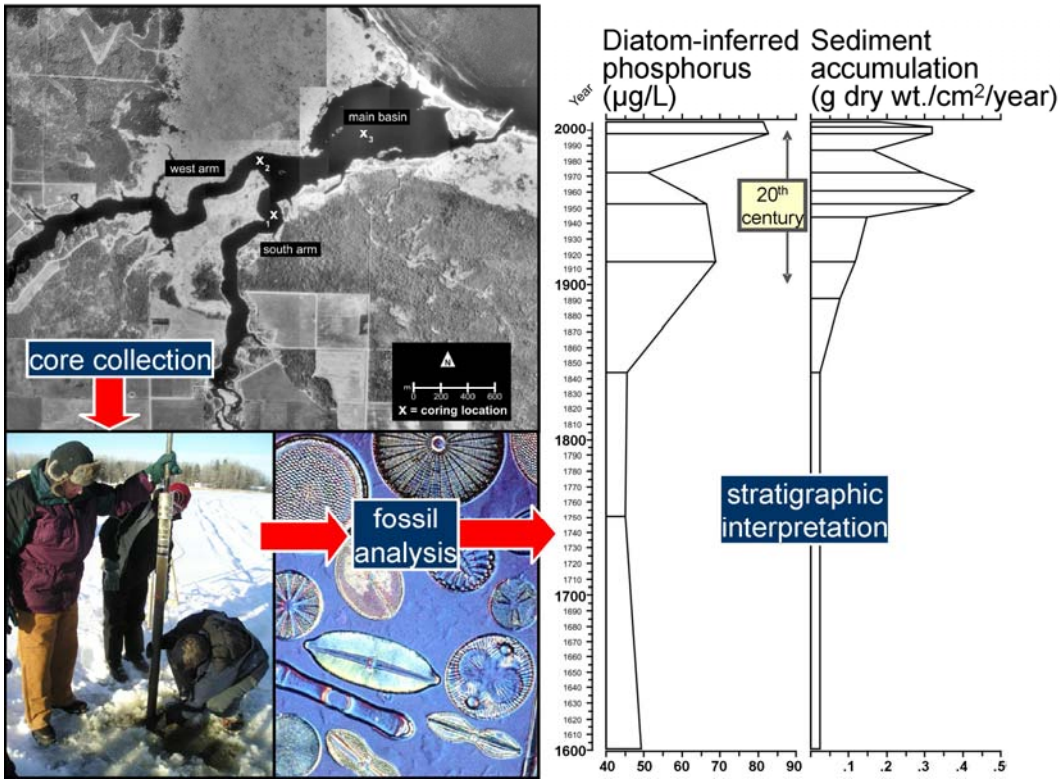


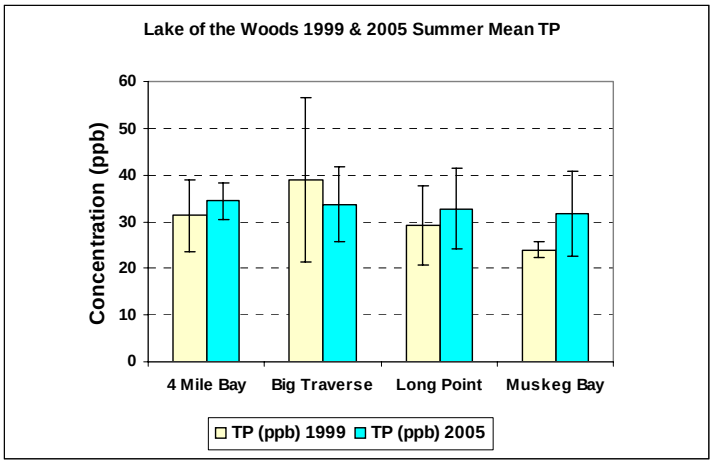
Figure. Sediment core locations in Zippel Bay and a summary of paleolimnological methods employed to reconstruct ~400 years of limnological history.

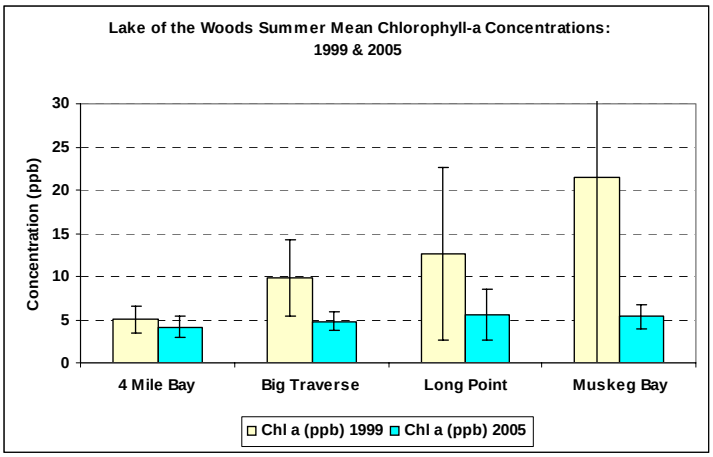
8. LAKE OF THE WOODS TROPHIC STATUS REPORT 2005

Mike Hirst, *Jesse Anderson*
Lake of the Woods Soil and Water Conservation District

In 2005, Lake of the Woods Soil and Water Conservation District (SWCD), with the Minnesota Department of Natural Resources (MNDNR) and the Minnesota Pollution Control Agency (MPCA) collaborated on a monitoring effort. This involved duplicating the 1999 study to observe the changes that have occurred in 5 years on water quality on the southern portion of Lake of the Woods. Both studies involved collecting samples at the four existing sites from May- September, and sampling an additional site on the Rainy River at Baudette (a MPCA Milestone monitoring station).

Results indicate that phosphorus concentrations in 2005 were slightly, but not significantly, higher than those measured in 1999 at three of four sites. However, chlorophyll-a in 2005 was lower at all four sites as compared to 1999. These two results, though intuitively conflicting, display the complexity of algal production and blooms in Lake of the Woods. While phosphorus is a primary factor, several other factors influence algal production and our ability to accurately measure chlorophyll-a in this large windswept lake. Among the factors that appear to be important are: patchiness of blooms, water color and suspended sediments and climatic factors such as temperature, rainfall, and wind. Future studies will hopefully shed light on the relative importance of the various factors and improve our ability to protect the water quality of Lake of the Woods. Upon completion, the 2005 study report will be placed on the MPCA web site and may be found at:
http://www.pca.state.mn.us/water/lakereport.html#LakeWoods .





9. TEMPORAL TRENDS IN THE WATER CHEMISTRY OF CLEARWATER BAY (PT 1)

Tom Mosindy, *Ontario Ministry of Natural Resources, Kenora*

Water quality data from the Clearwater Bay area of Lake of the Woods has been collected at regular intervals since 1984, largely to define usable habitat for lake trout which are the primary terminal predator in these coldwater basins. These data, spanning over two decades, provide one of the few long term records with which to track changes and assess variability in standard water quality parameters on Lake of the Woods. Changes in these parameters have a direct impact on the continued viability of lake trout populations in this lake. Total spring phosphorus, seasonal total nitrogen, chlorophyll α and Secchi depths showed no discernable trends in levels over time but varied considerably between sampling locations and between years. Most parameters exceeded the normal range of values that are characteristic of oligotrophic waters. Total P concentrations of 13 to 30 µg/L at most sites were almost twice the average for lake trout lakes in Ontario. Although usable lake trout habitat (dissolved $O_2 \geq 4$ ppm and temperature $\leq$15° C) remains restricted to $\leq$ 60% of the water column at all water quality sampling stations during mid September, a trend to increased amounts of optimal habitat (DO$\geq$ 6 ppm, temperatures $\leq$10° C) at two of the deepest sites i.e. #2-Deception Bay and #3-Clearwater Bay West has been noted in recent years (see graph). Lake trout remain vulnerable to changes in water quality within the Clearwater Bay area of the lake.

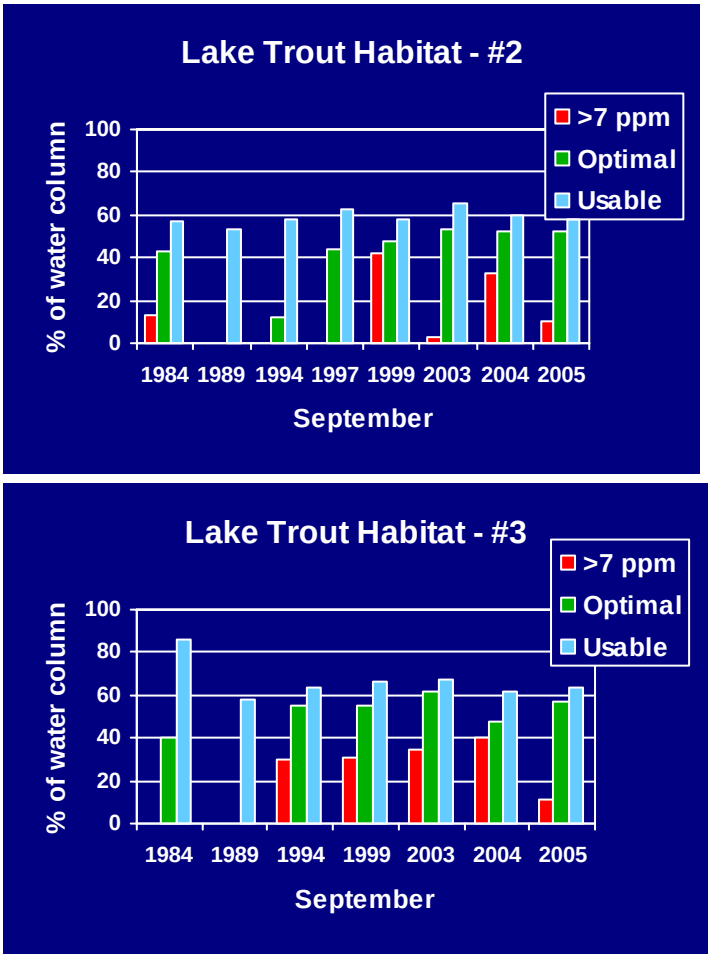


Figure. Optimal habitat (DO$\geq$ 6 ppm, temperatures $\leq$10° C) at two of the deepest sites i.e. #2-Deception Bay and #3-Clearwater Bay West.

9. TEMPORAL TRENDS IN THE WATER CHEMISTRY OF LAKE OF THE WOODS (PT 2)

***Bev Clark**, Ontario Ministry of the Environment, Dorset Environmental Science Centre, 1026 Bellwood Acres Rd., Dorset ON, P0A 1E0*

Late-summer, blue-green algal blooms in Lake of the Woods have generated increased interest in describing both seasonal and between-year differences in algal nutrient concentrations throughout the lake. Here we examine historical total phosphorus (TP) concentrations throughout Lake of the Woods to assess whether or not there have been changes in the water chemistry which could add credibility to the perception that there have been recent increases in the severity of these blooms. Monthly sampling of total phosphorus at many locations by Lake Partner Program volunteers and others has shown large seasonal differences in TP concentrations at many locations in the lake. This degree of seasonal variation makes it difficult to compare the data that are collected on different dates between different years. Distinct seasonal patterns in total phosphorus concentrations vary from north to south. However, the timing of minimum and maximum observed concentrations is similar between years. Historical TP data collected in the north end of the lake shows similar seasonal patterns and is within the observed between-year variation noted for TP data collected in recent years. These large seasonal shifts in TP concentrations throughout the year usually result in late summer concentrations that are well above 20 µg/L. There may not be notable differences in the lake's response to nutrient concentrations between years when TP remains high in the late summer.

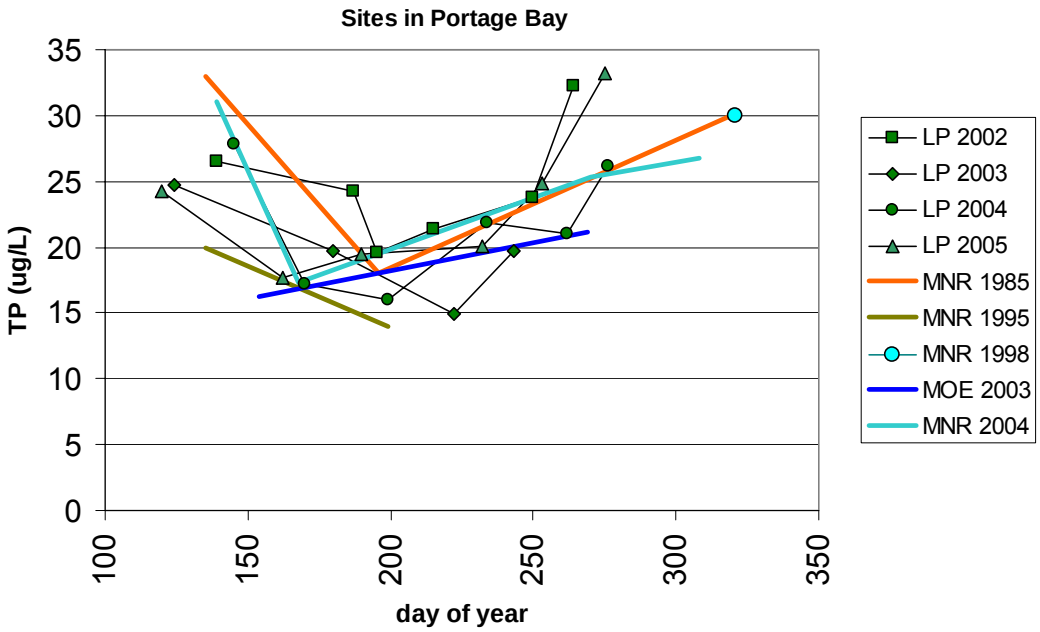


Figure. Seasonal, TP concentrations in Portage Bay between 1985 and 2005.

10. PHYTOPLANKTON BIOMASS AND MICROCYSTIN CONTENT IN LAKE OF THE WOODS

Huirong Chen and Phil Fedorak, Department of Biological Sciences, University of Alberta, Edmonton AB, T6G 2E9 Ellie Prepas, Chantal Nicholson, and Paul Dinsmore, Faculty of Forestry and the Forest Environment, Lakehead University, Thunder Bay ON, P7B 5E1 Hedy Kling, Algal Taxonomy and Ecology Inc., 31 Laval Drive, Winnipeg MB, R3T 2X8

The increased frequency, magnitude and toxicity of summer algal blooms in Lake of the Woods may be the result of eutrophication associated with expanded shoreline development and other human activities within its vast watershed. Our study of the relationships between nutrient concentrations and cyanobacterial (blue-green algal) toxins in Lake of the Woods is the first survey of its kind on the Boreal Shield of NW Ontario. Cyanobacterial biovolume and concentration of the liver toxin microcystin-LR were measured, as well as phosphorus and inorganic nitrogen concentrations in water samples collected from the north and north-central sectors of the lake during May-Sep 2004 and 2005. Total phosphorus concentrations ranged from 8 to 52 □g/L, indicating eutrophication at several sites, for example, Hay Island, Buff Island, Index Island, and Turtle Bay. In both years, cyanobacteria comprised 5 to 100% of the phytoplankton biomass from June onwards (median 72%) (see figure). Potentially toxin-producing cyanobacteria (mainly *Anabaena flos-aquae, but also Aphanizomenon flos-aquae, Lyngbya* sp*., and Gomphosphaeria* sp.) were present at most sites. In 2005, microcystin-LR concentrations in phytoplankton were positively related to *Anabaena* biomass and ammonium concentrations in lake water (r = 0.76 and 0.60, respectively; P < 0.001). Microcystin-LR and nutrient concentrations tended to be higher in the northern sector of Lake of the Woods, compared to the north-central sector, and concentrations were highest in August both years. Ongoing research will test hypotheses concerning relationships between increased nutrient loading and downstream eutrophication, and may ultimately shed light on some of the root causes behind increased nuisance and toxic algal bloom activity in Lake of the Woods.

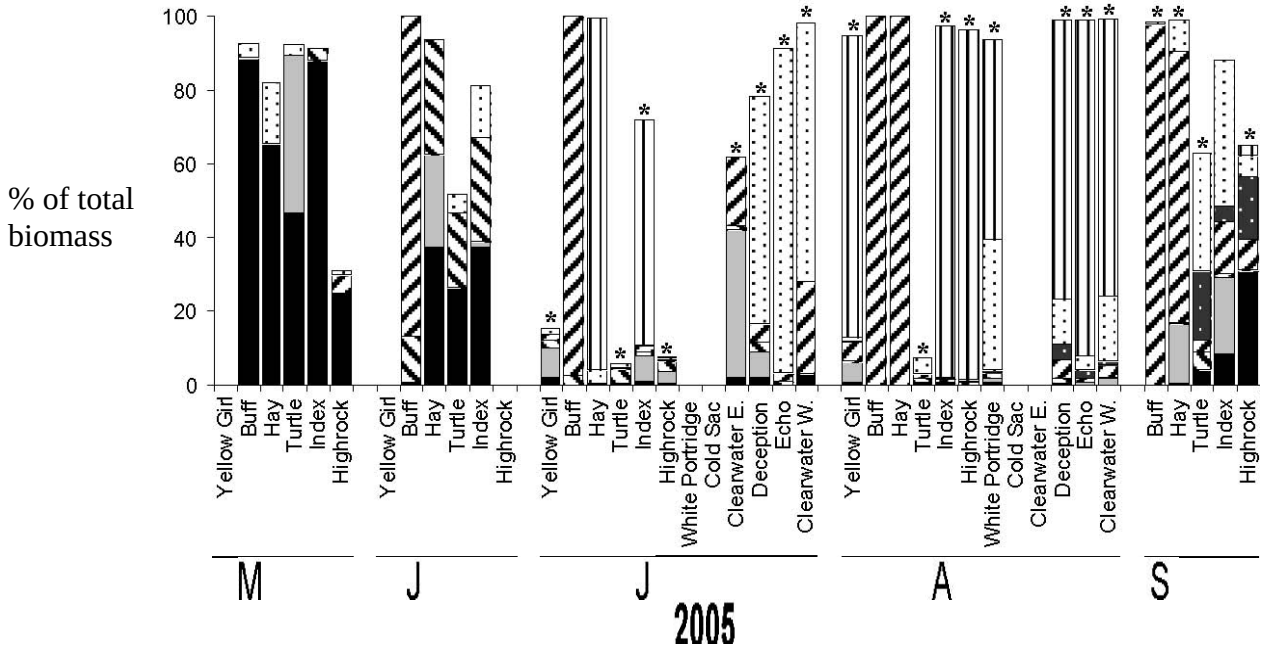


Figure. Phytoplankton community in Lake of the Woods during summer 2005. An asterix indicates that microcystin-LR was detected in the sample.

11. CYANOBACTERIA IN CANADIAN FRESHWATERS: TOXINS AND NEW EMERGING ISSUES

***Dr. Brian G. Kotak**, President, AlgalTox International, P.O. Box 268, Pine Falls, MB. Canada R0E 1M0. 204-367-2753 tel. miette@granite.mb.ca.*

Cyanobacteria are known to produce numerous secondary metabolites in productive surface waters and these can present serious acute and chronic threats to the health of pets, livestock, wildlife and even humans that consume them. The occurrence of the hepatotoxin microcystin-LR, (MC-LR) in Canadian freshwaters, has been studied for several decades. Their occurrence in western Canada appears to be widespread (Figure 1). In Alberta, where much of the research has been focused to date, 50-60% of phytoplankton samples collected from water bodies contains detectable concentrations of MC-LR. In some lakes, MC-LR is produced almost continually from May to October. Concentrations of the toxin in phytoplankton are extremely variable over the open water period, between years and also across a lake on a single day. This temporal and spatial variability is largely due to differences or changes in the abundance of the primary producer of the toxin: *Microcystis aeruginosa*. In addition, MC-LR is directly related to the nutrient phosphorus. Lakes with higher P concentration have a higher frequency of toxic blooms and also higher concentrations of MC-LR in the phytoplankton. In addition, MC-LR is also negatively correlated to inorganic nitrogen concentration (NO3, NH4) in water, as well as negatively related to N:P ratio. Eutrophication (nutrient enrichment) of lakes will therefore likely result in more frequent toxic blooms and higher toxin concentrations. Open water (i.e., away from shoreline surface bloom accumulations) MC-LR concentrations of up to 12 µg/L have been measured in phytoplankton from Alberta lakes. MC-LR concentrations of up to 6,400 µg/L in surface blooms accumulating along shorelines have been measured. MC-LR has also been detected in other parts of the aquatic food web, including invertebrate grazers (zooplankton, gastropods, clams) and fish, and has caused mass mortality of salmon raised in net pens off the coast of British Columbia and Washington. The recent discovery that many cyanobacterial also produce the non-protein amino acid, B-methylamino-L-alanine, which has been linked to Alzheimer's-like diseases, warrants attention.

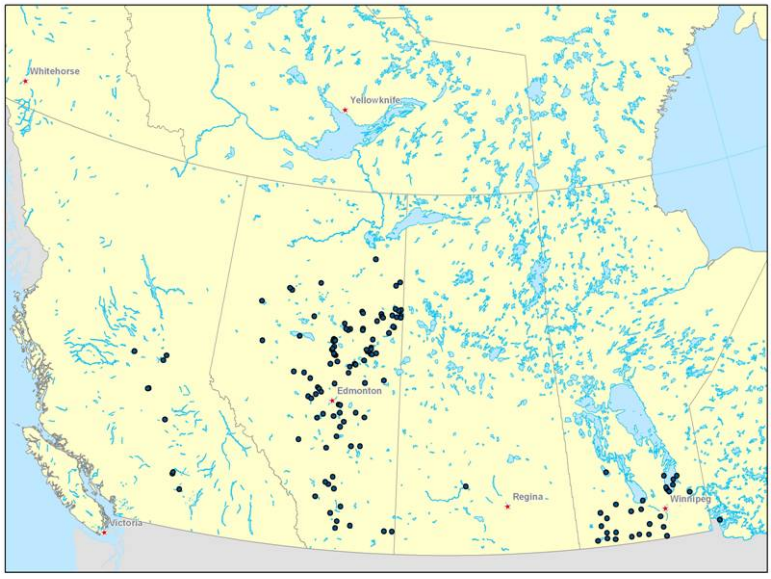


Figure. Location of lakes, reservoirs, farm dugouts and rivers in western Canada where microcystin has been detected.

12. BLUE-GREEN ALGAL TOXICITY: MINNESOTA'S RESPONSE

Steven Heiskary, Research Scientist III, Minnesota Pollution Control Agency
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in collaboration with Matt Lindon, MPCA St. Paul; Pat Baskfield, MPCA Mankato & Wade Gillingham, MPCA Marshall

Blue-green algal toxicity is not a new issue in Minnesota or elsewhere in the U.S. for that matter. However, late summer 2004 was marked by dog deaths that coincided with severe blue-green algal blooms on multiple lakes in Minnesota. Laboratory testing of lake samples indicated algal toxins were present in high levels in several samples. In response to these events an Interagency Work Group was assembled in 2005 to develop an information program to heighten awareness of this issue among lake users and lake management organizations. The poster below is one of the products of this effort. A brief overview of events from 2004 and products of the 2005 work group was provided at the Forum. In addition a program for testing samples for potential toxicity is under development for 2006. We also shared some other state responses to this issue and highlighted some actions undertaken by the North American Lake Management Society (NALMS) to further knowledge on this important topic. As a result of this presentation and further discussion in a work group on the second day of the Forum several steps to address blue-green algal toxicity in Lake of the Woods were proposed and are under development for 2006. One aspect of the strategy is a public information campaign. Information from Minnesota's campaign will be used as a basis for developing materials for Lake of the Woods property owners and visitors. Further details on other elements of the proposed strategy may be found in the work group notes that are a part of this proceedings.

Figure. Minnesota Public awareness Poster.

13. HISTORICAL RESEARCH ON SELECTED HUMAN ACTIVITIES AND NATURAL EVENTS LIKELY TO HAVE AFFECTED WATER QUALITY IN LAKE OF THE WOODS 1850-2005: Can historical research contribute to an understanding of the past 150 years of water quality trends on Lake of the Woods?

Catherine Macdonald, *Prairie Connections, Historical Research Consultants, 125 Chestnut St., Winnipeg, MB, R3G 1R4*

Scientists of the Lake of the Woods Sediment Core Analysis Project (LOWSCAP), Freshwater Institute, Canada Department of Fisheries and Oceans, have analyzed sediment core samples from six sites on Lake of the Woods. The core samples revealed datable trends in the deposition of certain elements and microfossils that indicate changes in water quality over the last 150 years. LOWSCAP scientists suspected that certain human activities and natural events caused the changes observed in the cores. Historian Catherine Macdonald was asked to undertake a feasibility study to determine whether it was practical to find historical data that would link these changes to actual human industrial and land use activities and to natural events such as the occurrence of forest fires in the basin. The feasibility study showed that, while historical research would likely help in understanding the trends discovered by the scientists, the scale of historical research required would be feasible only if partnerships were formed on both sides of the International Boundary among stakeholders with an interest in having the research completed. The study sets out a preliminary research plan and suggests ways of finding support and funding for the plan.

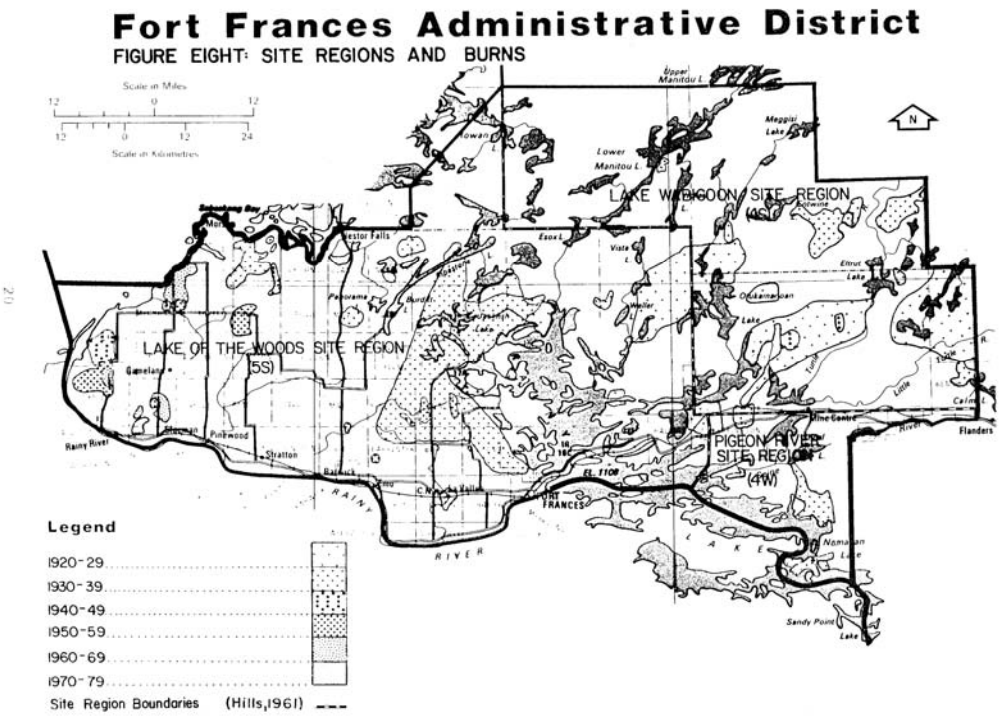
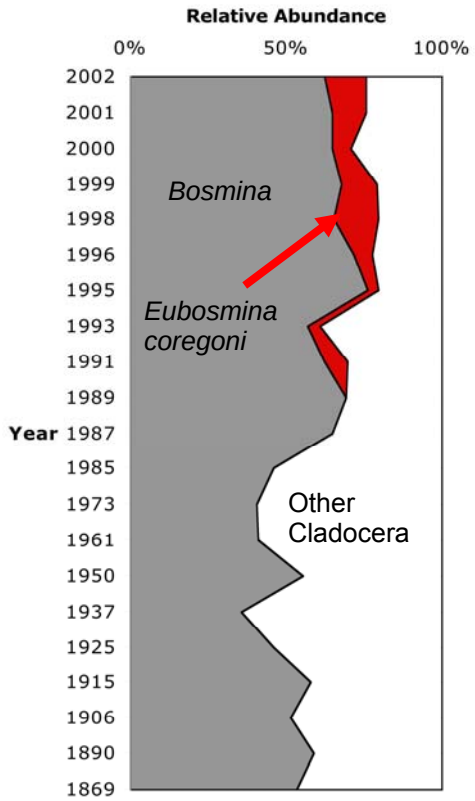


Figure: Site Regions and Burns, Fort Frances Administrative District, source: Ontario. Ministry of Natural Resources, *Background information: Fort Frances District land use plan: Northwestern region,* 1980

14. A PALEOLIMNOLOGICAL APPROACH TO EXAMINE THE INVASION DYNAMICS OF AN EXOTIC ZOOPLANKTON SPECIES, *EUBOSMINA COREGONI*, INTO LAKE OF THE WOODS, ONTARIO, CANADA

Karyn Suchy *and* ***Brenda Hann****, Department of Zoology, University of Manitoba, Winnipeg, MB, R3T 2N2*

Invasive species continue to pose a major threat to aquatic ecosystems around the world. Although ballast water is the most likely invasion route for non-indigenous species (NIS) entering the Laurentian Great Lakes, many NIS in this region are expanding their range to inland lakes and streams via overland dispersal and dispersal via riverine connections. This study uses cladoceran microfossils to examine the invasion dynamics of, *Eubosmina coregoni*, the first known zooplankton to invade Lake of the Woods (LOW). Top/bottom sediment samples are used to determine presence/absence at sites throughout LOW while long cores provide a historical account of *E. coregoni*'s abundance since its arrival in this water body. *E. coregoni* had the highest relative abundance in the northern and eastern regions of LOW, however, the abundance of all cladoceran remains was low in the southern region of the lake. Analysis of the long core from Clearwater Bay shows that *E. coregoni* first appeared in the northern region of LOW in the early 1990s (see Figure below). Results obtained in this study, in conjunction with similar data from Lake Winnipeg, could point to invasion routes into these inland water bodies. An understanding of these invasion routes may aid in the prevention of future invasions, including species such as the zebra mussel (*Dreissena polymorpha*) and the spiny waterflea (*Bythotrephes* sp.) that are already altering the food web dynamics of the Laurentian Great Lakes.



15. CLIMATE TRENDS IN MINNESOTA: SOME IMPLICATIONS

Mark Seeley,
Professor of Meteorology and Climatology
University of Minnesota, Dept of Soil, Water, and Climate

Since the new millenium began there has been increasing recognition by climatologists that Minnesota's climate is showing four distinct trends or changes in character: (1) warmer winters; (2) higher minimum temperatures; (3) higher frequency of tropical-like dew points in the summer months; (4) and an overall increase in precipitation. These climate trends, not without precedent in some cases, have serious implications for various sector's of the state's economy, as well as for management of the state's natural resources. Evidence for these changing climate patterns and their effects will be presented with varied perspectives, including acknowledged perceptions of risk that are based on cognitive, emotional, ethical, and political views of the issue of climate change.

16. LEAVING OUR LEGACY – ENVIRONMENTAL CHALLENGES IN THE 21ST CENTURY

Gord Miller, Environmental Commissioner of Ontario

There are a number of emerging socio-political issues that may impact the future water quality in the Lake of the Woods basin and in northern region basins in general. Many of these issues are thwarting our efforts to achieve a more sustainable culture. Compound consumptive growth at three percent, for example, requires us to double the base requirements for energy and resources every 23 years. This requirement for resources is aptly mirrored by the concept of peak oil whereby the costs to supply the resource will increase exponentially in the years following the realization of maximum production. This concept of peak oil is directly transferable to issues surrounding the quantity of available water resources. Other key environmental issues such as climate change are linked to many of these aspects of economic growth. Mitigation of issues such as climate change may be failing while, at the same time, adaptation to these external factors, by many organisms, may not be possible. The normal observed fluctuation between the upper and lower tolerance limits of many organisms, for example, may experience excursions beyond these limits when the baseline shifts through time (see Figure). Our inabilities to change our activities to respond to these stresses are based on both economic/ecological and urban/rural dichotomies. In the Lake of the Woods basin these issues, if left unresolved, may lead to competition for water for power production, agriculture and human consumption. Intensification of agricultural practises and more extreme climate events may lead to increased silt loads in the south while fire and blow downs may increase in the northern parts of the basin. While the direct water quality changes that take place as a result of these impacts are uncertain, exotic species will almost certainly increase in number and increasing exploitation of game fish populations will continue.

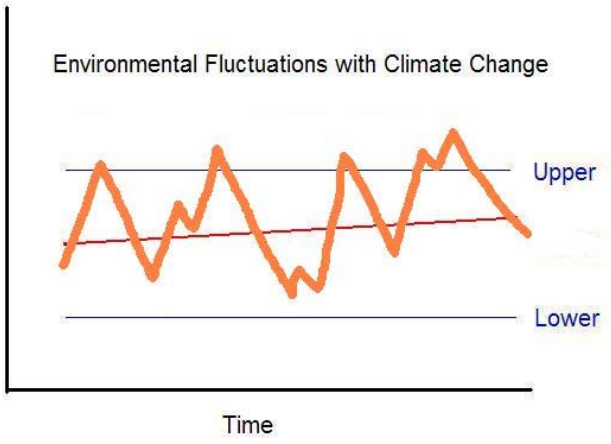


Figure. Conceptual diagram showing the impact of a shifting baseline (red line) on normal environmental fluctuations (orange line) relative to the upper and lower tolerance limits of an organism.

REMOTE SENSING AND LAKE OF THE WOODS

Steve Heiskary, Minnesota Pollution Control Agency, 520 Lafayette Road St. Paul MN 55155. (also NALMS project manager for remote sensing study)

Remote sensing is an increasingly used technique for assessing water quality and trends in lakes. The North American Lake Management Society (NALMS) and the Universities of Minnesota, Nebraska and Wisconsin are collaborating on USEPA funded research to assess the application of several different remote sensing platforms for this purpose – ranging from high resolution boat and plane-based sensors to various satellite-based sensors. One such platform being evaluated is the global monitoring system MODIS and how it can be applied to large lakes like Lake of the Woods.
MODIS images of the western Great Lakes region are automatically collected and posted on the web at http://www.lakesat.org/ each day. In late July and early August of 2005, a group of scientists and citizen volunteers (with some of the most significant collections being made on Lake of the Woods and Rainy Lake) made 170 field surveys of lakes across Minnesota and Wisconsin, collecting data on chlorophyll concentrations, water clarity, and other measurements. These data are being used for a more comprehensive demonstration of the use of MODIS imagery for monitoring large lakes in the region (Fig. 1). The data from this field sampling campaign was an ideal source for calibrating satellite-based water quality models, because they include a wide range of types of lakes, with very different levels of chlorophyll, colored dissolved organic carbon, suspended solids, and water clarity. These data allowed for a highly significant regression (predictive) equation to be developed. Results from that effort are depicted in Figure 1. This work is part of a larger study that is now being compiled into a guidance document by the collaborators and NALMS. This document and a training workshop are two products of this work. Details on this project may be found on the NALMS web site at www.nalms.org. An article, which documents some of the progress to date and further details on the MODIS work, will be included in the spring 2006 edition of NALMS LakeLine magazine.

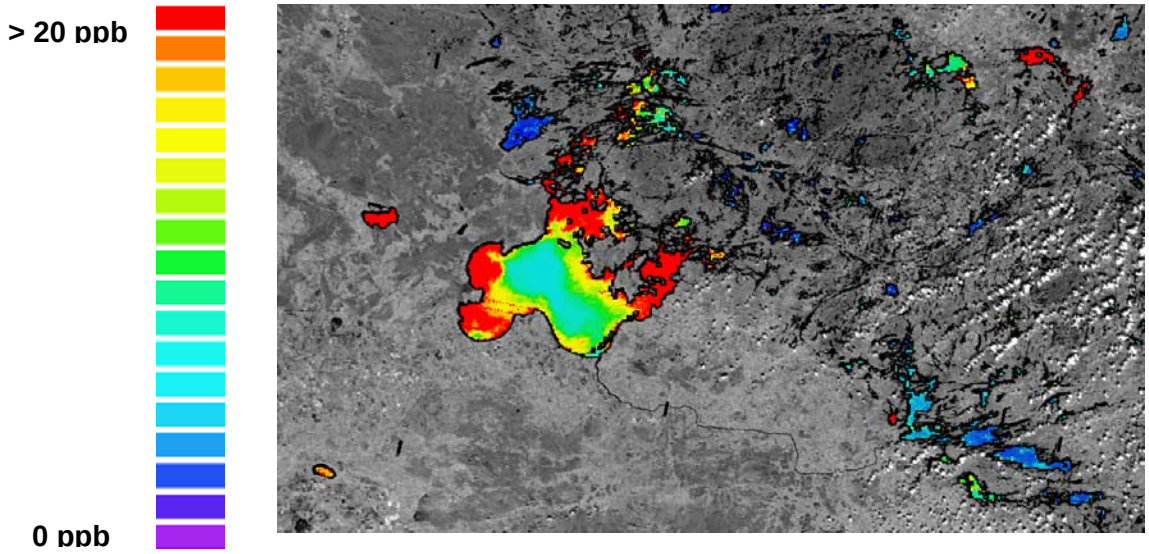


Figure. MODIS- estimated chlorophyll-a for August 1, 2005. Based on Terra MODIS image & multiple regression model developed from the ground truth data.

A COMPARISON OF RUNOFF AND NUTRIENT EXPORT DYNAMICS IN SMALL BOREAL SHIELD AND BOREAL PLAIN WATERSHEDS: INTRODUCTION TO THE LEGACY FOREST SMALL STREAMS PROJECT

Elyse Mussell, Paul Dinsmore, Janice Burke, and Ellie Prepas, Faculty of Forestry and the Forest Environment, Lakehead University, Thunder Bay, ON P7B 5E1

The Legacy Forest Small Streams (LFSS) Project was initiated in 2003 on the Canadian Boreal Shield near Thunder Bay, north-western Ontario. LFSS complements the Forest Watershed and Riparian Disturbance (FORWARD) Project based on the western Boreal Plain. Since 2001, FORWARD researchers have collected data and developed modeling capacity to link sustainable surface water management with landscape-based forest planning. Since the geology, forest vegetation and climate on the Boreal Shield differ from the Boreal Plain, baseline data are required to develop models for the pan-Canadian boreal forest. The focus of early-phase LFSS work is stream flow monitoring in seven small watersheds prior to forest harvest (slated for winter 2007/08). We present our first full year (2004) of baseline runoff data from the LFSS watersheds. Total runoff from watersheds in the two regions was similar (approx. 120 mm) for the open-water period (April 1 to October 31). The LFSS streams flowed year-round, while the FORWARD streams flowed from April through October, therefore total annual runoff was 20% higher from LFSS than FORWARD watersheds. However most runoff occurred during spring (April to June) and late fall (November) in LFSS watersheds, compared to summer (July to September) in FORWARD watersheds (see figure). Among-watershed variation in runoff was half that for FORWARD, possibly due to less localization of rain events and less spatial variation in soils. Hypothesized impacts of forest harvest on runoff from Boreal Shield compared to Boreal Plain watersheds include: 1) more dramatic short-term (< 2 years) response; 2) less variation in response among watersheds; and 3) more rapid recovery from disturbance.

Photo: V-notch weirs and stilling wells were installed as part of the infrastructure to monitor stream flow and water quality.

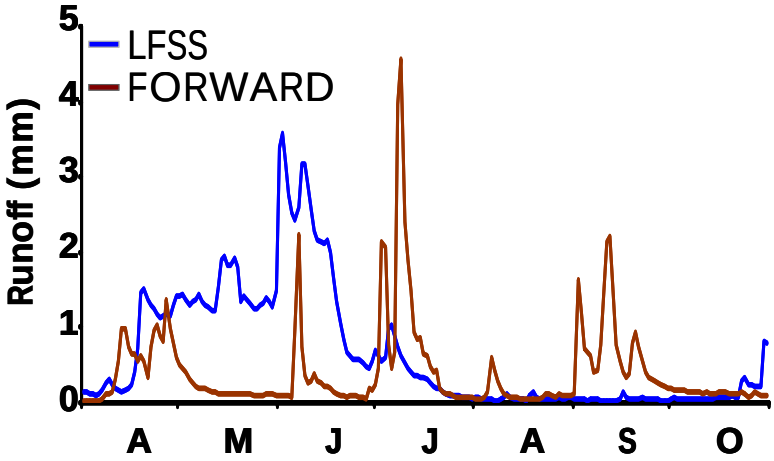


Figure: Hydrograph from typical LFSS (Boreal Shield, north-western Ontario) and FORWARD (Boreal Plain, north-central Alberta) study streams.

DETERMINING THE HISTORICAL IMPACT OF WATER-LEVEL MANAGEMENT ON LAKES IN VOYAGEURS NATIONAL PARK: NAMAKAN LAKE

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A before-after, control-impact paleolimnological analysis of sediment cores from four lakes in the Rainy Lake drainage is determining the timing and magnitude of ecological change resulting from historical water-level manipulations in Voyageurs National Park, a priority concern. Critical to implementation of the most recent rule curve changes in Rainy Lake is the need to understand both the natural variability of lakes in the Rainy-Kabetogoma-Namakan system and their response to nearly 100 years of hydromanagement. Toward this end, a series of five sediment cores has been recovered in 2005: Kabetogoma Lake; Namakan Lake (Junction Bay); two cores from Rainy Lake (Grindstone Bay and Kempton); and a core from our control lake, Lac La Croix, which is unimpacted by water-level manipulation. All cores are being inventoried for ^{210}Pb activity to determine age and sediment accumulation rates for the past 150 years. Sediment biogeochemistry has been determined using loss-on-ignition analysis. Subfossil diatom communities and chironomids will be analyzed in each core over the last 300-400 years to determine natural (pre-damming) variability of biological communities and their response to damming and historical water-level management scenarios.

Initial analyses have targeted the Namakan Lake sediment core. Lead-210 dating indicated that pre-European settlement (c. 1865) sediment is present below 25 cm core depth. Damming of the Rainy-Namakan-Kabetogoma system at the turn of the 20th century has resulted in two-fold increased sediment accumulation rates. Analysis of diatom communities is underway and indicates that a diverse diatom community (>40 genera) is preserved throughout the core. Variations in subfossil diatom communities will be used to determine biological response to natural and manipulated lake conditions and under different landuse patterns. Furthermore, a diatom calibration set based on modern assemblages and environmental conditions from 145 Minnesota lakes will be used to quantitatively reconstruct historical water quality parameters (e.g., TP, pH, ANC) from downcore diatom assemblages.

OVERVIEW OF THE MINNESOTA LAKE SUPERIOR BEACH MONITORING PROGRAM

Bauman, Heidi and Rauner, Melissa,
Minnesota Pollution Control Agency, Northeast Regional Office

Going to “The Lake” is one of the most popular summer activities along Minnesota’s Lake Superior coastline. Whether you are the beach to kayak, swim, surf or look for agates, water quality can have an impact on your experience at the beach. Despite their importance to the region's quality of life, beaches are being posted “Water Contact Not Recommended” because of sewage overflows, pet waste, storm water run-off and other kinds of pollution.

The Beaches Environmental Assessment and Coastal Health (BEACH) Act, passed in October of 2000, requiring States that border coastal or Great Lakes waters to develop beach monitoring and public notification programs. The BEACH Act also requires that States adopt EPA's new criteria for pathogen and pathogen indicators by April 2004. Minnesota is in the process of adopting revised rules and is planning on having them out for public review in early 2006 and adopted by the fall of 2006.

For the 2006 beach monitoring season, the Minnesota Pollution Control Agency (MPCA) was awarded $204,440 for on-going implementation of Minnesota’s beach monitoring and notification program. The purpose of this project is to monitor selected beaches along Lake Superior in accordance with BEACH Act requirements, allow for prompt notification to the public whenever bacterial levels exceeds EPA's established standards, and investigate alternative methods for public notification. This information is used to investigate long-term trends in water quality and to establish a beach monitoring and public notification plan that will assist communities along the lake shore to improve their ability to monitor and notify beach users of risks associated with high bacteria levels.

PALEOLIMNOLOGICAL INVESTIGATION OF KABETOGAMA LAKE, VOYAGEURS NATIONAL PARK

H.J. Kling, J.E. Elias†, and L.W. Kallemeyn††*
**Algal Taxonomy and Ecology Inc., 31 Laval Dr., Winnipeg, Manitoba.*
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†† US Geological Survey, Columbia Environmental Research Center, International Falls Biological Station, 3131 Highway 53, International Falls, Minnesota.

The large lakes of Voyageurs National Park have been subject to water level control for nearly 100 years. Investigations showed adverse effects of the artificial hydrologic regime on biological communities, which led the International Joint Commission to issue a new rule curve in 2000 that followed a more natural hydrologic regime. The effects of this new curve on the biota of the Park must be documented, but assessment is hampered by limited data from which to assess natural variability and a lack of pre-dam data.

Paleolimnological data facilitate assessment of natural variation over time and allow interpretation of the effects of historical management strategies. We analyzed abundance and composition of non-siliceous and siliceous microfossils in a lake sediment core from Kabetogama Lake and documented the pre- and post-impoundment quantitative variation over a period of approximately 150 years.

Results indicate that Kabetogama Lake has undergone a shift in trophic status beginning around the time of the dam installation in 1914 and increasing since the 1960s. Initial increases in zooplankton occurred following damming of the reservoir, indicating an increase in their food supply. Changes in the algae community since the 1960s are consistent with higher trophic conditions that may be occurring due to anthropogenic enrichment and long-term impoundment. Cyanobacteria were historically present, though recent increases in abundance and diversity may be due to increased water column stability and nitrogen limitation. The greatest changes in trophic status, however, are probably related to extreme water level fluctuations, climate change, and increased nutrient levels.

THE LEGACY FOREST SMALL STREAMS PROJECT: LINKAGES AMONG BOREAL SHIELD STREAMS, NUTRIENT DYNAMICS AND INTENSIVE FOREST MANAGEMENT IN NORTHWESTERN ONTARIO

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Daniel Smith, Department of Civil and Environmental Engineering, University of Alberta, Edmonton AB T6G 2W2
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Headwater catchments are the main source of water, organic material and sediment inputs in most river systems. Water quality in small catchments (<10 km^2) tends to respond quickly to natural perturbation and Intensive Forest Management, yet nutrient dynamics in headwater streams and wetlands, particularly within the Lake of the Woods drainage in northwestern Ontario, have been largely neglected. The Legacy Forest Small Streams (LFSS) Project was initiated in March 2003 to complement the Forest Watershed and Riparian Disturbance (FORWARD) Project on the western Canadian Boreal Plain. Since 2001, FORWARD researchers have been developing the modeling capacity to link watershed disturbance with landscape-based forest planning. LFSS began monitoring water quality and flow in seven small headwater streams within the Dog River-Matawin Forest Management Unit (50 km NW of Thunder Bay, ON) in spring 2004. We have also installed infrastructure to monitor post-harvest disturbance impacts planned for 2007-2008 (see figure). We are working with industry, government and First Nations partners to understand the transfer of substances from watersheds to surface waters and to develop models that can work with the spatially-based planning tools used by land managers. Research outcomes will be of economic interest to forest products companies. Further, they will contribute to an integrated watershed management approach where downstream water use sectors will also benefit. LFSS provides many graduate student research opportunities, including studies of watershed and wetland processes, upland and riparian vegetation community dynamics, soil nutrient and microbial dynamics, water quality and aquatic bioindicator responses to land-based disturbance, and the application of stochastic/deterministic modelling and other tools. Researchers also have the opportunity to compare processes within Boreal Shield and Boreal Plain watersheds. One of our long-term goals is to network with other stream research projects to facilitate knowledge transfer across the North American boreal forest.

Figure. V-notch weir and stilling well, installed as part of the infrastructure for evaluating stream discharge and water quality for selected watersheds within the Dog River-Matawin Forest Management Unit.

PARTNERSHIPS + PROJECTS = WATER QUALITY PROGRESS

Kelly Voigt

NRCS works with many different partners to accomplish water quality objectives on private lands. The poster will summarize the partnerships that exist and water quality projects that are planned and completed within the Rainy River and Lake of the Woods basins. The projects include riparian buffers, stream bank and shoreline erosion control, nutrient management plans, crop residue management, prescribed grazing and other best management practices that have a direct impact on water quality.

Working Group Notes

Working groups are composed of researchers and field technicians actively working in the group's subject area in the Rainy River Basin. Working groups serve two primary functions. First, they provide an opportunity for researchers to discuss concerns specific to their field, share successes and to collaboratively look at the research needs for the entire basin.

Second, specific recommendations are integrated into the basin monitoring effort by resource management agencies on both sides of the international border. For example, in 2005 the Monitoring Working Group recommended the use of volunteer monitors to ground-truth and provide data for calibration of satellite imagery for large lakes in the basin. This resulted in collaborative efforts on Rainy Lake and Lake of the Woods (described in the poster *Remote Sensing and Lake of the Woods*) involving local cottage owners and residents, charter boat captains, fishing guides and local, provincial/state and federal resource management agency staff.

In 2006, the Rainy River Basin Water Resources Center Steering Committee will promote the working group recommendations through trans-border coordination activities focusing on resource management agencies, the International joint Commission's International Rainy Lake Board of Control and International Rainy River Water Pollution Board and local organizations such as the Rainy River Basin Committee in Minnesota.

Summary of 2006 Recommendations:

Paleolimnology

1. Inventory of cores for LOW – use to support future grant proposals for the region (since future studies might be able to use these cores)
2. Once this is done Rainy River Water Resources Center could organize this and make information available on web site
3. Check on Rainy River inventory

Blue-Green Algae Toxicity

1. Scoping study: Interested people were identified to develop a preliminary monitoring plan and funding proposal. Leads - need to be identified.
2. Public information campaign – Sharon will develop a coordinated public info campaign patterned after MN approach.
3. Need to come up with recommendations to tourists – should they boil the water? Blue-greens, E. coli and Giardia respond differently to treatments.

Nutrient Criteria

1. Next year's LOW meeting: we would like to see a talk "A preliminary nutrient model for Lake of the Woods: a precursor to nutrient criteria"
2. Work should go forward to try to assemble basic info that would be needed to do some very basic empirical modeling of LOW.
3. MPCA proposes to include LOW for sampling in summer 2006 to allow for use assessment (does not imply listing, rather determining if it should be listed as current data set is not adequate for this).

Mercury

1. Establish a long-term mercury monitoring program could be set up across the basin and across different agencies/jurisdictions. Program

will include information related to mercury and collect basic, broadly applicable water quality/watershed information so that this monitoring program could be a useful tool not only to monitor mercury but also climate change and other stressors.

Volunteer Monitoring

1. There is a need for a volunteer coordinator that would be responsible for:
    a. collecting and maintaining volunteer data
    b. providing educational outreach to community groups/schools
    c. providing skills and training for volunteers

The 2007 International Lake of the Woods Water Quality Forum will include reports on progress integrating the working group recommendations along with the creation of a new working group tasked with integrating recommendations into basin monitoring efforts.

NUTRIENTS AND ALGAE WORKING GROUP – 9 March 2005
Compiled by Steve Heiskary and Euan Reavie, work group leaders

The workgroup convened on the second day of the Lake of the Woods (LOW) Forum had four major subject areas to address with respect to Lake of the Woods as follows: 1) Paleolimnological investigations, 2) Blue-green algal toxicity, 3) Remote sensing and 4) Nutrient budget and nutrient TMDL assessment. With respect to each topic the work group members were to discuss relevant studies that had been conducted and recommend new ventures that could be undertaken by members of the work group or others working on LOW issues. A summary of issues and action items follows:

1. Paleolimnology

Summary of last year's list of paleo studies and work conducted since that time.

- OMOE, top/bottom P reconstructions
- Zippel Bay, SE LOW, diatom-nutrient trends, sedimentation rates, anoxia study
- Voyageurs National Park, lake-level fluctuations, land-use impacts
- Fisheries and Oceans Canada, algae, chemistry, isotopes, sedimentation rates (currently 5 dated cores and others available)
- Cladoceran invasion histories. Comparison of a native cladoceran and a closely related invasive species. Makes use of the paleo record as a basis for documenting timing of invasive species entering the system.

Some discussion on diatom models revealed that while they have become a mainstay of paleoecological-nutrient studies, we acknowledge problems with some diatom models:

- poor species assemblage analogs
- shallow lake systems have very different assemblages and may lack modern-day analogs;
- taxonomy issues among study groups – need for workshops, mesh calibration sets

Primary needs to make better use of Paleo studies in LOW:

- need for historical data (noted that we have shown success in the St. Croix Basin relating paleo post-hoc to historical data);

- aerial photography – should be photos as old as 1929 for this region, which may lend some insight into landuse and other factors;
- extent of GIS data on both sides of the border?
- what level of detail is important?
- How much watershed disturbance can be tolerated before a lake responds?
- Other algal indicators – particularly blue-greens may be important to consider; however there may be development work to do much as was the case with diatoms. Storage considerations – some limitations to freeze-drying – affect on pigments?

Action items:

1. Inventory of cores for LOW – use to support future grant proposals for the region (since future studies might be able to use these cores). Once this is done Rainy River Water Resources Center could organize this and make information available on web site. Check on Rainy River inventory (ask Don and Wendy). Noted this could be important to the State of the Basin report.

2. Blue-green algal toxicity

Observations and issues to address

- Data limitations – need much more monitoring data, e.g. relating toxins to algae and other water chemistry information;
- DFO and LOW property owners group are concerned on this topic;
- long-term program is needed for the lake and integrating "bloom sampling" into volunteer program is one option for gathering more data;
- Know species! seasonality, bloom sizes, risk (note - microcystin is not necessarily coming from just Microcystis);
- Current Minnesota approach – postering, public awareness – would be well applied to LOW basin – need education within the health system too, since people might start calling about it;
- Cost of toxin analysis is quite variable based on analyte, testing kit or laboratory used, detection limits etc. May vary from $50 for microcystin to over $400 for a full suite (including anatoxin, saxitoxin, etc.). There are some kits that can be used but have some limitations.
- MN has used quali-tube kit and may improve capabilities in 2006;
- Look for labs that provide volunteer work 501(C3); should find out about labs that provide these services as it would be one way to advance this issue;
- Sampling as frequent as possible is the best – sources for seed funding are needed. However when designing study one must: 1) Determine what questions you are attempting to answer? 2) Determine required detection limits, accuracy and precision of analysis? 3) How and where will you store data? 4) How and who will analyze data and report to the public? 5) Should elevated Microcystin levels be found in s
- study how will this be shared with the public? Who will do this?

Recommendations:

1. Scoping study: Tentatively interested people were identified (Brian, Ellie, Bev, Hedy, Ryan & Chris).– plan to set up preliminary monitoring plan and (maybe) funding proposal. Leaders (Chris & Brian?) need to be identified to take hold of this project – it must not be put on the backburner. This study will make use of volunteers, low-budget approach that provides the info needed to develop the larger more

comprehensive study that is needed. **Status**: Several of the folks above met and discussed how this might be undertaken. Chris can offer some of the needed volunteer assistance. Brian is able to do some of the Microcystin analysis; however could not underwrite the entire study.

2. Public information campaign – Sharon will develop a coordinated public info campaign patterned after MN approach. Steve will provide her with documents and links to work from. **Status**:
3. We also need to come up with recommendations to tourists – should they boil the water? Blue-greens, E. coli and Giardia respond differently to treatments.

3. Remote sensing

- MODIS and Landsat were successfully applied to LOW, Rainy, Kabetogama and several other lakes this past summer. This is part of a larger NALMS/EPA study on remote sensing. That study will produce a guidance manual on the application of various remote sensing platforms, developed Landsat relationships for several Midwest states, a training workshop at upcoming NALMS symposia and likely a special issue of LakeLine magazine.

- Given the R^2 of regressions great promise for future application. Much interest in automating or broadening use of this technique to identify spatial and temporal changes in algal density, transparency and understand extent of blooms etc. Note MODIS flies over area 2 times per day and images are free.

- Mike Stainton shared work on Lake Winnipeg that may have application to LOW. Canada now in process of automating use of MODIS to routinely assess WQ of Winnipeg; may be applicable to LOW as well. Working in concert with a private corporation. Need further collaboration on this and related efforts (may mesh well with some of the NALMS efforts).

- Paul Anderson supplied some specific questions on MODIS as it might be applied to LOW and Rainy Lakes. These questions will be forwarded onto the researchers in the NALMS project for consideration. Steve will move these forward and try to assemble responses and incorporate into guidance manual that will be developed.

4. Nutrient criteria, TMDL listing and Nutrient budget development

- MN has developed ecoregion-specific P, Chl a and Secchi criteria that are in process of being adopted into state WQ standards. Standards language allows for site-specific standards as needed for reservoirs and waterbodies like LOW;
- Currently no site-specific criteria for LOW (though IJC has criteria for other Great Lakes);
- MN testing to date suggests LOW is very close to standard TMDL thresholds currently in use in MN. Suggest need for one more summer of testing to allow for TMDL assessment of the lake (2008 list considers data collected through summer 2006) TMDL Burden of proof – must exceed certain response variables – averages are calculated based on a minimum of 12 sample dates (details on MPCA web site);
- Downside of TMDL listing? -Negative connotations and tourism – unlikely to have much of an additional impact on tourism – people are already aware of problems, adding a nutrient criterion simply expands research and remedial considerations;

- Nutrient budget - Need to identify available data – such as nutrient flux from various sources/tributaries. Water pathways and a thorough inventory of what data/monitoring programs are currently out there. As for water and external nutrient budget – may not be as complicated as we think, since the Rainy River provides ~70% of the water supply to the lake;
- Suggested that we could attempt an empirical approach like BATHTUB to provide a reasonable estimate of nutrient and water budget Data needed: lake volume, area, watershed area; cottages/resorts; ag/forest/urban characteristics (GIS data); areal precipitation measurements; nutrient measurements – combination of actual measurements and export coefficients;
- We appear to have the means to do some empirical work right now – who can do it is the primary question?

Action items:

4. Next year's LOW meeting: we would like to see a talk "A preliminary nutrient model for Lake of the Woods: a precursor to nutrient criteria"
5. Work should go forward to try to assemble basic info that would be needed to do some very basic empirical modeling of LOW. BATHTUB or an equivalent model was suggested for this purpose. Breaking lake into the "sectors" that fisheries uses may be a good starting point as the bathymetry and flow patterns have been compiled already. Need to determine extent of gauging of major inflows and outflows, though there was a sense that we may be in good shape on this. This would need to be a collaborative effort. Uncertain how to get this initiated or viewed as a priority. This would be a desirable step prior to a much more comprehensive modeling effort such as what might be conducted as part of a Phase I study or TMDL. A more complex dynamic model will need be developed at some point in the future. As a part of this will need a physical mixing component to demonstrate clearly and accurately water flow patterns and volumes. This is expensive and would be implemented at a later date.
6. MPCA proposes to include LOW for sampling in summer 2006 to allow for TMDL assessment (does not imply listing, rather determining if it should be listed as current data set is not adequate for this). Will likely require sampling assistance from LOW SWCD as with previous efforts. Steve will follow-up.

MERCURY WORKING GROUP – 9 March 2005
Compiled by Trent Wickman, work group leader

The group met to review current mercury research, identify research needs and identify opportunities for collaboration.

We went around the room and shared our current mercury activities. Although a number of groups have ongoing mercury research projects, everyone basically said they had little available money to start new projects, or continue current projects very far into the future.

In light of the limited budgets the group discussed what would be the most important item for a land management (or other similar) agency to monitor related to mercury (i.e. wet deposition vs soil, vs water, vs biota). The consensus was young of the year fish since fish are the main point of exposure for humans and wildlife and young of the year fish will show the affects of changes in watershed mercury loads more quickly than predator fish.

We then discussed if/how a long-term mercury monitoring program could be set up across the basin (and potentially beyond) and across different agencies/jurisdictions. The group decided that this program should not only collect information related to mercury but also collect basic, broadly applicable water quality/watershed information so that this monitoring program could be a useful tool not only to monitor mercury but also climate change and other stressors, either currently known or emerging in the future. A few of these sites could also be studied more intensely so that mechanisms could be better understood. The idea is that this monitoring program would identify the set of lakes/rivers to be monitored, the parameters to be monitored, and the protocols to be used. Then the each different agency could plug into this framework and identify which site(s) it could monitor, and/or help pay for lab cost at some sites while other agencies do the field work, etc. A number of different combinations of collaborative work methods could be developed between agencies. The NPS is currently developing a monitoring protocol for their units in the Great Lakes region which could be used as a starting point.

To implement this idea the state/provincial agencies would need to lead a process to develop the long term water quality monitoring plan. In Minnesota this would be MPCA but in Ontario the group was not sure if it would be OME or MNR. These groups would not necessarily need to contribute funds and/or field work to the actual monitoring activities but instead be in the position to oversee the development of the long term monitoring plan and its implementation.

A piece to developing the long term quality monitoring plan would be to identify existing data rich sites since historical water quality information will be very valuable. Working across jurisdictional boundaries will help inform the selection of new sites since data rich sites that are nearby but in other jurisdictions may be just as valuable as a new site within the same jurisdiction. An example of this that was discussed was ELA. The group felt that the work done there is generally applicable across the watershed. It was also mentioned that the future of ELA is uncertain at this time.

VOLUNTEER MONITORING WORKING GROUP – 9 March 2005
Compiled by Kelli Saunders and Bev Clark, work group leaders

The need to hire a volunteer coordinator was discussed and MPCA representatives indicated that they were hoping to provide funds for this position with a tentative start date sometime in July 2006. This position would be responsible for:

- collecting and maintaining volunteer data
- providing educational outreach to community groups/schools
- providing skills and training for volunteers

The group spent considerable time sharing knowledge and discussing potential for collaboration between projects. Minnesota Waters was interested in the program design aspects of the Ontario Benthic Biomonitoring Program and offered to provide training and resources where possible.

Sampling potential at the south end of Lake of the Woods was discussed as a collaborative project between Mike Hurst and the Ontario Lake Partner Program. Kiley Hanson offered to provide similar support to sample Sabaskong Bay and to continue sampling along the Rainy River. A project to conduct weekly sampling at a location in the north end of the lake was discussed with LOWDPOA and others. LOW Soil and Water Conservation District expressed an interest in sampling near the mouth of the Rainy River.

Existing sampling efforts were reviewed including:

- Lake Partner Program volunteer monitoring – 50 locations mostly in the north
- Rainy R. F. N. Watershed Program at 16 sites on the river including 5 years of biweekly E. coli. and total coliform data, 7 Lake Partner sites near confluences to the Rainy River and 6 benthic sites.

Barriers to monitoring activities and possible solutions were discussed. Access to field sampling activities for school groups was hindered by inadequate transportation. Some suggested solutions mentioned were; SWCD education funding, PCA Prevention and Assistance Branch support, Voyageurs National Park Education Program support and potential for support from Boise. Additional support for school programs was identified, e.g. Online activity guide for stream monitoring www.vsmp.org , RRCC education courses, and Rainy River F.N. programs.

Programs initiated at the previous WQ forum volunteer monitoring workshop such as the satellite ground truth study were reviewed and this successful effort was outlined in a poster presented by Steve Heiskary during the conference.

METER CALIBRATION WORKSHOP
By Don Graves

Bill Littleton from the Ohio YSI office and Travis Degroote, YSI Technical Sales Representative presented a calibration workshop to eight participants representing the following agencies: MPCA, City of Kenora, Soil and Water Conservation District, LOW County, MOE Thunder Bay/Kenora, FOE, and RRCC. A few of the participants were new to the YSI equipment and it was their first exposure to its calibration. Others were familiar with the instruments but needed a refresher course on calibration, maintenance and storage. Participants commented that the workshop was very beneficial and it gave them more confidence with their YSI instruments.