

Lake Winnipeg Research Consortium Inc.

2016 / 2017 Annual Report

Science and Education Programs

March 2017

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INTRODUCTION

The Lake Winnipeg Research Consortium (LWRC) Inc. is a registered charity that was founded in 1998 to address the need for scientific studies on Lake Winnipeg following the 1997 Red River flood of the century. Its main objective, realized through the Science Program, is to facilitate science on Lake Winnipeg by providing a dedicated research platform, the Motor Vessel (M.V.) *Namao*, to its science members, and by convening those members annually at a Science Workshop. A secondary objective of the LWRC, met through its Education Program, is to provide educational opportunities to schools and other institutions of learning.

2016 marks the 15th year that the LWRC has facilitated science on Lake Winnipeg. Despite some challenges associated with the drydock facility at Hnausa and re-certifying the M.V. *Namao*, three surveys were again successfully carried out during the open water season. This report summarizes the activities associated with LWRC's Science Program, including acquisitions, the on-lake field program based off of the M.V. *Namao*, and the annual gathering of science members at the LWRC's Science Workshop. The on-lake education programming (Lake Ecology Field Program) was adversely impacted by the aforementioned challenges with re-certifying the vessel. Other aspects of the Education Program are thus described herein.

SCIENCE PROGRAM

Since 2002, the LWRC has offered three, whole-lake research surveys annually - spring, summer and fall – that cover an established network of sampling stations. (Two notable exceptions to this were in the fall of 2005 and the spring of 2014.) For the first 10 years, roughly 65 stations comprised the “offshore” station network on Lake Winnipeg. As new stressors are imposed on the lake ecosystem and research questions and monitoring needs change, the LWRC’s Science Program has responded in part by modifying this station network. In 2012, two “nearshore” stations were introduced in the north basin in an effort to begin to characterize the nearshore area prior to the imminent arrival of zebra mussels. The ecological changes associated with this invasive species can be profound, and the nearshore area will be the first to manifest such changes. In 2014, 10 additional nearshore sites were introduced for a total of 12 stations encompassing the entire lake. A concomitant reduction of offshore stations to 50 was necessary in order for participating science members to accommodate the nearshore stations without additional resources. There are also three outflow stations at the lake’s outlets. All nearshore and outflow stations are accessed by workboat, deployed from the M.V. *Namao*.

In 2016, the LWRC launched a second vessel, M.V. *Fylgja*, a 12.8 m touring boat converted for research purposes. Her full history can be found on the LWRC’s website. With a mere one metre draft, M.V. *Fylgja* complements the M.V. *Namao*’s capabilities by further facilitating special projects in the nearshore of the south basin and narrows of Lake Winnipeg.

Field Program - Open Water Season 2016

Three research surveys were carried out during the 2016 open water season on board M.V. *Namao*. The spring survey ran between June 2nd and June 19th; the summer survey between July 18th and July 31st; and the fall survey between September 12th and September 30th. The fall research survey was completed earlier than usual due to limitations imposed by ongoing complications related to the 5-year drydock inspection, mentioned above. A total of six days were lost to weather – three each during the spring and fall surveys.

During each survey, the LWRC continued to implement its decontamination protocols but on a reduced scale, notably between basins only. Decontaminating equipment between stations is no longer necessary since zebra mussels are now documented in the entire south basin, and by all accounts are doing well. The complete decontamination protocols can be found on the LWRC website.

Appendix A provides a summary of the research and monitoring carried out during the 2016 field season on board M.V. *Namao*. The M.V. *Fylgja* was merely showcased in 2016.

Science Workshop

The annual Science Workshop was held on December 6th and 7th, 2015 at the Qualico Family Centre, Assiniboine Park in Winnipeg. Appendix B contains the list of workshop participants - surprisingly well attended despite the blizzard. After the previous year's special State of the Science II Workshop, which was discussion-based focusing on the big picture and development of a Science Plan, this year's Workshop was comparatively passive and traditional following a format of presentations and questions.

The Science Workshop was made up of two sessions. Day 1 was dedicated to the Food Web, from fish to bacteria, and Day 2 to Modeling, Water Quality and State of the Lake (Appendix C – Agenda). Presentations were either “full” or “mini”, the latter representing projects that are typically in the early stages of development. Abstracts of the workshop presentations are below and the full presentations posted on the LWRC’s website.

Abstracts

Walleye Skinny without Smelt

Geoff Klein

Sustainable Fisheries Unit, Wildlife and Fisheries Branch, MB Sustainable Development

The Lake Winnipeg fish index netting program is designed to evaluate Walleye and Sauger stocks. Relative weights of Walleye began to decline after 2011 in the north basin and in 2013 in the channel area and south basin. Decreasing Walleye condition in the north basin is thought to be due to rarity of their primary diet item, Rainbow Smelt. Decreasing condition in the south basin is likely due to Walleye immigrating from the north. A decline in relative weights of Sauger predates the Walleye decline. For large Sauger (> 38 cm), condition has continued to decline, while small Sauger condition has improved since 2012.

Commercial Fishing Update - Nothing Changes if Nothing Changes

Bill Galbraith

Sustainable Fisheries Unit, Wildlife and Fisheries Branch, MB Sustainable Development

The Manitoba commercial fishing sector has experienced significant changes over the past year. These changes deal either with the way commercial fisheries are to be managed or the way the products from these commercial fisheries are to be marketed and sold. Both factors will result in substantial changes to how the commercial fisheries in Manitoba are regulated and operated.

In an effort to build on past accomplishments and efforts made towards achieving certification of Manitoba's commercial fisheries, the department re-organized a portion of the Fisheries sections of Wildlife and Fisheries Branch into the new *Sustainable Fisheries Unit*. The mission of this new unit is to create maximally productive fisheries

able to meet sustainable fishing certification standards, by working collaboratively with stakeholders and using sound science and community knowledge.

The department has also been working with fishers, local communities, local political leadership and commercial tourism operators to achieve and maintain eco-certification of 18 additional commercial gillnet and mixed use fisheries located throughout the Western, Northwestern and Interlake Regions of the province.

The Premier of Manitoba's May 3rd, 2016, mandate letter to the Minister of Sustainable Development directed the department to develop and implement a credible strategy to secure certification of Manitoba's commercial fisheries. In response to the Premier's mandate, the *Sustainable Fisheries Unit* has proposed an action plan based on three paths:

- **Maintenance** – this path involves activities required to ensure that the certification status of certified commercial fisheries is maintained. Presently this encompasses only the Waterhen Lake Walleye and Northern Pike commercial gillnet fishery.
- **Moving Forward** – this path involves undertaking the necessary management actions/activities to secure certification status for fisheries that have requested certification, and thus are currently in the pre-certification phase. This currently encompasses the 18 separate commercial fisheries located throughout the Western, Northwestern and Interlake regions of the province that have submitted written confirmation that they wish to work with the department to achieve certification of their fisheries under the Marine Stewardship Council (MSC) Program.
- **Building** – For fisheries neither yet certified, nor in pre-certification, or provided a commitment to achieve certification, the department will create maximally productive fisheries able to meet sustainable fishing certification standards, by building on and improving collaboration with stakeholders and investing in sound science and community knowledge to develop credible stock status indicators for management of lakes. This includes such fisheries as lakes Winnipeg, Manitoba and Winnipegosis.

On August 16, 2016, the Government of Manitoba announced that it is moving to create flexible marketing options for Manitoba's commercial fishers. Fisheries Envoys have been put in place with the responsibility of developing a new framework for commercial fish sales under a flexible marketing environment.

The Fisheries Envoys are to conduct consultations with commercial fishing communities, indigenous groups, business and others to identify and understand issues and opportunities. The Fisheries Envoys are to engage the federal government on its withdrawal from the Freshwater Fish Marketing Act, including determining mutually beneficial timing and addressing the necessary administrative transitions. In addition, the fisheries envoys will:

- identify new regulations, policies and systems needed to establish the new marketing system;
- establish a process for effective and sustainable fisheries management, such as catch and sales reporting requirements; and
- make contact with private-sector interests wanting to develop local fish-processing facilities or marketing co-operatives.

The Wildlife and Fisheries Branch is currently working on drafting new fisheries marketing regulations, as well as building a new data collection system in response to changes coming from moving away from the current structure towards a flexible marketing system.

Lake Winnipeg Basin Fish Movement Study

Doug Watkinson¹, Colin Charles¹, Colin Kovachik¹, Doug Leroux¹, Mark Pegg², Stephen Siddons², Geoff Klein³, Paul Blanchfield¹, Mike Stainton¹, Mike Rennie⁴, Eva Enders¹

¹Freshwater Institute, Fisheries and Oceans Canada

²University of Nebraska, Lincoln, Nebraska

³Wildlife and Fisheries Branch, MB Sustainable Development

⁴Department of Biology, Lakehead University, Thunder Bay, Ontario

In May 2016, Fisheries and Oceans Canada initiated, in partnership with the University of Nebraska, Province of Manitoba, Lake Winnipeg Foundation, and Lakehead University, a large-scale fish movement study to address research interests and management concerns in the Lake Winnipeg Basin. To date, 121 Channel Catfish, 43 Lake Sturgeon, 40 Common Carp, and 40 Bigmouth Buffalo have been tagged with VEMCO hydroacoustic transmitters in the Netley-Libau Marsh, Red or Winnipeg rivers. In addition, 150 Walleye will be tagged in Lake Winnipeg in spring 2017. Tagged fish are detected using an array of passive receivers (VEMCO, model VR2W, n=121) positioned in the south basin of Lake Winnipeg and the Red, Winnipeg, and Assiniboine rivers. Most receivers have been downloaded in September and October 2016. The available data from only 3-5 months of fish detection has already provided valuable insights into the movement and residency of fish in the basin, fish passage at the St. Andrews Lock and Dam as well as the trans-border migration of individual fish into the US portion of the watershed. This multiyear study will provide long-term information on temporal and spatial patterns of fish habitat use in the Lake Winnipeg Basin. A positive spin off of the study is the collection of Zebra Mussel colonization, density, and growth data over the entire south basin along a 7 x 7 km grid, which will be analyzed in 2017.

Pelagic Fish Community Update

Chelsey Lumb¹, William Franzin^{2,3}, and Doug Watkinson²

¹Wildlife and Fisheries Branch, MB Sustainable Development

²Freshwater Institute, Fisheries and Oceans Canada

³Laughing Water Arts and Science, Inc. (present address)

Prey fish are an integral part of the food web, acting as a key energy link between lower trophic levels and predatory fish. The offshore, small-bodied fish community in Lake Winnipeg is assessed to monitor abundance and distribution of fish populations. There are large differences in species composition and biomass in the pelagic fish community in different regions of the lake. Until recently, the prey fish community in the north basin was made up of predominantly non-native Rainbow Smelt (*Osmerus mordax*), while in the channel and the south basin, native Emerald Shiner (*Notropis atherinoides*) and Cisco (*Coregonus artedi*) were the dominant species. Results from pelagic fish surveys from 2002 to 2015 suggest Rainbow Smelt biomass decreased to less than 10 percent of previous levels (long term average biomass) since 2014. In the channel and the south basin, biomass of Emerald Shiner and Cisco appeared to be at lower levels from 2011 to 2014 compared to previous years, biomass of both species seemed to increase in 2015. After nine years of low biomass, native Goldeye (*Hiodon alosoides*) biomass in the south basin began to increase in 2013 to levels not observed since 2003. Results from pelagic fish surveys can be used to aid in evaluating the relative importance of top-down and bottom-up regulation in the Lake Winnipeg food web, with implications for fisheries and water quality management.

A Study of the Lake Whitefish Diet Following the Invasion of Zebra Mussels in Lake Winnipeg (mini)

Chelsey Lumb¹, Geoff Klein¹, Michael Rennie², and Patricia Ramlal³

¹Manitoba Sustainable Development, Winnipeg

²Lakehead University, Thunder Bay

³Fisheries and Oceans Canada

We initiated a study in 2016 to use stable isotopes to re-examine the diet of the Lake Winnipeg Lake Whitefish following the invasion of Zebra Mussels in the lake. The data that we collect will be compared to the pre-invasion data of Ofukany et al. (2014). We anticipate that the current study will involve collecting samples for the next two to three years and the data will be compared. Starting in 2017 we will provide annual updates of the data and possible trends that can be inferred from that data.

Bathymetry and Habitat Survey of Lake Winnipeg – Proposed (mini)

Doug Watkinson

Freshwater Institute, Fisheries and Oceans Canada

No abstract submitted. This presentation described a proposal that aims to address the high priority need for substrate mapping of Lake Winnipeg. Interpolated habitat maps detailing both water depth and substrate, as well as distribution and density maps of zebra mussels would provide important information in support of numerous research initiatives,

including water quality modelling (ECCC), fish habitat availability and fish movement studies (DFO, MB).

Microplastic Pollution in Lake Winnipeg (mini)

Philip Anderson¹, Sarah Warrack¹, Jonathan K. Challis³, Mark Hanson², Victoria Langen⁴ and Michael Rennie⁴

¹Department of Biology, University of Saskatchewan, Saskatoon

²Department of Environment and Geography, University of Manitoba

³Department of Chemistry, University of Manitoba

⁴Department of Biology, Lakehead University, Thunder Bay

Microplastics are an emerging contaminant of concern in aquatic ecosystems. To better understand microplastic contamination in North American surface waters, we report for the first time densities of microplastics in Lake Winnipeg, the 11th largest freshwater body in the world. Samples taken in 2014, 2015 and 2016 revealed similar or significantly greater microplastic densities in Lake Winnipeg compared with those reported in the Laurentian Great Lakes. Plastics in the lake were largely of secondary origin, overwhelmingly identified as fibres. We detected significantly greater densities of microplastics in the north basin compared to the south basin of the lake in 2014, but not in 2015 or 2016. Mean lake-wide densities across all years were comparable and not statistically different. Scanning electron microscopy with energy dispersive X-ray spectroscopy indicated that 23% of isolated particles on average were not plastic. In 2014, corrected densities of microplastics were significantly greater at the northern Saskatchewan River inflow vs. southern basin inflows, but not in 2015 or 2016. While the impact of microplastics on aquatic ecosystems is still largely unknown, our study contributes to the growing evidence that microplastic contamination is widespread even around sparsely-populated freshwater ecosystems, and provides a baseline for future study and risk assessments.

Coordinated Aquatic Monitoring Program (CAMP)

Jennifer Van de Vooren
Manitoba Hydro

The Coordinated Aquatic Monitoring Program (CAMP) was initiated in 2006 by the Province of Manitoba and Manitoba Hydro to monitor the health of water bodies affected by Manitoba Hydro's generating system. Data are collected on 44 waterbodies over eight regions of the province and include a suite of aquatic ecosystem, physical environment, and hydrologic parameters. Indicators of ecosystem health were developed in 2014 with the assistance of the IISD, to focus the analysis and reporting process. CAMP monitors a few sites (Grand Rapids, Sturgeon Bay, Mossy Bay, Warren Landing, 2-Mile Channel) in or near the north basin of Lake Winnipeg.

***First Record and Rapid Geographic Expansion of Spiny Water Flea (*B. longimanus*)
in Manitoba, Canada 2009 - 2014***

Wolfgang Jansen¹, Ginger Gill¹, and Brenda Hann²

¹North/South Consultants Inc.

²Department of Biological Sciences, University of Manitoba

The spiny water flea (SWF; *Bythotrephes longimanus*), an aquatic invasive zooplankton species native to Eurasia, was first recorded from Manitoba waters at the Pointe du Bois Generating Station on the Winnipeg River on 18 July, 2009. Based on drift net (43 x 85 cm opening; 950 µm mesh) samples in early June, SWF drift density upstream and downstream of the Pointe du Bois Station was highly variable with maximum densities of 23.3 individuals/m³ in 2010 (9 samples) and 9.4 individuals/m³ in 2012 (60 samples). The only consistent trend was that densities obtained from surface sets were approximately 50 times higher than those from bottom sets. In September of 2011, SWF was found in very small numbers in kick-net samples from nearshore areas of the Winnipeg River at Lac du Bonnet, approximately 50 river kilometers downstream of Pointe du Bois. In the fall of the same year, SWF were identified from the stomachs of eight Cisco (*Coregonus artedi*) collected from the south basin of Lake Winnipeg near the mouth of the Winnipeg River, indicating that the invader has become part of the local food web. Subsequent captures of relatively large numbers of SWF in kick-net samples from Mossy Bay at the north end of Lake Winnipeg in 2014 (when first sampled since 2010) and from Playgreen Lake approximately 7 km north of the Lake Winnipeg outlet in 2012 provide evidence for a rapid expansion of this species throughout Lake Winnipeg and further downstream in the Nelson River. Yearly (Cross and Split lakes; lower Nelson River) or tri-yearly (Little Playgreen, Sipiwersk, and Stephens lakes; Limestone forebay) kick-net (nearshore) and benthic grab (offshore) sampling for aquatic invertebrates between 2012 and 2016 provided zero catches of SWF. These results suggest that if SWF has colonized the upper Nelson River system, population densities are currently low.

Aquatic Invasive Species Program Update (mini)

Laureen Janusz

Wildlife and Fisheries Branch, Manitoba Sustainable Development

With the cooperation of several partners including Sustainable Development Regional Operations and Water Science Management, the Lake Winnipeg Research Consortium, Swan Valley Sport Fish Enhancement and Manitoba Hydro (North South Consultants) 73 waterbodies were sampled. The primary focus was on Zebra Mussels, however Spiny Waterflea monitoring was conducted as a complementary component of the Zebra Mussel monitoring. This mini presentation will provide a summary of the results to date.

Response of Zooplankton and Zoobenthos in Lake Winnipeg to Increasing Nutrient Loading

Brenda Hann¹, Alex Salki², Mirna Wishart¹, and Sue Watson³

¹Department of Biological Sciences, University of Manitoba

²Salki Consultants Inc., Winnipeg, MB

³Environment and Climate Change Canada, Burlington, ON

Both zooplankton and zoobenthos in Lake Winnipeg are subject to multiple environmental stresses most notably increased nutrient loading over the last 20 years. This stimulus from the bottom up in the food web is hypothesized to lead to increased densities overall. Long-term datasets for two major components of the pelagic food web were synthesized: zooplankton (1969-2006, summer) and zoobenthos (1969-2013, summer). Zooplankton densities have increased substantially since 1969 in the north basin, but not consistently in the south basin. In the north basin, Cladocera and cyclopoid copepods were more abundant whereas calanoid copepods were more prevalent in the south basin. Zoobenthos densities were consistently elevated since 1969 primarily in the north basin. However, responses of dominant taxa varied among basins, e.g. Oligochaeta, Mollusca, and Chironomidae were most abundant in the north basin; *Diporeia* was most prevalent in the Narrows; Ephemeroptera and Trichoptera had highest densities in the south basin. The zoobenthos community composition changed substantially in 2013 with large declines in Mollusca throughout the lake and increased densities of Chironomidae especially in the Narrows and south basin. Environmental factors related to these patterns were examined.

An Analysis of Remote Sensing Algal Bloom Indicators for Lake Winnipeg in Relation to Climate and Environmental Variables (2002 – 2011)

Caren Binding

Water Science and Technology Directorate, Environment and Climate Change Canada,
Burlington, ON

Satellite remote sensing has been used to develop quantitative algal bloom indicators for Lake Winnipeg which are applied in a study of the spatial and temporal trends in bloom conditions in relation to climate and environmental variables. Algorithms are based on reflectance features observed in the near-infra-red portion of the spectrum that relate to scattering and absorption properties of algal cells. Applied to daily, monthly, and annual MERIS imagery for the period 2002-2011, assessments are made of lake-wide variations in chlorophyll concentrations to further our understanding of temporal change in bloom conditions, seasonal bloom progression, and identify areas of persistently elevated biomass. Quantitative remote sensing algal bloom indicators are presented that allow an objective multi-year assessment of bloom severity, extent and timing. These measures are then related to a number of climatic and environmental variables to further understand the drivers of year-to-year bloom variability. A strong relationship is presented supporting the dependence of annual bloom severity on lake TP loadings.

Aerobic Anoxygenic Phototrophs in Lake Winnipeg and Their Role in Biochemical Cycling and Toxin Tolerances (mini)

Steven Kuzyk

Department of Microbiology, University of Manitoba, Winnipeg

Lake Winnipeg has been under scrutiny over recent decades due to eutrophication, with concern towards cause and effect. Surveys investigating the impact of excess nutrients to higher level organisms and chemical content have been initiated, but information gaps still remain for the lakes ecology, specifically for non-eukaryotic organisms.

Furthermore, the microbial composition is largely unknown, including the impact of nutrient loading to the current bacterial population, as well as their importance as primary producers for this fresh water ecosystem. Therefore, we have commenced a microbial ecology study that encompasses all microbial life, but focuses on different groups of phototrophic bacteria; such as cyanobacteria, aerobic anoxygenic phototrophs, and anaerobic anoxygenic phototrophs. Our population studies have included identification of unique species, noting their temporal and spatial variations, as well as their affect on chemical cycling within Lake Winnipeg.

Evaluation of Suspended Sediment Samplers Across Lake Winnipeg in Order to Investigate the Lake as a Source of Sediment Within the Nelson River System

Masoud Goharrokhi¹, David Lobb¹, Greg McCullough², and Phil Owens³

¹Department of Soil Sciences, University of Manitoba, Winnipeg

²Centre for Earth Observation Science (CEOS), University of Manitoba, Winnipeg

³University of Northern British Columbia, Prince George

Suspended mineral sediments in Lake Winnipeg ultimately derive from major tributary inflows (mostly the Red River, which cuts through glacio-lacustrine deposits to the south) and from massive erosion of glacial deposits along the north shore. At any given time, the more proximate source of suspended sediments have been resuspended locally from the bottom. We collected significant quantities of suspended sediments by continuously centrifuging and filtering more than 2 million liters of lake water in transit and at stations during spring and summer cruises 2016. To assess the efficiency of a high-volume, continuous-flow centrifuge system and a high-volume, continuous-flow filtration system in collecting suspended particles under different levels of sediment concentration, weather conditions, and operating durations, samples were collected of the ambient lake water as well as from the outlets of these devices. The nature and distribution of suspended sediment in the water column, in inflows and outflows, and in eroding banks will be quantified. In conjunction with this study, more than 50 bottom sediment cores were also obtained from selected stations and along two transects running southward from north shore of the Lake. We will use sediment fingerprinting techniques to discriminate north shore versus tributary sources of sediment in these dated cores and in the outflow of the lake to quantify the fate of north shore eroded materials.

Modelling Efforts: Updates and Future Direction

Ram Yerubandi, Agnes Richards, Isaac Wong, Craig McCrimmon, and Luis Leon

Watershed Hydrology and Ecology Research Division, Canada Centre for Inland Waters,
Environment and Climate Change Canada, Burlington

No abstract was submitted. This presentation provided a summary of the water quality modeling efforts accomplished during Phases 1 and 2 of the Lake Winnipeg Basin Initiative. These included: set up and calibration of the lake model WASP and development of watershed model SWATs (for the La Salle, Boyne, and Little Saskatchewan); model integration with various load reduction scenarios and impacts on the lake and watersheds; and decision support system tools to model a suite of BMPs in SWAT and to evaluate load reduction scenarios. Future modelling during Phase 3, if funded, will include CanSWAT modelling for the entire Red-Assiniboine Basin (including BMP scenarios), as well as continued lake modelling based on 3D TUFLOW-AED2 (new generation of ELCOM-CAEDYM) with new unstructured grid and zebra mussel component.

A Summary of Water Quality in Lake Winnipeg: 1999 to 2016

Elaine Page
Manitoba Sustainable Development

No abstract was submitted. This presentation included a description of the provincial water quality monitoring program on Lake Winnipeg, a summary of the long-term changes in nutrients and chlorophyll, as well as an initial summary of the new nearshore water quality data. In addition, plans for the 2017 season were described.

Isotopes in Nutrients

Geoff Koehler
National Hydrology Research Centre, Environment and Climate Change Canada,
Saskatoon

No abstract was submitted. This presentation described the use of nitrogen and oxygen isotope “fingerprinting” of nutrient sources within the Red and Assiniboine river basins to determine spatially explicit sector or jurisdictional nutrient source apportionment. This information will be used to determine if nutrients are derived from hotspots or more diffuse sources and ultimately to target and optimize landscape scale nutrient management strategies.

Nutrient Extraction from the Red River by a Healthy Netley Libau Marsh, as Driven by Lake Seiches (mini)

Greg McCullough¹, Michael Stainton², and Buster Welch³

¹Centre for Earth Observation Science (CEOS), University of Manitoba, Winnipeg

²Fisheries and Oceans Canada - retired

³Independent

Lake Winnipeg seiches back up the Red River and drive its water in and out of Netley Libau Marsh. The healthy marsh removes on the order of half a tonne of phosphorus per km² per yr. Future restoration efforts will be mentioned briefly. Note - this is preliminary because we are just now processing the 2016 data.

Lake Winnipeg Harmful Algal Blooms

Arthur Zastepa, Sue Watson, and Jay Guo

Watershed Hydrology and Ecology Research Division, Canada Centre for Inland Waters, Environment and Climate Change Canada, Burlington

No abstract was submitted. The focus of this research is to identify key factors contributing to changes in planktonic diversity, integrity and occurrence of harmful algal blooms and their potential for toxicity. The work is ongoing and, resources permitting, will expand to include algal and cyanobacterial secondary metabolites, and the potential effects of zebra mussels on algal and cyanobacterial taxa / genotypes and toxicity.

Looking at the Relationship Between Algal Toxins and the Chemical, Physical and Biological Parameters in Lake Winnipeg (mini)

Desiree Stratton and Gordon Goldsborough

Department of Biological Sciences, University of Manitoba, Winnipeg

This study will examine the correlations between chemical, physical and biological parameters using the 18-year dataset collected at 63 offshore and nearshore stations on Lake Winnipeg from 1999 to 2017. Lake Winnipeg has become more eutrophic due to high nutrient loading of P and N mainly from the Red River watershed. This has increased the occurrence and size of algal blooms in the littoral and pelagic zones. Since 1969, the abundance of planktonic diatoms in the open-water season has decreased and shifted to mainly toxin-forming cyanobacterial taxa such as *Anabaena*, *Aphanocaspa*, *Microcystis*, *Oscillatoria* (*Planktothrix*), *Pseudoanabaena*. Concentrations of the hepatotoxin microcystin-LR, measured since 1999, were greatest when N:P ratios were low and N-fixing algae were abundant.

Detection and Quantification of β-N-methylamino-L-alanine in Lake Winnipeg Cyanobacteria (mini)

Stephanie Bishop and Susan Murch (presented by Karen Scott, LWRC)
Chemistry, University of British Columbia, Kelowna

β-N-methylamino-L-alanine (BMAA) is a non-protein amino acid, produced by cyanobacteria, found worldwide, accumulated through ecosystems and food webs and associated with neurodegenerative disease in humans. We receive 46 samples from the

Lake Winnipeg Collections in 2016. An aliquot of each sample was freeze dried for analysis of BMAA and its isomers, 2,4-diaminobutyric acid (DAB), 2,3-diaminobutanoic acid (BAMA) and N-(2-aminoethyl) glycine (AEG). We are using a validated analytical method for detection and quantification of the amino acids by LC-MS/MS. An aliquot was also cultured with standard BG11 medium, BG11 medium supplemented with 1.0 mM glutamine or nitrate-free BG11 medium to establish in vitro cultures of each of the collections. These studies will establish the presence and concentration of the neurotoxic amino acids in Lake Winnipeg collections and will create a collection of microbes for further study of metabolism and biochemistry.

Indicators / State of the Lake Report Update

Kevin Jacobs¹ and Elise Watchorn²

¹Water Quality Branch, Manitoba Sustainable Development

²Water Quality Monitoring and Surveillance, ECCC, Winnipeg

Manitoba Sustainable Development and Environment and Climate Change Canada are leading the production of a suite of indicators to track and report on water quality and ecosystem health in the Lake Winnipeg basin. A new, formal process has been established to coordinate this State of Lake Winnipeg indicators project, and to invite the participation of experts from agencies working on Lake Winnipeg. This talk will include a description of this new process and an update on indicators currently in development.

In a parallel process, Environment and Climate Change Canada and Manitoba Sustainable Development are also leading the production of a second State of Lake Winnipeg technical report, covering the period 1999 to 2016. Participation is being sought from scientists and managers who have conducted research, monitoring and other work in Lake Winnipeg and its watershed. This talk will outline the proposed structure of the report, including updated data analyses throughout, chapters on new subject areas, and an expanded exploration of many topics included in the first report. The process of report development, and anticipated timeline, and plans for release will also be described.

LWRC's Honours and Graduate Student Scholarship

In the 2011 - 2012 fiscal year, the Science Program introduced an *Honours and Graduate Student Scholarship* to encourage and promote research initiatives by young scientists on Lake Winnipeg. A generous initial contribution of \$20,000 over five years by the Manitoba Government and General Employees' Union allowed the establishment of the fund, and subsequent smaller contributions are being made to help maintain the fund.

The 2016 - 2017 recipient of the scholarship was Shawna Philpott from the University of Brandon in support of her project entitled *Effects of land-use change on the prairie population of the eastern tiger salamander (*Ambystoma tigrinum*)*. This project combines research and citizen science in order to define suitable habitat within the Red River Basin in Manitoba and make management recommendations for this endangered species.

Shawna received a \$2,000 scholarship for stipend support.

EDUCATION PROGRAM

The primary goal of the LWRC's Education Program is to contribute to greater environmental literacy through the study of Lake Winnipeg, within the Provincial school curriculum. To this end, the Education Program has two main components, the Lake Ecology Field Program (LEFP) and the development of web-based, mixed-media resources. Additional programming initiatives are described below.

Lake Ecology Field Program

The LEFP is a unique hands-on learning opportunity on board M.V. *Namao*, offered to students from grades eight to university level. Students set sail from Gimli, Manitoba on a half-day excursion in the south basin of Lake Winnipeg to sample and analyze various components of the lake ecosystem from *E. coli* in water to macroinvertebrates in sediment, and possibly even microplastics depending on the day. In addition to field and lab work, students are responsible for taking accurate field notes, including drawing specimens, and completing an on-board written assignment. Prior to the field excursion, all students are required to view several on-line presentations describing the lake ecosystem and changes imposed on it by multiple stressors. These on-line resources are updated on a regular basis to reflect the most recent lake and watershed science and in response to student and teacher feedback on their effectiveness.

As previously mentioned, the LEFP was disrupted in 2016 – 2017 due to the drydock challenges associated with re-certifying the ship, as well as severe weather. Consequently, the LEFP was offered on only one day in the spring of 2016.

Other Initiatives

Teachers' Workshop on Board M.V. *Namao*

In an ongoing effort to meet educators' needs and to reach a greater number of students, the Education Program has initiated the development of a two-day, summer, *Teachers' Workshop* on board M.V. *Namao*. The purpose of this initiative is to provide teachers with the theoretical and hands-on experience needed to confidently introduce and explore the Lake Winnipeg ecosystem, and associated subjects that are inevitably impacted when such an ecosystem is compromised, with their students within the existing Provincial curriculum. This initiative is in development.

“LWRC Water Award” - Manitoba Schools Science Symposium

The LWRC is introducing a new *Water Award* at the Manitoba Schools Science Symposium (MSSS). Junior, intermediate and senior student projects that focus on water quality, quantity or remediation will be eligible. Winners will receive a certificate, a cash prize of \$100, and an opportunity to join the LWRC science team for a half day on board the research vessel *Namao* during the summer research survey.

Website

The LWRC's website continues to serve as the primary repository of information related to the LWRC's Science and Education Programs, ship operations, governance and the lake itself. All programming documents are now housed on the website. The Lake Winnipeg Satellite Image Library, an archive dating back to 2003, continues to grow. As part of the implementation of the Strategic Plan, a new website is in development, to be launched in mid-2017.

APPENDICES

Appendix A - Research and Monitoring Activities Conducted off the Motor Vessel *Namao* during the 2016 Open Water Season

Agency	Lead	Project	Spring	Summer	Fall	Details
Manitoba Sustainable Development	Jacobs	Long-term water quality monitoring of Lake Winnipeg	X	X	X	All offshore lake stations - nutrients, chlorophyll a, other routine chemical parameters*, vertical depth profile measurements of light, temperature, dissolved oxygen, turbidity, and conductivity (Seabird), <i>E. coli</i> . 14 long-term stations - metals and major ions, whole water phytoplankton for identification, enumeration, and biovolume estimates, macroinvertebrate samples (in triplicate, spring only), and surface sediment samples (summer only) for metals, nutrients, organic content, and particle size analysis (percent sand, silt, and clay). Three stations nearest the inflow of the Red, Winnipeg, and Saskatchewan rivers - pesticides (summer only starting 2013). Microcystin-LR and cyanobacterial cell counts where nuisance algae blooms occur.
	Jacobs	Nearshore water quality monitoring	X	X	X	Nearshore station transects at 1m, 2m and 3m depths - general chemistry, N and P (total particulate and dissolved), chlorophyll, TSS, turbidity, PAR, calcium
	Lumb & Heuring	Lakewide offshore trawl surveys for status and trend monitoring of pelagic fish	X	X	X	Spring 30 stations; summer all stations; fall 30 stations
	Janusz	<i>Bythotrephes</i> monitoring		X	X	Two vertical zooplankton hauls taken at each offshore station - 76 µm mesh size - composited. Samples taken starting two m off the lake bottom
	Janusz	Zebra mussel veligers and adults	X	X	X	Veliger sampling at all stations including Warren landing and Two-Mile - offshore and nearshore; substrate samplers at Pine Dock, Grand Rapids, George I., Macbeth

Agency	Lead	Project	Spring	Summer	Fall	Details
Environment and Climate Change Canada	Yerubandi	Physical lake model - assessment of hydrodynamics and model-based nutrient status	X		X	Spring - Recover winter moorings 502, 505; re-deploy 500, 502, 505; drop camera south basin. Fall – retrieve moorings; deploy winter moorings 502, 505
	Yerubandi	Water quality monitoring;	X	X	X	Seabird vertical depth profiles taken on the downcast - temperature pH, DO, %sat DO, turbidity, conductivity & PAR – all stations Prov WQ/LWRC sampled
	Watson & Guo	Nutrients and harmful algal blooms		X		All stations (1 m) - TP, TDP, PP, DIN, DIC, DOC, toxins (particulate & dissolved), chl-a, phycocyanin, metabolites, POC/PON, TSS, DNA, picoplankton, phytoplankton. Select stations – surficial sediment (Ekman x3) for DNA and toxins
Fisheries & Oceans Canada; MB Sustainable Development; Lakehead U.	Ramlal, Lumb, Klein & Rennie	C & N stable isotopes - food web (zooplankton, benthos, forage fish)		X	X	Stations 2, W10, 12B, W8, W13, W7, 39, 34S, W6; nearshore stations 4NS, 9NS, 1NS, 12NS (at 3 m) sampled for zooplankton, benthos, and forage fish
Algal Taxonomy & Ecology Inc.	Kling	Phytoplankton	X	X	X	14 long-term stations + nearshore (surface water - 0 to 0.5 m) preserved
U. Manitoba	Stadnyk	Development of a Stable Water Isotope ($\delta^{18}\text{O}$ and $\delta^2\text{H}$) Monitoring Network (SWIMN) in the Nelson River Basin	X	X	X	Stations 22, 23B, 33 - profiles at 3-4 m intervals. Warren's Landing and Two-Mile Channel outflow - composite samples Water samples are being analyzed for stable water isotopes ($\delta^{18}\text{O}$ and $\delta^2\text{H}$).
U. Manitoba	Kuzyk (student) & Yurkov	Anoxygenic phototrophs – biochemical cycling and toxin tolerances	X	X	X	Stations W9, 7NS, W10 and 57B
U. Manitoba; U. Winnipeg	Hanson & Wong	Passive samplers for polar organic contaminants and persistent organic pollutants	X	X	X	Passive samplers deployed and/or retrieved at ODAS weather buoys. (International AQUA-GAPS Monitoring Network)

Agency	Lead	Project	Spring	Summer	Fall	Details
U. Manitoba	Hann	Zoobenthos	X	X	X	All offshore and nearshore (at 1 m) stations - one sample per site - 200 micron mesh
U. Manitoba	Hann	Zooplankton community	X	X	X	Vertical haul; 29 stations along N/S transect – 70 micron mesh
U. Manitoba	Goharrokhi, Lobb & McCullough	Sediment	X	X		Spring - sediment coring at stations 33, 34S, 26S, W1, 21, 39, W6, W10; north shore sediment transects (x2) & littoral samples. Summer – sediment coring at stations 59, W9, 11NS, 2-Mile; suspended sediment in transit, 11NS, 2-Mile, Warrens, at anchor, W stations
U. British Columbia	Murch	BMAA algal toxin		X	X	Duplicate water samples from algal blooms (frozen, fresh)
Lakehead U. & U. Manitoba	Rennie, Hanson & Challis	Characterizing micro-plastics	X			Manta trawls at stations 2, 3B, 7, 59, W9, W8, 65, W6, W4, W1, 28, 22, 12NS
Manitoba Hydro	Chaze	Same chemistry as Province	X	X	X	Warren Landing, Two-Mile Channel (inflow and outflow); Two-Mile transects (fall only)

Appendix B. Science Workshop participants and affiliations

Name	Agency
Armstrong, Nicole	Manitoba Sustainable Development
Ayles, Burton	Fisheries and Oceans Canada - retired
Bayer, Barb	ALS Environmental
Binding, Caren	Environment and Climate Change Canada, Burlington
Challis, Jonathon	University of Manitoba
Charles, Colin	Freshwater Institute, Fisheries & Oceans Canada, Winnipeg
Chaze, Ainslie	Manitoba Hydro
Durhack, Travis	University of Manitoba
Enders, Eva	Freshwater Institute, Fisheries & Oceans Canada, Winnipeg
Farmer, Kristina	Environment and Climate Change Canada, Winnipeg
Galbraith, Bill	Manitoba Sustainable Development
Geisler, Marianne	University of Manitoba
Glowacka, Bozena	ALS Environmental
Goldsborough, Gord	University of Manitoba
Hann, Brenda	University of Manitoba
Hanson, Mark	University of Manitoba
Hemphill Lee-Ann	ALS Environmental
Hesslein, Ray	Fisheries and Oceans Canada - retired
Heuring, Laura	Manitoba Sustainable Development
Higgins, Scott	International Institute of Sustainable Development - ELA
Jacobs, Kevin	Manitoba Sustainable Development
Janson, Wolfgang	North/South Consultants Inc.
Janusz, Laureen	Manitoba Sustainable Development
Klause, Jenna	Student - Manitoba Sustainable Development
Klein, Geoff	Manitoba Sustainable Development
Koehler, Geoff	Environment and Climate Change Canada, Saskatoon
Kuzyk, Steven	University of Manitoba
Leon, Luis	Environment and Climate Change Canada, Burlington

Name	Agency
Lindeman, Dorothy	Environment and Climate Change Canada, Winnipeg
Lumb, Chelsey	Manitoba Sustainable Development
McCullough, Greg	University of Manitoba
Page, Elaine	Manitoba Sustainable Development
Parker, Brian	Manitoba Sustainable Development
Paterson, Michael	International Institute of Sustainable Development - ELA
Ramlal, Patricia	Freshwater institute, Fisheries and Oceans Canada
Rutherford, Les	Environment and Climate Change Canada, Winnipeg
Scott, Karen	Lake Winnipeg Research Consortium
Swanson, Gary	Manitoba Hydro
Toews, Jay	Independent
Van de Vooren, Jennifer	Manitoba Hydro
Watchorn, Elise	Environment and Climate Change Canada, Winnipeg
Watkinson, Doug	Fisheries and Oceans Canada
Zastepa, Arthur	Environment and Climate Change Canada, Burlington

Appendix C. Science Workshop Agenda

Science Workshop 2016
Lake Winnipeg Research Consortium Inc.
December 6th & December 7th, 2016
Assiniboine Park, Winnipeg, Manitoba
Qualico Family Centre - Tamarack Room

DAY 1 – FOOD WEB plus
8:30 a.m. to 5:00 p.m.

8:30 a.m.	Opening remarks	Karen Scott ¹
	Walleye skinny without smelt	Geoff Klein ²
	<i>Nothing changes if nothing changes</i> - Commercial fishing update	Bill Galbraith ²
	Lake Winnipeg basin fish movement study	Doug Watkinson ³
10:30 a.m.	Coffee	
10:45 a.m.	Pelagic fish community update	Chelsey Lumb ⁴
	A study of the lake whitefish diet following the invasion of zebra mussels in Lake Winnipeg (mini)	Patricia Ramlal ³
	Habitat survey - proposed (mini)	Doug Watkinson ³
	Microplastic pollution in Lake Winnipeg (mini)	Mark Hanson ⁵
12:15 p.m.	Lunch	
1:00 p.m.	Coordinated Aquatic Monitoring Program	Jennifer Van de Vooren ⁶
	First record & rapid geographic expansion of spiny water flea (<i>B. longimanus</i>) in MB, Canada 2009-2014	Wolfgang Jansen ⁷
	Aquatic Invasive Species Program update (mini)	Laureen Janusz ⁴
	Response of zooplankton & zoobenthos in Lake Winnipeg to increasing nutrient loading	Brenda Hann ⁸
3:00 p.m.	Coffee	
3:15 p.m.	Analysis of remote sensing algal bloom indicators in relation to climate & environmental variables (2002-2011)	Caren Binding ⁹
	Aerobic anoxygenic phototrophs in Lake Winnipeg and their role in biochemical cycling and toxin tolerances (mini)	Steven Kuzyk ¹⁰
	Investigation of Lake Winnipeg as a source of sediment within the Nelson River system	Masoud Goharrokhi ¹¹
4:45 p.m.	Wrap up Day 1	

AGENDA
Science Workshop 2016
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DAY 2 – MODELING, WATER QUALITY & STATE OF THE LAKE		
8:30 a.m. to 1:00 p.m.		
8:30 a.m.	Modelling efforts: updates and future directions	Luis Leon ⁹
	Long-term water quality monitoring	Elaine Page ¹²
	Nutrient isotopes	Geoff Koehler ¹³
	Nutrient extraction from the Red River by a healthy Netley-Libau Marsh, as driven by lake seiches (mini)	Buster Welch ¹⁴
10:30 a.m.	Coffee	
10:45 a.m.	Harmful Algal Blooms	Arthur Zastepa ⁹
	Algal toxins & the chemical, physical & biological parameters in Lake Winnipeg (mini)	Desiree Stratton ⁸
	Detection & quantification of β-N-methylamino-L-alanine in Lake Winnipeg cyanobacteria (mini)	(Susan Murch ¹⁵)
	Indicators / State of the Lake update	K. Jacobs ¹² & E. Watchorn ¹⁶
12:30 p.m.	Wrap up	Karen Scott ¹

Affiliations

¹Lake Winnipeg Research Consortium Inc.

²Sustainable Fisheries Unit, Wildlife and Fisheries Branch, Manitoba Sustainable Development

³Freshwater Institute, Department of Fisheries & Oceans Canada

⁴Wildlife and Fisheries Branch, Manitoba Sustainable Development

⁵Department of Environment and Geography, University of Manitoba

⁶Manitoba Hydro

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¹⁰Department of Microbiology, University of Manitoba

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¹⁵Department of Chemistry, University of British Columbia

¹⁶Environment and Climate Change Canada, Winnipeg