Lake Winnipeg Research Consortium Inc.

2014 / 2015 Annual Report

Science and Education Programs

Strategic Plan

April 2015

Report prepared by Dr. Karen J. Scott

Programs Coordinator

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INTRODUCTION

The Lake Winnipeg Research Consortium (LWRC) Inc. is a charitable organization 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 is to facilitate science on Lake Winnipeg by providing a dedicated research platform, the Motor Vessel (M.V.) *Namao*, to its science members. Since 2002, three research surveys have been conducted annually over the entire lake in the spring, summer and fall (with the exception of 2005).

As described in previous reports, the LWRC continues to sample on behalf of an increasing number of these science agencies unable to provide their own on-board personnel. The 2014 field season was no different in this regard and included benthos, zooplankton and small-bodied fishes (pelagic trawls). In addition, the LWRC sampled the lake outflows for general water chemistry and stable water isotopes, deployed and retrieved POCIS, carried out manta trawl tows for a microplastics survey, and sampled the north shore for a Special Project erosion study. The LWRC also deployed and retrieved moorings and assisted in the routine operation of the Seabird for Environment Canada. In some of these cases, the absence of a dedicated technician on board the ship was certainly justified, as sampling was infrequent. However, in other instances, including most of the food web, the time and effort of the LWRC to accommodate this sampling was considerable. More importantly and of much greater concern, is that this trend is a testament to the diminishing science capacity on Lake Winnipeg, the consequences of which are all the more serious now that zebra mussels are in the lake.

The ecological changes associated with zebra mussels can be profound, and based on the Laurentian Great Lakes' experience, the near-shore area will be the first to manifest such changes. If conditions are suitable for their growth, the high filtration rates of zebra mussels can lead to increased water clarity and nutrient concentrations in the near-shore area, which in turn may result in greater benthic (attached) algal productivity and macrophyte growth. Associated with this excess near-shore benthic primary productivity can be high bacterial growth, due in part to the protection from UV radiation that they afford to bacteria. Over time, changes in nutrient cycling and productivity in the near-shore can impact primary productivity in the offshore areas of the lake, and ultimately these changes can be reflected higher up the food web to fish.

Given the important influence that zebra mussels can have on nutrient cycling, not to mention the rest of the food web, the ultimate success of many of the current initiatives aimed at reducing nutrients entering Lake Winnipeg, such as those funded by the Lake Winnipeg Basin Stewardship Fund, will be difficult to evaluate from the lake's perspective without more adequate long-term lake monitoring coupled with appropriate whole ecosystem research programs, that include the entire food web. The "long-term ecologically relevant nutrient objectives" being developed by the Province of Manitoba would also benefit from more robust post-invasion data for model validation, as would other important questions, such as those related to nutrients and fish productivity.

The LWRC's Science Program is limited in its capacity to develop research and monitoring programs since its role is to facilitate science on Lake Winnipeg, not to conduct science *per se*. Nevertheless, the LWRC continues to move forward on a number of initiatives to further support and facilitate the on-lake effort of its science members and their respective monitoring and research programs. For example, in addition to sampling on behalf of many agencies, which is more by necessity than by choice, in 2014 the Science Program began to re-evaluate the offshore station network and enhance its near-shore station network (described below). This is an important step forward as it provides the opportunity to better characterize and monitor the near-shore without compromising the offshore effort or expending additional resources. It also allows ship time to be directed toward Special Projects, which may not otherwise be possible within the confines of the scheduled surveys but may be required as research questions change with the arrival of zebra mussels. The Science Program is also enhancing on-board infrastructure when possible and acquiring relevant science equipment, which is made available to science agencies. Lastly, as described in previous reports, the academic community continues to remain largely absent from the on-lake science effort. To address this, the LWRC established a scholarship to support the research of honours and graduate students. In addition, the LWRC will assist in the development of an NSERC Strategic proposal, which, if successful, has the added benefit of supporting a non-academic partner, such as Fisheries Branch, which continues to suffer annual decreases in funding.

The sustainability of the LWRC is also of considerable importance since a dedicated research vessel is required to study and monitor a lake of this size. To address this, the LWRC completed its first Strategic Plan in 2015, which focused largely on stabilizing and diversifying its funding base, and enhancing Board governance to ensure long-term sustainability and adequate succession planning.

This report summarizes the activities of the Science and Education Program during the 2014/2015 fiscal year, including: the on-lake Field Program and some of the aforementioned initiatives to support the on-lake science effort; the annual Science Workshop; Science Program acquisitions; the 2014 LWRC Scholarship; and the various components of the Education Program. In addition, the Strategic Plan is presented in an abridged format.

SCIENCE PROGRAM

Field Program - Open Water Season 2014

The 2014 open water season can be deemed successful despite some challenges, notably those associated with zebra mussels. The *Namao* was not available for the spring survey due to the attempted eradication of zebra mussels and consequent closure of Gimli Harbour during the potassium treatments. Consequently, the 21-foot aluminum workboat was used in the spring, from June 9th to June 26th, to sample a reduced suite of parameters and stations, including the Provincial W stations and new near-shore stations (see "Station Network Re-Evaluation" below) in the south basin and narrows. No stations in the north basin were sampled during the spring survey due to logistical and safety concerns associated with working from a small vessel. The *Namao* was back in service for the summer survey, which ran from July 22nd to August 8th for a total of 15 sailing days. The fall survey ran from September 15th to October 8th for a total of 17 sailing days. No days were lost to weather during the summer survey; however, nine days were lost in the fall. Summaries of the studies and monitoring carried out during the three research surveys are included in Appendix A.

Zebra Mussels – Decontamination Procedures and Other Measures

Zebra mussels were first discovered in October 2013 in a number of Lake Winnipeg harbours, including Gimli Harbour, where the M.V. *Namao* resides. In the spring of 2014, the Province of Manitoba (Conservation and Water Stewardship) in collaboration with ASI Group Limited, carried out liquid potash treatments in an effort to eradicate the seemingly isolated populations that existed in these harbours. The treatments were considered successful based on the experimental controls (no live adults) and subsequent negative results for veligers in and around the harbours.

The M.V. *Namao* remained docked in Gimli Harbour during the entire liquid potash treatment period (May 29th to June 14th, 2014). Consequently, the hull of the ship was also treated. In addition, SCUBA divers visually inspected the hull of the ship on June 11th, 2014 and no zebra mussels were found. As a result of these measures, the Province of Manitoba deemed the M.V. *Namao* to be "a low probability risk as a vector for the spread of zebra mussels" at the start of the summer research survey in July 2014.

To further prevent the accelerated spread of zebra mussels by scientific equipment, the LWRC developed Decontamination Procedures (Appendix B) to be followed during scheduled research surveys and other non-science activities, such as weather buoy deployment on Lake Winnipeg. In brief, following discussions with the Province of Manitoba, heat and drying (when possible) were chosen as the primary means to decontaminate scientific and other equipment that is used during the operation of the M.V. *Namao*. Heat is the only known means to effectively kill all life stages of both zebra mussels and spiny water flea, another recent aquatic invasive species in Lake Winnipeg. To this end, the LWRC's Science Program acquired a 2.2 HP, 1200 PSI commercial grade hot water

pressure washer capable of a 48°C to 60°C rise in water temperature. The use of heat in the decontamination process was carried out prior to leaving every sampling station. This high level of effort will be evaluated on an ongoing basis by the Science Program Coordinator and revised as needed. There are a few instances when heat treatment with a hot water pressure washer on station is not a suitable option for decontamination and an alternative approach must be taken (Appendix B).

On August 29th, 2014, Manitoba Conservation and Water Stewardship announced that results from increased monitoring showed that zebra mussels were reproducing in the south basin, outside of the treated harbours, as evidenced by the presence of veligers and juveniles at five sites.

In preparation for the fall research survey, another SCUBA inspection was performed on the hull of the M.V. *Namao*. No zebra mussel specimens were found during the inspection; however, due to strong west winds, which held the ship hard fast to the wharf, the starboard side from the chine to the waterline was not inspected. When conditions improved, crew members from the M.V. *Namao* used a snow rake to systematically scrape the starboard hull. No adult specimens were found; however, two juveniles (non-reproducing) were removed from the hull and preserved. Again, the ship was deemed a low risk vector for the spread of zebra mussels. The decontamination protocol for equipment was again rigorously implemented during the fall survey.

Additional assurances that the M.V. *Namao* will continue to remain a low-risk vector for the accelerated spread of zebra mussels include the following:

1) Anchor, anchor chain, and mooring lines to be pressure washed with hot water at every station if in contact with lake water;

2) Ballast water is treated town water. It is used to rinse the fresh water tanks in the spring and is then transferred to the ballast tanks for the open water season and pumped out in the fall. This prevents the transport of lake water as ballast;

3) Lake water intake associated with the engines is continuous and therefore released on site. This water also becomes heated, creating a lethal environment to veligers;

4) Intake strainers to be thoroughly cleaned and decontaminated at scheduled locations. Samples of strainer debris to be periodically collected and preserved for veliger analysis; and

5) During the M.V. *Namao*'s refit in the summer of 2015, anti-fouling paint will be applied to the hull.

Station Network Re-evaluation – Offshore and Near-shore

Prior to 2014, 65 stations comprised the LWRC's offshore station network on Lake Winnipeg. Five of these stations were quite close to shore or at river mouths, and required the use of a workboat for sampling, but were, nevertheless, still considered "offshore". In 2012, two near-shore stations were introduced in the north basin in an effort to begin to characterize the near-shore area prior to the arrival of zebra mussels. Each of the 67 stations is visited three times a year during the spring, summer and fall research surveys.

As previously described (2013/2014 Programs Report) the issue of re-evaluating or optimizing this station network had been discussed on a cursory level over the years. This year, the need to re-evaluate the station network was acted upon in light of numerous factors including: the arrival of zebra mussels; the consequent and immediate need for a greater near-shore effort; the general lack of additional resources by science agencies to do so; as well as the need for the LWRC's Science Program to remain relevant to its science members as research questions and monitoring needs change.

The approach taken to re-examine the offshore station network was straightforward. All active science personnel were provided with a summary spreadsheet that included the list of offshore, near-shore, and outflow stations, as well as the parameters being sampled at each of those stations, and the agency or lead investigator carrying out the work. A proposed set of stations to drop was put forward to the group and feedback was solicited. Responses were summarized and the revised set of stations to drop was again sent out for feedback. Eventually, the group agreed by consensus on a reduction from 65 to 50 offshore stations. The list and details can be found on the LWRC website.

In addition to the reduction in the offshore station network, 10 new near-shore sites were established for a total of 12 stations encompassing the entire lake - see website for locations and details. The importance of characterizing and monitoring the near-shore areas of the lake cannot be over-emphasized now that zebra mussels are becoming established in the lake.

Science Workshop

The annual Science Workshop was held on February 18th and 19th, 2015 at the Siobhan Richardson Field Station, Fort Whyte Centre in Winnipeg. This venue is ideally suited to promote participation and dialogue among workshop invitees, one of the main objectives of the meeting. Appendix C contains the list of workshop participants.

The Science Workshop was made up of five sessions followed by a discussion (Appendix D – Agenda). Day 1 sessions included: Nutrients/Primary Productivity; Biota; and Contaminants, Toxins and Microplastics. Day 2 sessions included: Sediment; and Data Management and Communications. Abstracts of the workshop presentations are below and the full presentations are posted on the LWRC's website.

Session One – Nutrients and Primary Productivity

STATE OF LAKE WINNIPEG: UPDATE

E. Watchorn
Manitoba Conservation and Water Stewardship, Water Science and Management Branch

This presentation will provide an overview of the Provincial water quality monitoring program on Lake Winnipeg, including a description of the network changes made in 2014 replacing some offshore stations with new stations in the nearshore area. For several offshore parameters of interest, including total phosphorus, total nitrogen, and chlorophyll a, 1999-2014 North and South Basin annual means will be presented, and temporal patterns discussed. The implications of a reduced offshore network on the calculation of these values will be described. 2014 North and South Basin nearshore means (for calcium, nutrients, chlorophyll) will be compared with offshore means, in the context of assessing suitability for the establishment of zebra mussels. The results of 2014's beach and lake monitoring for cyanobacteria and algal toxins will be reported. The presentation will include a brief review of water quality and quantity of the major tributaries to Lake Winnipeg, and will conclude with a description of monitoring plans for 2015.

THE DEVELOPMENT OF ECOLOGICALLY RELEVANT NUTRIENT TARGETS FOR LAKE WINNIPEG AND ITS TRIBUTARIES

J. Shead
Manitoba Conservation and Water Stewardship, Water Science and Management Branch

Lake Winnipeg's water quality has been deteriorating over time, with particular concern arising over the past few decades to the effects of accelerated nutrient enrichment in the lake and resulting increase in the frequency and severity of algal blooms. In response to the need to have nutrient targets developed for Lake Winnipeg, the Water Quality Management Section of Manitoba Conservation and Water Stewardship in association with Environment Canada developed an extended version of the eutrophication Water Analysis Simulation

Program (WASP) model that had previously been developed to assess water quality in Lake Winnipeg (Zhang and Yerubandi 2012). The extended WASP model is the basis for the development of ecologically relevant nutrient targets for Lake Winnipeg. The spatially segmented eutrophicaton model of Lake Winnipeg, a summary of reduction scenarios performed, and draft phosphorus and nitrogen loading targets for Lake Winnipeg's major tributaries will be presented.

SEASONAL VARIATION IN NUTRIENT EXPORT FROM PRAIRIE STREAMS IN THE RED RIVER BASIN

K. Rattan[1], P. Chambers[1], J. Culp[1,2] & A. Yates[3]
[1] Environment Canada, Burlington; [2] University of New Brunswick, Fredericton, New Brunswick; [3] Western University, London, Ontario

Human activity is a major contributor of phosphorus (P) and nitrogen (N) to small watersheds in the Canadian prairies. Non-point nutrient sources are challenging to quantify and manage because they come from activities that are distributed over a wide range of area and are variable in time and space due to the role of climate in determining the frequency and intensity of nutrient export. The aim of this study was to quantify patterns in nutrient concentrations across hydrological seasons in 10 sub-watersheds of the Red River Basin, Manitoba Canada, and evaluate critical factors affecting P and N export in relation to human activity. Discharge showed a strong seasonal pattern of high discharge during snowmelt, low discharge with rainfall-induced peaks during summer and fall, and low or no discharge during winter. Total and dissolved P and N showed highest concentrations and loads during snowmelt for all three sampling years (2010, 2013, and 2014), with the exception of occasional summer peaks associated with rain events and wastewater lagoon discharge. Patterns in nutrient loading were strongly influenced by the snowmelt period. On average, 75% of the total P load and 82% of the total N load were delivered during snowmelt. P and N exports were significantly correlated with agricultural land area (specifically canola and small grains) and fertilizer application. Additionally, partial least squares regression analysis indicated that the critical water quality factors affecting water chemistry were land use and hydrology. Our results recognized key drivers of stream-water total and dissolved nutrients, providing the groundwork for modeling nutrient losses and developing effective land use practices to reduce export of bioavailable nutrients.

AN UPDATE ON ENVIRONMENT CANADA'S SATELLITE REMOTE SENSING ACTIVITIES ON LAKE WINNIPEG

C. Binding & T. Greenberg
[1]Watershed Hydrology and Ecology Research Division, Environment Canada, Burlington

An update will be provided on ongoing efforts to develop and implement satellite remote sensing monitoring of Lake Winnipeg water quality. A new analysis of satellite-derived water clarity will be presented incorporating data from both the SeaWiFS (1997-2011) and MODIS

(2002-present) missions, providing a measure of spatial and temporal change in water clarity in anticipation of potential impacts on water clarity from zebra mussels. Work has continued on refining algorithm approaches to detect algal bloom occurrences, including the development of a suspended sediment mask to reduce the potential of false positive bloom flags resulting from enhanced particulate scattering. Bloom statistics (e.g. areal extent, intensity) will be presented from the MERIS mission for 2002-2012 as well as preliminary results from a new Cyanobacteria Dominance Index (CDI) that relates phycocyanin to chlorophyll absorption features. A brief update on current and future sensors will be provided for future remote sensing applications.

A COMPARISON OF THE SPATIAL DISTRIBUTION OF ALGAL METABOLISM IN LAKES WINNIPEG AND ERIE

M.P. Stainton[1], S. Watson[2], R. Bourbonniere[2], M. Holoka[1] & S. Page[1]
[1]Department of Fisheries and Oceans Canada; [2]Environment Canada (Burlington)

During the summer of 2014, autonomous instrumentation for monitoring algal metabolism was in operation on the *Namao*, on Lake Winnipeg and the *Limnos* on lakes Erie and Ontario. Measurements of fixation and respiration were made on station and at hourly intervals, while under way. Continuous measurements of chlorophyll, dominant algal groups and carbon deficiency were also made. At some stations 14C estimates of carbon fixation were measured allowing comparison between a long standing, widely used method and results from novel instrumentation. The spatial distribution of algal metabolism in lakes Erie and Winnipeg is compared from the standpoint of forecasting future impacts of mussel populations on Lake Winnipeg productivity. The potential use of remote sensing to monitor algal productivity is explored.

ISOTOPIC IDENTIFICATION OF NITROGEN AND SULFUR NUTRIENT SOURCES IN THE LAKE WINNIPEG WATERSHED: IMPLICATIONS FOR POTENTIAL TRANSFER TO AQUATIC FOOD WEBS

D. X. Soto, G. Koehler, K. A. Hobson
Environment Canada, Saskatoon

Nutrient inputs have augmented considerably in Lake Winnipeg and its watershed during last decades. These inputs to the Lake Winnipeg watershed include loadings from agriculture (inorganic and organic fertilizer and animal waste) and urban sources (sewage, wastewater discharge). Stable isotope analysis is a powerful tool to identify nutrient sources to aquatic ecosystems and important baseline isotopic data was collected previously for the Lake Winnipeg foodweb. We report now on preliminary isotopic data derived from the Assiniboine and Red River, specifically concentrating on $\delta^{15}N$ and $\delta^{18}O$ values in nitrate as a means of identifying sources of dissolved nitrate such as fertilizers and animal (and human) waste, ultimately leading to higher trophic-level fish. Additionally, dissolved sulfates can similarly provide information on nutrient origins and we are investigating the use of $\delta^{34}S$

measurements in dissolved sulfates and fish in the major river flows into Lake Winnipeg. Our investigations promise to assess seasonal patterns of nutrient sources and loads to Lake Winnipeg and will serve as a monitor of aquatic foodweb trophic responses to further changes in the Lake Winnipeg system.

Session 2 - Biota

PROVINCIAL AIS UPDATE: ZEBRA MUSSEL MONITORING AND PROPOSED AIS LEGISLATION

L. Janusz
Manitoba Conservation and Water Stewardship, Fisheries Branch

No abstract submitted

LAKE WINNIPEG PELAGIC FISH COMMUNITY MONITORING

C. Lumb[1], H. Clark[1], B. Franzin[2], G. Klein[1], S. Milne[3], B. Parker[1] & D. Watkinson[4]
[1]Manitoba Conservation and Water Stewardship, Fisheries Branch; [2]Laughing Water Arts & Science; [3]Milne Technologies; [4]Department of Fisheries and Oceans Canada

The objectives of offshore pelagic fish surveys in Lake Winnipeg are to assess the status of prey fish populations that support top predators and to provide an early indication of year class strength of Walleye. Data from surveys started in 2002 form a baseline against which effects of changes can be assessed, such as changes in lake trophic state and/or establishment of aquatic invasive species, like zebra mussels. Annual age-0 Walleye relative abundance from Lake Winnipeg revealed a number of consecutive, moderately strong year classes that have supported the fishery since 2009. Development of an index is underway to estimate future Walleye year class strength using age-0 assessments and index gill net survey catches. Prey fish populations are important to monitor because prey fish integrate lower trophic level productivity, and act as a key energy link between lower trophic levels and predatory fish. Of the most commonly caught species in Lake Winnipeg, greater biomass of native Emerald Shiner and Cisco were found in the south basin and the channel, compared to the north basin. Biomass of the non-native Rainbow Smelt was greater in the north basin compared to the south basin or the channel. The difference in the spatial distribution of native and non-native prey fish species in Lake Winnipeg may add instability to the fish community. Results from pelagic fish surveys suggest a decrease in Rainbow Smelt biomass starting in 2013. Because Rainbow Smelt are the dominant prey item of Walleye and Sauger in the north basin, decreased abundance could affect growth of Walleye and Sauger.

Environment Canada and Manitoba Conservation and Water Stewardship are developing indicators of ecosystem health and water quality for Lake Winnipeg. Fish indicators currently under development are prey fish populations, which include native and non-native mid-level consumers, Walleye and Sauger, which are top consumers of the pelagic food web.

EXTENSION OF A WALLEYE PRODUCTION MODEL TO MANITOBAN LAKES AND PREDICTED CONSEQUENCES OF DREISSENID ESTABLISHMENT

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[1] University of Manitoba, Winnipeg; [2]International Institute for Sustainable Development; [3]Lakehead University, Thunder Bay

Walleye (*Sander vitreus*) constitute an important natural resource in Canadian inland lakes, both on and off the Boreal Shield. In the province of Manitoba a large and valuable commercial walleye fishery is supported by lakes predominantly on the Boreal Plains which contributes 62% to the national average annual harvest value. With the recent invasion of zebra mussels (*Dreissena polymorpha*) into Lake Winnipeg, concern is rising in regards to the potential effect of these filter feeding mussels on walleye production. The objectives of this study were to develop and evaluate walleye production models that accurately predict walleye yield from lakes across different ecozones (Boreal Shield and Boreal Plains) and to predict the outcome of dreissenid establishment on walleye yield in these lakes as a consequence of increased water transparency. The results here are a starting point for evaluating the effects of dreissenids on vulnerable ecosystems and provide examples for managers of extending those predicted effects to other ecosystem aspects beyond water clarity alone.

Session 3 – Contaminants, Toxins and Microplastics

A SUMMARY OF FISH MERCURY MONITORING CONDUCTED BY MANITOBA CONSERVATION AND WATER STEWARDSHIP

K. Jacobs
Manitoba Conservation and Water Stewardship, Water Science and Management Branch

The Manitoba Government, Manitoba Hydro and Fisheries and Oceans Canada began monitoring mercury levels in fish from Manitoba's major water systems in the 1970s. The Water Quality Management Section of Manitoba Conservation and Water Stewardship (CWS) regularly monitored mercury and other metal concentrations in fish tissues from river systems that included the Assiniboine, Red, Souris, Winnipeg, and Saskatchewan rivers from 1978 to 1992. Site selection was based upon the premise that these locations would most likely identify a contamination issue if one existed. Regular monitoring of most of these sites in Manitoba was discontinued in 1992 in part because data from the early 1990s showed mercury concentrations had declined compared to the early 1980s and appeared relatively stable. Manitoba CWS continued to collect and analyze fish tissue samples for mercury since 1992 on an opportunistic basis (fish being collected by other branches for population monitoring) or in response to specific areas of concern for example flooding events on major lakes, the Flin Flon/ Creighton Human Health Risk Assessment, or contaminant spills. Samples were collected, frozen and analyzed when sufficient funds were available for analysis. Manitoba Conservation and Water Stewardship is a partner in the Coordinated Long Term Monitoring Program with Manitoba Hydro (CAMP). A component of this

program includes long term tri-annual monitoring of muscle tissue in fish in reference areas and areas affected by hydroelectric development in Manitoba. This presentation will summarize the history of fish mercury monitoring conducted by Manitoba Conservation and Water Stewardship and will include a brief overview of recent results from Lake Winnipeg.

WASTEWATER CONTAMINANTS, PESTICIDES, AND ALGAL TOXINS IN LAKE WINNIPEG AND ITS WATERSHED

D. Moore[1], M. Hanson[1] & C. Wong[2]
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As an agricultural province with trans-boundary river systems, Manitoba is vulnerable to contaminant loadings from multiple sources. To better understand the risks these contaminants pose to the watershed and to Lake Winnipeg, we have undertaken a number of varied initiatives over the past several years. These include: passive sampling to characterize contaminant loadings to the lake, ecological and human health risk assessments of microcystins in Lake Winnipeg, and a new initiative to review and evaluate almost 20 years of provincial pesticide monitoring data in collaboration with Manitoba Conservation and Water Stewardship. This talk will provide an update on these projects, as well as plans for 2015.

ASSESSING PLASTIC POLLUTION IN LAKE WINNIPEG

M. Rennie[1,2]; H. Kling[3]; K. Scott[4]
[1]International Institute for Sustainable Development; [2]Lakehead University, Thunder Bay;
[3]Algal Taxonomy & Ecology Inc.; [4]Lake Winnipeg Research Consortium Inc.

Recent estimates of plastic pollution around the globe are beginning to provide context to the enormity of the problem. Between 4 to 12 million tonnes annually are estimated to be dumped into oceans by coastal countries every year, and nearly 270,000 tonnes are estimated to potentially reside in the world's oceans currently. It has become evident that the problem of plastic pollution also impacts freshwaters- microplastics in the water column and sediment have been reported in the Great Lakes, and there is evidence that plastic fibres are consumed by great lakes fishes. Large plastic debris can pose a threat to large birds and fishes if retained in the gut, by effectively reducing stomach volume and feeding efficiency. Additionally, plastics can preferentially adsorb both organic and inorganic contaminants, which can enter the food chain and pose a risk to human health through consumption of wild fish and waterfowl. Lake Winnipeg drains a landscape of one million km^2 and within that watershed can receive waste from 7 million people, making it vulnerable to plastic pollution. We present anecdotal evidence of microplastic pollution in Lake Winnipeg, and describe recent survey efforts and planned work to assess the current state of plastic pollution in Lake Winnipeg.

SOIL EROSION AND SEDIMENTATION WITHIN THE LAKE WINNIPEG BASIN

D. Lobb
University of Manitoba, Winnipeg

Over the past 15 years, there have been considerable advances in our understanding of soil erosion and sedimentation within the watersheds of the Lake Winnipeg Basin. This presentation provides an update on several current research initiatives within the Basin, including studies of the interactions water erosion and other forms of soil erosion, the sources of sediments within ditches and streams and ditches, the role of wind erosion in atmospheric deposition of sediments and nutrients to waterways and waterbodies, and the modelling of erosion and sedimentation processes.

IDENTIFYING THE SEDIMENT SOURCES IN NORWAY HOUSE CREE NATION USING A SEDIMENT FINGERPRINTING TECHNIQUE

J. Theroux, D. Lobb & A. Farenhorst
University of Manitoba, Winnipeg

The lack of clean drinking water has long been a major problem in many First Nations communities in Canada. Norway House Cree Nation is a First Nation community located in north-central Manitoba, where drinking water originates from their local Jack River.

Based on community oral history, it was identified that high sediment loading from nearby Lake Winnipeg and the 2-Mile Channel could be a significant contaminant affecting source water quality. The goal of this community-based study is to identify when, and to what extent suspended sediments could be affecting the community drinking water supply and to determine where in the landscape they are originating. Twelve Phillips sediment samplers were deployed at six sites from June through October 2014. Surface soil samples were also collected, allowing us to use a sediment fingerprinting technique to determine what proportion of the suspended sediments entering the intake are originating from the 2-Mile Channel, Lake Winnipeg, or local sources. Further sampling in the early spring using a continuous flow centrifuge will be done to supplement the analysis required for sediment fingerprinting.

Based on a high level of community interest, additional environmental sampling for mercury and hydrocarbons in soil, sediment, water, and fish was also conducted in September 2014. This sampling provides baseline data for community members to monitor over time.

SEDIMENT AND NUTRIENT LOADING TO LAKE WINNIPEG BY EROSION OF ITS NORTH SHORE

Greg McCullough[1], Michael Stainton[2], Sue Watson[3]; Hedy Kling[4], Purnak Shah[3], Craig Irwin[3] & Marianne Geisler[5]

[1]University of Manitoba, Winnipeg; [2]Fisheries and Oceans Canada, Winnipeg; [3]Environment Canada, Burlington; [4]Algal Taxonomy & Ecology Inc., Winnipeg; [5]Lake Winnipeg Research Consortium Inc.

Glaciolacustrine silt and clay forms a steep, 7–8 m high bank stretching 46 km from the east end of Limestone Bay to near Warrens Landing along the north shore of Lake Winnipeg. In a presentation to the LWRC in 2013, we reported that from 1984–2011, an average of 1000–3000 Gg of sediment containing 500–1600 Mg of phosphorus were eroded from this shoreline annually. In this talk, we present data from surveys of sediment plumes developed after erosive wind events in summer and fall, 2014. Samples were collected from 3 transects, at 100, 200, 400, 700, 1500 and 4000 m from shore. Total suspended solids (TSS) ranged from 20–37 mg/l at 100 m from shore to 5–15 mg/l 4 km offshore. Total phosphorus (TP) also graded from high nearshore to low offshore—from 40–80 ug/l to 20–40 ug/l—but there was little gradient total organic carbon and nitrogen. Most of the TP gradient was due to decreasing particulates with increasing distance from shore. Total dissolved phosphorus gradients were small, and varied from increasing to decreasing among transects sampled. Organic carbon:nitrogen ratios in the particulates were near the Redfield ratio, except from some higher values nearshore in autumn. Nitrogen:phosphorus ratios ranged from above Redfield nearshore to near Redfield offshore, suggesting an increasing contribution of phytoplankton to TSS with increasing distance offshore. This inference was supported by the shift from 10–20% to 25–65% organic contribution to TSS with increasing distance from shore. Chlorophyll concentration and algal biomass (by microscope counts) also increased with increasing distance from shore, as might be expected from the decreasing turbidity gradient.

Our presentation also includes a brief discussion of sediment and phosphorus sampling at the outflow of the lake. Historically, outflow chemistry has been determined from samples collected on the Nelson River at Jenpeg Dam, 100 km downstream of Lake Winnipeg. From 2001–2014, the median TSS at Jenpeg was 8.6 mg/l, or 156% higher than in the expected outflow source water in northeastern Lake Winnipeg (n = 40 paired same-season observations). TP was 14 ug/l, or 36% higher. Using observations at Jenpeg, annual TSS export is 680 Gg higher than would be expected from median concentrations in the lake near its outflow. TP export is 1100 Mg/y higher than would be expected. It is not clear how much of this discrepancy is explained by capture of sediment-rich water from the erosion plume along the north shore of Lake Winnipeg, and how much may be due to bank erosion in lakes between the outlet and Jenpeg Dam.

SEDIMENT RE-SUSPENSION, DEPOSITION RATES AND ANOXIC NUTRIENT RELEASE IN LAKE WINNIPEG

S. Watson[1], G. Matisoff[2], J. Guo[1], A. Duewiger[2] & M. Dittrich[3]
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There has been a dramatic rise in severe algal blooms in Lake Winnipeg (LW), attributed to increased nutrient inputs from the watershed. However, the sources and internal cycling of these nutrients are not well resolved, particularly in reference to the sediments. We addressed this issue in two related projects. In the first of these, over the past several years, we have investigated the origins and transport of nutrients associated with suspended sediments. Much of the external loading to LW is associated with suspended particles but the transport and fate of this nutrient fraction within the lake and the importance of internal loading via resuspension is unknown. We employed 7Be, 210Pb, and 137Cs activities of suspended matter in tributaries and in the lake water column, in sediment traps and in bottom sediments to estimate sediment resuspension and mass accumulation rates. Comparing long term sedimentation rates in 137Cs and 210Pb dated cores with the seasonal sediment accumulation in the sediment traps indicated that 95-98% of suspended matter in the water column was resuspended bottom sediment. This is consistent with a 2-component mixing model using the 7Be/210Pb ratio in each potential sediment source that indicated that resuspension of bottom sediment accounted for 78-95% of the suspended material in the water column. The 137Cs profiles indicate a 15-16 year system time integration constant and surface mixed layers of 3.7-7.3 cm to explain the uniform activities of the surface bottom sediments. In this talk we will present an update on this work and our recent mapping of the suspended material and associated nutrient fractions across LW. In the second project, initiated this past year, we undertook a preliminary investigation of internal loading from anoxic sediments using peepers deployed over the past field season at two sites in the North Basin. This activity was designed to evaluate the potential importance of this internal loading mechanism, given periodic reports of bottom anoxia, and data from other shallow eutrophic waterbodies showing significant release from an anoxic microlayer that had remained undetected using shipboard profiling instruments. We will present the preliminary results from this second project.

Session 5 – Data Management and Communications

UPDATES TO THE LAKE WINNIPEG BASIN INFORMATION NETWORK

C. Herbert
University of Manitoba, Winnipeg

The Lake Winnipeg Basin Information Network (LWBIN) is a web based open access data and information network created by Environment Canada as part of the Lake Winnipeg Basin Initiative under Canada's Action Plan on clean water. It was created in order to help

address key water quality issues within the lake and its contributing watersheds. In 2012 management of the network transferred to the University of Manitoba under the Centre for Earth Observation Science (CEOS).

The LWBIN was created to support research, education and decision making in the basin through three key strategies:
Aid Transparency:

- In 2013, the Government of Canada signed the G8 Open Data Charter. The Charter requires all publicly funded data, including data collected by government and universities to be preserved in a format that is accessible, understandable and in a long term digital data repository. The LWBIN provides users with a long-term, stable data centre with the capability to store multiple types of data including digital images and documents.

Build Understanding:

- Research data is complex and fluid. Raw or processed scientific data and field reports may be publicly available but are not really accessible or understandable to everyone. The LWBIN provides searching, graphing and mapping tools to help users better understand the information.
- Datasets are downloadable for users who want to use their own tools to look at the data.
- The Know Your Watershed Interactive map provides a visual platform to quickly access information about the watersheds in the Lake Winnipeg Basin.
- Building data products: to add relevancy and value to individual datasets by mashing up multiple independent data sources.

Create Awareness:

- The Lake Winnipeg Basin is big – almost 1 million square km. It drains parts of four Canadian provinces and four U.S. States. The LWBIN provides a central open access data hub where users can access the WHO, WHAT WHEN and WHERE of the basin. (Who is working in the basin, and WHAT, WHEN and WHERE are they doing it?) through: Searchable maps and tables of research; and Links to websites so users can access additional sources of information

These key strategies allow the LWBIN to provide researchers and managers at all levels with a central hub of science expertise and information for decision making, helping build collaboration and community within the basin by adding value to individual users and organizations' data.

EUTROPHICATION-RELATED INDICATORS REVIEW: LAKE WINNIPEG AND ITS WATERSHED

K. Farmer
Environment Canada (Winnipeg)

No abstract submitted

Science Program Acquisitions

In 2014/2015, the LWRC's Science Program acquired an EVOS inverted microscope for the enhanced real-time monitoring of live plankton including planktonic life stages of the zebra mussel (abundance and distribution). This microscope will be available on board the M.V. *Namao* during scheduled research surveys.

Honours and Graduate Student Scholarship

In 2011/2012, the LWRC created 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 (MGEU) allowed the establishment of the fund, and subsequent smaller contributions are being made to help maintain the fund.

Johanna Theroux (University of Manitoba) was the 2014/2015 recipient of the scholarship. Her community-based Master's project near Norway House Cree Nation involves identifying suspended sediment sources in order to better characterize its impact on the community's drinking water. Johanna received $1,500 to help offset costs associated with presenting her findings to community members.

EDUCATION PROGRAM

The primary goal of the LWRC's Education Program is to contribute to greater environmental literacy through the study of Lake Winnipeg and 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. The Education Program continues to evolve to meet the needs and interests of Manitoba teachers, described below.

Lake Ecology Field Program

The LEFP is a unique hands-on learning opportunity on board M.V. *Namao*, which is offered to students from grades 8 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 including water, phytoplankton, zooplankton and benthos. Recent additions to the program include the analyses of *E. coli* (bacterium), microcystin-LR (common algal toxin) and most recently microplastics. While on board, 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 as revealed by the most recent lake and watershed science.

The LEFP was not offered during the 2014/2015 year due to the attempted eradication of zebra mussels in the spring, and to severe weather in the fall.

Web-Based Resources

For teachers who wish to introduce Lake Winnipeg into the classroom without leaving the school, the LWRC Education Program continues to develop and update a series of "out of the box" web-based resources, as time and funding permit. In addition, teachers can request a class visit and presentation by the Education Program Coordinator. This component of the Education Program is available to students from grades one to university level.

The LWRC website (www.lakewinnipegresearch.org) continues to serve as the primary repository for information related to both the Science and Education Programs. As well, the website is populated with information suitable for the general public, such as the Image Library and Satellite Image Blog, found at www.lakewinnipegresearch.org/blog. This resource is intended to explore the Lake Winnipeg ecosystem through imagery, including satellite images, aerial photographs, microscopy, student art, and data.

Other Initiatives

Manitoba Schools Science Symposium

The 2014 recipients of the Save Our Lake (SOUL) Lake Winnipeg prize are Winnica and Philip from Sisler High for their joint project examining aquatic plants and phosphate. These two young scientists received a $300 prize offered by SOUL, a sub-group of the Grindstone Cottage Owners' Association (GCOA), as well as the opportunity to join the LWRC science team for a half day on board the research vessel *Namao*.

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

Although one of a kind in Manitoba, the Lake Ecology Field Program is very costly to run and is limited in the number of students that can participate. Therefore, 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. The workshop concept will initially be presented to interested teachers at the 2015 Science Teachers' Association of Manitoba (STAM), Special Area Group of Educators (SAGE) Conference in the fall of 2015. Barring any unforeseen circumstances, the first workshop on board the M.V. *Namao* will be offered to teachers in the summer of 2016.

STRATEGIC PLAN

The primary goal of the LWRC is "*To provide researchers with a dedicated and capable research platform such that research regarding the lake can be conducted where and when it is needed in a safe and effective manner*". It goes without saying, therefore, that without its science member agencies conducting research and monitoring on Lake Winnipeg, the LWRC has little purpose. The reverse is equally important - without the LWRC and its dedicated research vessel, whole lake research and monitoring programs would not be possible logistically. The sustainability of the LWRC is as important as enhancing the on-lake science and monitoring effort, as previously discussed.

To address this, the LWRC completed its first Strategic Plan in 2015. The purpose of this Plan was to identify current operational and governing priorities of the LWRC and to determine how they will be proactively achieved or overcome in the next two years in order to enhance and ensure the longer-term sustainability and relevance of the LWRC and its Programs. The time period is restricted to two years to provide a solid foundation upon which a subsequent three- to five-year Strategic Plan can be developed. The strategic priorities, goals and objectives are presented in an abridged format in Appendix E. Dr. Karen Scott, Programs Coordinator, chaired the committee for the development of the Strategic Plan and will lead its implementation.

APPENDICES

Appendix A – Research and Monitoring Activities Conducted off the Motor Vessel *Namao* during the 2014 Open Water Season.
Note – spring survey carried out using the workboat at select stations in the south basin and narrows (see Field Program above for details)

Agency	Lead	Project	Spring	Summer	Fall	Details
Conservation & Water Stewardship	Lumb & Heuring	Lakewide offshore trawl surveys for status and trend monitoring of pelagic fish		X	X	Summer all stations; fall 27 stations (LWRC sampled reduced network - 2, 5, 36S, 59, W9, W11, W10, 60C, 57B, 9S, 12B, 44S, 53, 68, W8, W13, 13B, 54, 64, 65, 45, 39, 21, 34S, 28, W5, W7)
	Watchorn	Long-term water quality monitoring of Lake Winnipeg	X	X	X	**All lake stations** - nutrients, chlorophyll a, other routine chemical parameters*, vertical depth profile measurements of light, temperature, dissolved oxygen, turbidity, and conductivity (Seabird), *E. coli*. **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.
	Fisheries Branch	*Bythotrephes* 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
	Fisheries Branch	Zebra mussel veligers and adults	X	X	X	Veliger sampling at all stations (offshore and nearshore); substrate samplers at Pine Dock, Grand Rapids, George I., Macbeth
University of MB	Hann	Zoobenthos		X	X	One sample per site - all sites - 200 micron mesh; LWRC sampled

Agency	Lead	Project	Spring	Summer	Fall	Details
	Hann	Zooplankton community		X	X	Vertical haul; LWRC sampled; 29 stations along N/S transect
	Stadnyk	Development of a Stable Water Isotope ($\delta^{18}O$ and $\delta^{2}H$) Monitoring Network (SWIMN) in the Nelson River Basin		X	X	LWRC to sample - stations 33, 22, 23B, Warren's Landing and Two-Mile Channel OF. Water samples are being analyzed for stable water isotopes ($\delta^{18}O$ and $\delta^{2}H$). Stations 22, 23B - profiles at 3-4 m intervals. Warren's Landing - composite sample and Two-Mile Channel outflow composite - spring, summer and fall
	McCullough (Watson, Kling)	North shore plume study		X	X	5 transects between 2-Mile Channel and station 33 sampled for: peat & clay (shore); surface water: & sediment (at 100, 300, 700, 1500, & 4000 m from water's edge). Photos.
UM; University of Winnipeg	Hanson & Wong	Characterize a suite of 11 algal toxins in the surface waters		X	X	Toxins - microcystin-LR, -RR, -YR, -WR, -LA, -LY, -LW, and –LF, as well as anatoxin-a. POCIS deployed and retrieved at weather buoys by LWRC
Environment Canada	Yerubandi	Physical lake model - assessment of hydrodynamics and model-based nutrient status			X	LWRC to deploy & retrieve moorings (500, 504, 505)
	Bibeault	Water quality monitoring;		X	X	Vertical depth profiles taken on the downcast - temperature pH, DO, %sat DO, turbidity, conductivity & PAR – all stations Prov WQ/LWRC sampled
	Watson, Guo, Davis, Chiu	Sediment, lower food web, microbial genetics.		X	X	Fluoroprobe profiles, nutrients, suspended sediment and DNA. Possible collection of surficial sediment at each station.
	Hobson & Koehler	Stable isotope analyses - forage fish, bulk plankton		X		LWRC to run trawl & sample bulk plankton. Summer - bulk plankton & forage fish community (15 x each species) - central north (Stn W1) and south (Stn W12) basins plus river mouths (RR, WR, SR).
	Binding	Validation of satellite methods for remote sensing of algal blooms on Lake Winnipeg		X		Profiling spectro-optical instrumentation to measure *in situ* optical properties and coincident WQ information to validate and further develop methods for satellite detection

Agency	Lead	Project	Spring	Summer	Fall	Details
						of algal blooms. Two profilers - an AC9 (winch deployment) and a free-falling Satlantic radiometer (deployed by hand)
EC; Algal Taxonomy & Ecology Inc.	Watson & Kling	Pico/bacterio-plankton, phytoplankton		X	X	Net haul (10 um) - 14 long-term stations + blooms - live with subsample preserved. Surface water (0 to 0.5 m) all stns (biomass & composition) - preserved.
DFO	Stainton	Algal metabolism study			X	Install and operate equipment that automatically measures Net Primary Production and Respiration at 60 to 120 minute intervals along the ships track
MB Hydro	Chaze, Zaccharias	Same chemistry as Province		X	X	Warren's Landing only – LWRC/Prov to sample
Lakehead University	Rennie / 5 Gyres	Characterizing microplastics			X	Manta trawls at stations 2, 3B, 7, 59, W9, W8, 65, W6, W4, W1, 28, 22. Trawls deployed by LWRC

Appendix B. Decontamination Procedures for M.V. *Namao*, 2014

Lake Winnipeg Research Consortium Inc.
Decontamination Procedures
Motor Vessel NAMAO
Last update – September 12th, 2014

SUBJECT: Lake Winnipeg Research Consortium's decontamination procedures for scientific and related equipment used on board M.V. *Namao* during the open water season, aimed to prevent the transport of larval (veliger) and adult zebra mussels within the sampling station network on Lake Winnipeg.

DECONTAMINATION PROCEDURES AND OTHER MEASURES

Following discussions with the Province of Manitoba, the LWRC has opted to use heat and drying (when possible) as the primary means to decontaminate scientific and other equipment that is used during the operation of the M.V. *Namao*. Heat is the only known means to effectively kill all life stages of both zebra mussels and spiny water flea, another recent aquatic invasive species in Lake Winnipeg.

The following general approach, based on the Provincial cleaning and disinfection methodology, will be used when applicable and feasible: **visually inspect and surface clean** gear to remove plants, animals and sediment; **hot water pressure wash** at very close proximity for a minimum of 10 seconds (at 60°C) to 2 minutes (at 50°C) and at a minimum pressure of 250 psi; **hot water soak** for 10 minutes at 50°C (normal hot water heater is 60°C); **dry for 5 days** once gear has been cleaned and disinfected.

To this end, the LWRC's Science Program acquired a 2.2 HP, 1200 PSI commercial grade hot water pressure washer capable of a 48 to 60°C rise in water temperature. The decontamination process will initially be carried out prior to leaving <u>every sampling station</u>. This high level of effort will be evaluated on an ongoing basis and revised as needed. There are a few instances when heat treatment with a hot water pressure washer on station is not a suitable option for decontamination and an alternative approach will be taken (included below).

Sampling Equipment and Work Spaces on board M.V. *Namao*

1) <u>Trawls</u> – includes both the forage fish and manta trawls. Decontamination on deck to take place immediately following every use. In addition, two separate forage fish trawls will be used, one dedicated to the south basin and narrows (up to and including station W13) and the other to the north basin.
2) <u>Ekman, ponar, heavy buckets</u> – to be heat sprayed on deck and air dried when possible.
3) <u>Nets (phytoplankton, zooplankton, zebra mussel veliger, spiny water flea), Secchi disk and sampling bottles</u> – due to the size and/or light weight of these pieces of equipment, they are to be placed in a designated container at the stern of the ship for the decontamination process followed by air drying (nets, lines).

4) Seabird – to be decontaminated after every use following established Environment Canada procedures. The outer surface to be gently heat sprayed.

5) pCO2 Monitor and algal on-line analyzer – no decontamination is proposed as these instruments sample, analyze and dispose of whole lake water in real time (as the ship is travelling and while on station) and wastewater is discharged back into the lake with an estimated lag time of 1 minute from collection.

6) Primary production/respiration incubator – at 1 to 2 hour intervals, 15 litres of lake water are collected, filtered (70 micron), held for 1 to 2 hours and released. The lag time between collection and release poses a risk in terms of biota disposal and warrants decontamination measures. Given the large volumes of water associated with this instrument, an automated decontamination system using chlorine after each incubation cycle will be used.

7) Satlantic free falling Optical Profiler and Wetlabs ACS – due to the highly sensitive optical sensors on these instruments and o-rings, heat spraying is not a valid option for decontamination. Instead, the instruments were wiped down after each use with a cloth that had been heat sprayed. Additional recommendations from the manufacturer include scrubbing the instruments with a low concentration of acetic acid (household vinegar grade - 10 to 20%) and soaking overnight. Once the instrument/package is soaked, it should be thoroughly rinsed with clean water.

8) Boat deck – to be pressure washed with heated water once sample processing is completed.

9) Lake water hoses – to be left running to ensure no trapped water remains in the hose. If turned off at the end of the day, must be turned back on at the same location. Alternatively, the contents of the hose can be contained and then heat treated prior to release into the lake.

10) Work spaces (labs, stern box) – to be wiped with vinegar after each station.

11) Excess or post-processing lake water that is contained – this may include rinse water from Ekman processing, fish sorting water, filtrate etc. If the ship is still on station, the water may be returned back to the lake. If no longer on station, excess water must be heat treated prior to returning to the lake.

12) Workboat and inflatable – to be pressure washed inside and out following every use. In addition, hot potable water will be attached to the motor's auto flushing system as a decontamination measure after every use.

M.V. *Namao*

As described above, the M.V. *Namao* was not deemed a high-risk vector for the spread of zebra mussels for the 2014 summer and fall research surveys. (The spring survey was cancelled as a precautionary measure while Gimli Harbour was being treated.) Additional assurances that the M.V. *Namao* will continue to remain a low-risk vector for the spread of zebra mussels include the following:

1) Anchor, anchor chain, and mooring lines to be pressure washed with hot water at every station;

2) Ballast water is treated town water. It is used to rinse the fresh water tanks in the spring and is then transferred to the ballast tanks for the open water season and pumped out in the fall. This prevents the transport of lake water as ballast;

3) Lake water intake associated with the engines is continuous and therefore released on site. This water also becomes heated, creating a lethal environment to veligers;

4) Intake strainers will be thoroughly cleaned and decontaminated at scheduled locations. Samples of strainer debris will be periodically collected and preserved for veliger analysis; and

5) During the M.V. *Namao*'s refit in 2015, anti-fouling paint will be applied to the hull to further minimize the risk as a transport vector.

Appendix C. Science Workshop participants and affiliations

Name	Agency
Binding, Caren	Environment Canada, Burlington
Farmer, Kristina	Environment Canada, Winnipeg
Geisler, Marianne	University of Manitoba
Herbert, Claire	University of Manitoba
Hobson, Keith	Environment Canada, Saskatoon
Jacobs, Kevin	Manitoba Conservation & Water Stewardship
Janusz, Laureen	Manitoba Conservation & Water Stewardship – Fisheries
Koehler, Geoff	Environment Canada, Saskatoon
Kristofferson, Al	Lake Winnipeg Research Consortium Inc.
Lobb, David	University of Manitoba
Lumb, Chelsey	Manitoba Conservation & Water Stewardship - Fisheries
Lyng, Dylan	Manitoba Conservation & Water Stewardship
McCrae, Merrin	University of Waterloo
McCullough, Greg	University of Manitoba
Moore, Dana	University of Manitoba
Rattan, Kim	Environment Canada, Burlington
Rennie, Mike	Lakehead University, Thunder Bay
Richmond, Dan	Lake Winnipeg Research Consortium
Rutherford, Les	Environment Canada, Winnipeg
Salki, Alex	Salki Consultants Inc.
Scott, Karen	Lake Winnipeg Research Consortium
Shead, Justin	Manitoba Conservation & Water Stewardship
Smith, Aaron	University of Manitoba
Soto, David	Environment Canada, Saskatoon
Stadnyk, Tricia	University of Manitoba
Stainton, Mike	Fisheries and Oceans Canada, Winnipeg
Theroux, Johanna	University of Manitoba
Tipples, Mo	Lake Winnipeg Research Consortium (Board Member)
Toews, Jay	Independent
Watchorn, Elise	Manitoba Conservation & Water Stewardship
Watkinson, Doug	Fisheries and Oceans Canada
Watson, Sue	Environment Canada, Burlington
Welch, Chani	Environment Canada, Burlington

Appendix D. Science Workshop Agenda

Lake Winnipeg Research Consortium
Annual Science Workshop
February 18th and 19th, 2015
Siobhan Richardson Field Station, Fort Whyte Centre
1961 McCreary Road, Winnipeg

General Schedule

Wake up (coffee, tea, snacks etc provided on site)	8:00 AM to 8:25 AM
Morning Presentations	8:30 AM to Noon (w/ break)
Lunch (provided on site)	~Noon to 1:00 PM
Afternoon Day 1	1:00 to ~4:30 PM (w/ break)
Afternoon Day 2	1:00 to ~3:00 PM

– DAY 1 –

Greetings – K. Scott (LWRC)

Nutrients & Primary Production

- State of Lake Winnipeg: update – E. Watchorn[1]
- The development of ecologically relevant nutrient targets for Lake Winnipeg and its tributaries – J. Shead[1]
- Seasonal variation in nutrient export from prairie streams in the Red River Basin – K. Rattan[2], P. Chambers[2], J. Culp[2,3] & A. Yates[4] ([2]Burlington)
- An update on Environment Canada's satellite remote sensing activities on Lake Winnipeg – C. Binding[2] & T. Greenberg[2] ([2]Burlington)
- A comparison of the spatial distribution of algal metabolism in lakes Winnipeg and Erie – M.P. Stainton[5], S. Watson[2], R. Bourbonniere[2], M. Holoka[5] & S. Page[5]
- Isotopic identification of nitrogen and sulfur nutrient sources in the Lake Winnipeg watershed: implications for potential transfer to aquatic food webs – D. Soto[2], G. Koehler[2] & K. Hobson[2] ([2]Saskatoon)

LUNCH

Biota

- Provincial AIS update: zebra mussel monitoring and proposed AIS legislation – L. Janusz[1]
- Pelagic fish community monitoring – C. Lumb[1], H. Clark[1], B. Franzin[6], G. Klein[1], S. Milne[7], B. Parker[1] & D. Watkinson[5]
- Extension of a walleye production model to Manitoban lakes and predicted consequences of dreissenid establishment – M. Geisler[8], M. Rennie[8,9] & D. Gillis[8]

Contaminants, Algal Toxins & Microplastics

- A summary of fish mercury monitoring conducted by Manitoba Conservation and Water Stewardship – K. Jacobs[1]
- Wastewater contaminants, pesticides, and algal toxins in Lake Winnipeg and its watershed – D. Moore[8], M. Hanson[8] & C. Wong[10]
- Assessing plastic pollution in Lake Winnipeg – M. Rennie[8,9], H. Kling[11] & K. Scott[14]

– DAY 2 –

Sediment

- Soil erosion and sedimentation within the Lake Winnipeg Basin – D. Lobb[8]
- Identifying the sediment sources in Norway House Cree Nation using a sediment fingerprinting technique – J. Theroux[8], D. Lobb[8] & A. Farenhorst[8]
- Nutrient supply and losses due to bank erosion along the north shore of Lake Winnipeg – G. McCullough[8], M. Stainton[5], S. Watson[2], H. Kling[11]; P. Shah[2], C. Irwin[2] & M. Geisler[14] ([2]Burlington)
- Sediment influx and re-suspension in Lake Winnipeg – S. Watson[2], G. Matisoff[12], J. Guo[2], A. Duewiger[12] & M. Dittrich[13] ([2]Burlington)

Data Management & Communications

- Updates to the Lake Winnipeg Basin Information Network – C. Herbert[8]
- Eutrophication-related indicators review: Lake Winnipeg and its watershed – K. Farmer[2] (Winnipeg)

LUNCH

Science Program Updates / 2015 Field Season Planning

- Science Program updates – changes, acquisitions, field schedules, other
- Near-shore network – need to discuss sampling frequency & additional parameters
- Proposed Special Projects (i.e. not within the offshore station network) &/or potential collaborations
    - Defining the sources and timing of non-point nutrient loading and determining how such loading can be modified by internal lake processes (CFI Proposal, R. North – U. Brandon)
    - Assess the transfer of nutrient sources into the top predators of the food web (fish). Additionally, looking for scale and otolith collections in the watershed. (Soto, Koehler & Hobson – EC Saskatoon)
    - Potential use of deuterium (D/H) as a trophic tracer, for instance, in the south basin of LK WPG, sampling of walleye, pelagic fish, zooplankton, etc in the summer cruise. (Soto, Koehler & Hobson – EC Saskatoon)
    - Acoustic work in the north basin (summer), likely mostly at night. Dependent on what work plans and budgets for next fiscal year (2015/16) and borrowing the acoustics equipment from DFO. (Lumb – MCWS Fisheries Branch)
    - Near-shore benthic algae (Kling, AT&E)
    - Sediment samples at river mouths for plastic deposition. Repeat some manta trawl surveys. (Rennie – IISD)

Anticipated Wrap-Up ~ 3 PM latest – venue will remain open/available for informal discussions

Affiliations: [1]MB Conservation and Water Stewardship; [2]Water Science & Technology Directorate, Environment Canada (various locations); [3]University of New Brunswick, Fredericton, NB; [4]Western University, London, ON; [5]Fisheries & Oceans Canada; [6]Laughing Water Arts & Science; [7]Milne Technologies; [8]University of Manitoba; [9]International Institute for Sustainable Development; [10]University of Winnipeg; [11]Algal Taxonomy & Ecology Inc.; [12]Dept. Earth, Environmental & Planetary Sciences, Case Western Reserve University, Cleveland OH; [13]Dept. Physical & Environmental Sciences, University of Toronto, Scarborough Toronto, ON; [14]LWRC

Appendix E. Abridged Strategic Plan (2015 – 2017)

The purpose of this Strategic Plan is to identify current operational and governing priorities of the LWRC and to determine how they will be proactively achieved or overcome in the next two years in order to enhance and ensure the longer-term sustainability and relevance of the Corporation and its Programs. The time period for the Plan is restricted to two years to provide a solid foundation upon which a subsequent three- to five-year Strategic Plan can be developed.

ORGANIZATIONAL TENETS

MISSION: The Corporation is dedicated to facilitating multidisciplinary research on Lake Winnipeg in Manitoba, promoting educational opportunities regarding the Lake, and fostering communication among all parties having an interest in the Lake

GOALS OF THE LWRC: To encourage, promote, and facilitate multidisciplinary research that will lead to a better understanding of the condition of the lake and human activities within its drainage basin:

- To provide researchers with a dedicated and capable research platform such that research regarding the lake can be conducted where and when it is needed in a safe and effective manner;
- To provide educational opportunities to students interested in any aspects of the research regarding the lake; and
- To facilitate the communication of research results to resource managers, commercial fishers, First Nations people and other lake residents as well as recreational users and other parties interested in the lake, including the general public.

STRATEGIC PRIORITIES (2015 – 2017)

The strategic priorities for this two-year period align well with the mission and goals of the LWRC and directly address the need to:

- Stabilize and diversify our funding base;
- Strengthen governance to ensure long-term sustainability;
- Augment the value and relevance of our programming; and
- Enhance communication with our various constituencies.

GOALS

1. Achieve financial stability by addressing current financial shortcomings and longer-term fundraising in a strategic manner

2. Optimize organizational efficiency, function and succession planning
3. Add value to and maintain relevance of the LWRC's Programs
4. Communicate effectively and regularly with the LWRC's constituencies to provide value and maintain credibility

STRATEGIES

Goal 1. Achieve financial stability by addressing current financial shortcomings and longer-term fundraising in a strategic manner

- Enhance the financial accounting system to provide greater details at the Board level, as well as for planning and fundraising purposes
- Develop a fundraising strategy to take advantage of public and private support for the LWRC, including use of the endowment fund

Goal 2. Optimize organizational efficiency, function and succession planning

- Define and enhance Board sub-structure
- Clarify expectations of paid personnel and Board of Directors
- Define the reporting structure for summarizing activities to consistently and effectively update the Board
- Unify, organize and store agency records

Goal 3. Add value to and maintain relevance of the LWRC's Programs

- Enable and foster deeper partnerships with science agencies, with emphasis on Academia
- Enhance on-board science infrastructure and adapt field programming to more effectively reflect changes to user needs
- Ensure safe and efficient on-board facilities by means of a review and evaluation of safety protocols on board both research vessels

Goal 4. Communicate effectively and regularly with the LWRC's constituencies to provide value and maintain credibility

- Develop a communications plan that articulates and integrates the role and relevance of the LWRC's Programs within the collective interests of all contributors