Lake Winnipeg Research Consortium Inc.
2019 / 2020 Annual Report

Science and Education Programs

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Programs Coordinator

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LAKE WINNIPEG
RESEARCH CONSORTIUM

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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 signs of water quality deterioration associated with the 1997 Red River flood of the century.

The LWRC is governed by a board of nine directors with representation from its various classes of membership, which includes: Research (3 directors); Contributing (3 directors); Participating (2 directors); and General (1 director). The election of directors from any particular class of membership, if required, takes place during the Annual General Meeting. Current membership of the LWRC is over 30 agencies representing various government and university departments, municipalities, communities, corporate and other organizations. Many of the research members comprise the active on-lake science team.

Three part-time personnel oversee the day to day operations of the LWRC (Managing Director), its programs (Programs Coordinator) and research vessels (Superintendent of Marine Operations), while the Motor Vessel (M/V) *Namao* requires a seasonal crew of nine.

The main objective of the LWRC, realized through the Science Program, is to facilitate science on Lake Winnipeg by providing dedicated research platforms, the M/Vs *Namao* and *Fylgja*, within an established infrastructure of sampling stations, to its science members. In addition, the LWRC convenes those members and others who are actively involved in Lake Winnipeg science, at an annual Science Workshop. The role of the LWRC's Science Program has been pivotal in providing continuity to the overarching science effort on Lake Winnipeg as government departments undergo changes in leadership and personnel, and the engagement of academia is project-based and funding dependent.

A secondary objective of the LWRC, met through its Education Program, is to provide educational opportunities in various forms to schools and other institutions of learning. The primary goal of the LWRC's Education Program is to contribute to greater environmental literacy through the study of Lake Winnipeg. To this end, the Education Program has two main components, the Lake Ecology Field Program and the development of web-based, mixed-media resources. Classroom visits and supporting Special Projects are an implicit component of the LWRC's education programming.

Between Science and Education, the LWRC offers two educational awards. The LWRC's Lake Winnipeg Water Award is offered to public school grades 7 to 12 through the Manitoba Schools Science Symposium, and the Dr. G. H. Lawler Memorial Scholarship is offered to honours and graduate university students.

This report briefly summarizes the main activities comprising the LWRC's Education and Science Programs for the fiscal year 2019/2020.

Education Program

Lake Ecology Field Program

The Lake Ecology Field Program (LEFP) was offered in the spring of 2019. A total of 216 students and teachers from 11 schools, ranging from grade 6 to university participated in the half day field excursions on board M/V *Namao*.

For more information about the program, visit
http://www.lakewinnipegresearch.org/education-program/

Lake Winnipeg Water Award – Manitoba Schools Science Symposium

The LWRC offers a Lake Winnipeg Water Award at the Manitoba Schools Science Symposium (MSSS) in support of junior, intermediate or senior student projects that focus on water quality, quantity or remediation. Winners receive a certificate, a cash prize of $100, and an opportunity to join the LWRC science team for a half day on board the M/V *Namao* during the summer research survey.

This year's winner of the LWRC's Lake Winnipeg Water Award went to grade 7 student Thomas Gale for his project *Microplastics: Can Washing a Blanket Pollute the Environment?* Thomas received $100 and joined the science team *Namao* for a half day to help sample the lake. Thomas also shared his project on board the ship during our open house on Canada Day long weekend.

Dr. G. H. Lawler Memorial Scholarship

Since 2011/2012, the LWRC has offered financial and field support to honours and graduate students through its scholarship program to encourage and promote research initiatives by young scientists on Lake Winnipeg. The establishment of this fund was made possible by a generous initial contribution of $20,000 over five years by the Manitoba Government and General Employees' Union: subsequent smaller contributions are being made on an ongoing basis to help maintain the fund.

Following the passing of one of the LWRC's founding directors in May 2019, the scholarship was renamed the Dr. G. H. Lawler Memorial Scholarship In recognition of Dr. Herb Lawler's important contributions to the LWRC and Lake Winnipeg.

The 2019/20 Dr. G. H. Lawler Memorial Scholarship was awarded to Matt Thorstensen, a Ph.D. Candidate in Dr. Ken Jeffries lab in the Department of Biological Sciences, University of Manitoba. Matt's research looks at the population structure and body condition of walleye (pickerel) in Lake Winnipeg using genomics combined

with physiological, ecological, and environmental data. The $3,825 scholarship will be used to cover the cost of the open access fee for one of Matt's publications in the journal *Ecology and Evolution.*

Open House on Board M/V *Namao*

Over 750 people toured the M/V *Namao* in an afternoon as part of the Canada Day celebrations in Gimli. Scientists from Environment and Climate Change Canada, Fisheries and Oceans, Manitoba, IISD-ELA, the University of Manitoba, and Lincoln Middle School were on board to share with the public their research projects and monitoring results, and a number of volunteers helped distribute various communications products including the new LWRC pamphlet and postcard. This event took place on the same day as the Save the Lake fundraiser, organized by the Gimli Yacht Club and Kiwanis Club, to raise funds for both the LWRC and the Lake Winnipeg Foundation.

Science Program

Journal of Great Lakes Research – Lake Winnipeg Special Issue

The LWRC Science Program is working with the *Journal of Great Lakes Research* (JGLR) on another Lake Winnipeg Special Issue, to be published in February 2021. The first Special Issue was released in 2012. The JGLR is a multidisciplinary journal that publishes papers on theoretical and applied subjects related to the world's largest lakes and their watersheds. It is distributed by the International Association for Great Lakes Research (IAGLR).

Field Program - Open Water Season 2019

The spring research survey ran between May 28th and June 14th and was preceded by the Education Program (Lake Ecology Field Program), which took place between May 21st and May 27th. The summer survey ran between July 22nd and August 9th and the fall survey between September 16th and October 4th, with no disruptions. Field logs are available on the website at http://www.lakewinnipegresearch.org/documents/

Appendix A describes the LWRC's offshore and nearshore station network, and Environment and Climate Change Canada's (ECCC) and Fisheries and Oceans (DFO) nearshore sampling stations.

Appendix B is a map of the mooring network including 2019 changes.

Appendix C provides a summary of the research and monitoring carried out during the 2019 field season on board M/V *Namao* by participating science agencies.

Science Workshop

The annual Science Workshop was held on February 4th and 5th at the Qualico Family Centre, Assiniboine Park in Winnipeg (Appendix D – Agenda) with nearly 60 scientists, managers and students in attendance (Appendix E – Participants). This year's LWRC's Science Workshop aimed to provide an opportunity to update the larger on-lake science community on previous and ongoing studies, as well as future planning of new projects.

Science Workshop Presentations

Abstracts were not submitted by presenters at the Science Workshop. Instead, brief descriptions of the talks are provided below along with links to non-editable pdf versions of the presentations. Where no presentation is available, a full abstract was provided by the author.

Click the title to download the presentation.

Manuscripts submitted to the JGLR Lake Winnipeg special issue are also indicated.

Reporting

State of Lake Winnipeg reporting – status and path forward

Sharon Reedyk

Environment and Climate Change Canada (Edmonton)

Under the Science Subsidiary Agreement in 2010, Canada and Manitoba committed to reporting on the ecological status of Lake Winnipeg through a State of the Lake report and ecological indicators. The first State of the Lake report, covering the period from 1999 to 2007, was released in 2011. The second State of the Lake report covers the period from 2008 to 2016, with some exceptions, and provides an update to the information contained in the first report. This presentation focused on some of the key knowledge gaps that remain, general challenges associated with reporting on the state of the lake, as well as an update on the indicator factsheet series.

The full technical report (English) was released in April 2020 and made available as an electronic document on the Government of Manitoba and CANWIN websites. The highlights document is available in both official languages.

Modelling

(Update on) Seasonal hydrodynamic and water quality in Lake Winnipeg: field observations and three-dimensional modelling

Jun Zha, Reza Valipour, Luis Leon, Phil Fong, Craig McCrimmon, David Depew, and Ram Yerubandi

Environment and Climate Change Canada (Burlington)

The development of an integrated modelling framework by ECCC for the U.S. and Canadian watersheds is ongoing. By integrating a watershed model with a lake model, this work will help predict Lake Winnipeg's response to changes in nutrient loading due to the implementation of best management practises and/or climate change. Moreover, by integrating the effects of zebra mussels on phosphorus recycling into the lake model, the relative importance of this exotic species on algal growth will also be assessed. An update on progress was presented, with emphasis on the lake modeling aspect of the initiative.

This research will be submitted to the Lake Winnipeg JGLR special issue.

A Comparison of the Red-Assiniboine Basin SPARROW with a Bayesian approach

E. A. Blukacz-Richards[1,2], Alex Neumann[2], G. Benoy[3], Dale Robertson[4], Félix Ouellet[1,2], David Saad[4], and George Arhonditsis[2]

[1]Environment and Climate Change Canada (Burlington), [2]University of Toronto, [3]International Joint Commission, [4]United States Geological Survey

It is well known that the Red River is the most important source of nutrients to Lake Winnipeg. However, a more precise understanding of nutrient sources and their origin within the Red River Basin is needed in order to more strategically target remedial efforts to reduce nutrient loading to Lake Winnipeg.

SPARROW (SPAtially Referenced Regression On Watershed Attributes) is a watershed model that uses a mass balance approach within a spatially defined network of streams and reservoirs. SPARROW models are used to understand water quality conditions within a watershed by tracking downstream transport of nutrients from various sources (wastewater treatment plants, agricultural–fertilizer and manure, forests/wetlands, stream channels) with consideration for landscape delivery factors that influence transport and losses of these nutrients (in streams and reservoirs).

The research described in this presentation used the Red-Assiniboine Basin SPARROW model developed by the United States Geological Survey as a guide for running a Bayesian SPARROW in order to account for sources of uncertainty at the outflows and for each catchment. Bayesian SPARROW will be used to examine sources across multiple spatial scales for hot-spots identification and across multiple temporal scales (wet/dry years; different drought indicators and indices; spring freshet vs summer baseflow; separate years). Model predictions can be incorporated in adaptive risk-based watershed management.

Wetlands

Optimization of wetland management strategies in the Lake Winnipeg Watershed as sustainable measure towards eutrophication

Forough Fendereski, Irena Creed, and Charles Trick

University of Saskatchewan, Saskatoon

Higher loading of phosphorus to lakes is the primary cause of eutrophication, often due to human activities such as intensified use of fertilizers and urban and rural wastewater. In addition, climate change can exacerbate these pressures. Conversely, some watershed features, such as wetlands, can reduce nutrient loading and mitigate eutrophication. In the Lake Winnipeg watershed, it is estimated that 70% of the original wetlands has been lost, and of those remaining, there is considerable loss of biogeochemical and hydrological function and services, such as retention of nutrients. This presentation describes a conceptual model to optimize wetland management from individual wetlands to wetlandscapes within the Lake Winnipeg watershed in an effort to explore linkages between wetlandscape properties (i.e. size, shape, order, connectivity) and phytoplankton standing stock in Lake Winnipeg.

Netley-Libau Marsh pilot restoration project

Gordon Goldsborough

Department of Biological Sciences, University of Manitoba

Shoreline erosion and loss of emergent vegetation areal extent since 1929 has resulted in large expanses of open water in Netley-Libau Marsh on the south shore of Lake Winnipeg. This presentation described the intent of a multi-partner, two-year project that aims to demonstrate techniques for creating marsh vegetation in a small area of Netley-Libau Marsh. Those techniques include building marsh terraces with dredged sediment derived from the main channel of the Red River and conducting seed bank trials to create vegetation on these terraces.

Lake Science – Water Quality, Primary Production, and Lower Food Web

Provincial Water Quality Monitoring of Lake Winnipeg: Program Update (not available for download)

Andrew Burton

Manitoba Agriculture and Resource Development

Since 1999, Manitoba Sustainable Development (now called Agriculture and Resource Development), in partnership with the Lake Winnipeg Research Consortium Inc., has operated an extensive water quality monitoring program on Lake Winnipeg. See Appendix A-1 (station network) and Appendix C (parameters sampled).

This presentation provided a summary of some of the results from the provincial water quality monitoring program including nutrient loading (1994 to 2016), In-lake nutrients concentrations (1999 to 2018), algal blooms, offshore dissolved organic carbon (2018 and 2019), and offshore mercury (2018 and 2019).

Additional information can be found in the Nutrient Status Report, which was released in February 2019, and in the aforementioned State of the Lake report. Both are available for download at (https://www.gov.mb.ca/sd/water/lakes-beaches-rivers/lake-winnipeg.html) under the dropdown section Reporting and Assessment.

Sediment phosphorus dynamics and implications for internal loading

David Depew[1], Emily Krutzelmann[1], Kim Rattan[1], Reza Valipour[1], Maria Dittrich[2], and Stefan Markovic[2]

[1]Environment and Climate Change Canada (Burlington), [2]University of Toronto

This presentation provided a brief update on a research project that is exploring phosphorus cycling in sediments. Specifically, the objectives of this work are to evaluate the capacity of sediments to retain and release phosphorus contributing to the internal load, derive flux estimates, and integrate findings into the ecological modelling framework currently underway within ECCC (described above). This work addresses an important knowledge gap that is key to understanding how long the lake will require to respond to remedial efforts being undertaken to reduce phosphorus entering the lake.

Lake Winnipeg nearshore monitoring: program update

Elise Watchorn

Environment and Climate Change Canada (Winnipeg)

Much of the early research and monitoring on Lake Winnipeg was focused on the offshore region of the lake as that was accessible by the M/V *Namao*. With the inevitable arrival of zebra mussels, the nearshore area and coastal wetlands were deemed a knowledge gap, which needed to be addressed in order to understand how this invasive species would impact the lake ecosystem. Nearshore sampling programs were thus introduced by both the LWRC (in 2012) and ECCC (see Appendix A-2 for station locations).

This presentation described ECCC's nearshore monitoring program on Lake Winnipeg and illustrated the collaborative nature of the effort. Numerous collaborators are examining various aspects of the nearshore area, especially with regard to changes associated with the proliferation of zebra mussels on the phytoplankton community, and the extent, composition and toxicity of nearshore algal blooms. In addition, a partnership with Fisheries and Oceans Canada allows for the investigation of food web linkages including zooplankton, invertebrates and forage fish. (This work is briefly described in the pelagic fish survey presentation below.)

Data visualization and reporting tools for algal bloom monitoring in Lake Winnipeg: Update

Larissa Pizzolato, Caren Binding, and Chuiqing Zeng

Environment and Climate Change Canada (Burlington)

Since 2002, ECCC has produced satellite-derived algal bloom indices using optical imagery derived from remote sensing data made available by the European Space Agency (ESA). These include MERIS (MEdium Resolution Imaging Spectrometer) on the Envisat platform (2002–2012) and OLCI (Ocean and Land Colour Instrument) on the ESA's Sentinel 3 satellites (2016 to present). In addition, ECCC has developed automated processing workflows from satellite data acquisition to visual web portal delivery for daily (available in near-real time) and annual reporting of algal bloom indices. An update on algal bloom monitoring capabilities was presented and future plans to develop new data products to include water temperature and water clarity was described.

This research will be submitted to the Lake Winnipeg JGLR special issue.

Net ecosystem production in Lake Winnipeg (presentation not available for download)

Kate Yezhova[1], David Capelle[1], Mike Stainton[2], Tim Papakyriakou[1]

[1] Centre for Earth Observation Science, University of Manitoba, [2]Fisheries and Oceans Canada

Lakes are important sites for carbon fixation and CO_2 exchange with the atmosphere. For Lake Winnipeg, net primary production or actual carbon dioxide fixation rates have never been published. This is important as the CO_2 emitted by Lake Winnipeg could significantly offset the CO_2 taken up by land plants in the watershed.

This presentation describes some of the carbon work being carried out in the lab of Dr. Tim Papakyriakou, being led by Dr. David Capelle and involving a number of undergraduate students. The objectives of the project are: to quantify the gross oxygen production, gross oxygen consumption, and net primary production by the pelagic community across Lake Winnipeg over multiple seasons and years; to quantify the gross and net carbon fixation and remineralization by the pelagic community; and to identify key drivers influencing spatiotemporal variability in these variables

This research will be submitted to the Lake Winnipeg JGLR special issue.

Algae of the Manitoba great lakes

Claire Herbert[1] and Hedy Kling[2]

[1] Centre for Earth Observation Science, University of Manitoba, [2]Algal Taxonomy and Ecology Inc.

This presentation described work characterizing the phytoplankton communities in lakes Winnipeg, Manitoba and Winnipegosis in terms of species, counts and biomass.

This research will be submitted to the Lake Winnipeg JGLR special issue.

Lake Winnipeg sedimentation

Masoud Goharrokhi[1], D. Lobb[1], G. McCullough[2], P. Owens[3]

[1]Department of Soil Sciences, University of Manitoba, [2]Centre for Earth Observation Science, University of Manitoba, [3]University of Northern British Columbia, Prince George

The objective of the work described in this presentation was to examine bottom (surficial) and suspended sediment properties in Lake Winnipeg to better understand sediment dynamics, including: spatial and temporal variability of select sediment properties; sedimentation patterns throughout the lake; and distinguishing among sources such as sediment derived from north shore erosion or tributaries, notably the Red River.

This research will be submitted to the Lake Winnipeg JGLR special issue.

Foodwebs, nutrients, and stable isotopes

Geoff Koehler

Environment and Climate Change Canada (Saskatoon)

Stable isotopes provide a means to answer important questions related to the food web and changes therein, such as those caused by eutrophication, exotic species, and climate change. This presentation briefly described the stable isotope food web research up to present and provided an update on work supported in phase three of the Lake Winnipeg Basin Initiative. Starting year three of a four-year study, isotopic datasets now exist for forage fish samples from 2002 to present and sampling is complete for zooplankton, invertebrates, and water. A real-time water isotopic sampler is also now available for on-board sampling during research surveys.

This research will be submitted to the Lake Winnipeg JGLR special issue.

Aquatic Invasive Species

Aquatic invasive species: program update

Laureen Janusz

Manitoba Agriculture and Resource Development

This presentation provided an overview and update of the provincial Aquatic Invasive Species (AIS) Program, within its five program pillars – legislation, prevention,

monitoring, early detection and rapid response, and management and control. These five pillars work together and inform each other.

In addition, the Lake Winnipeg AIS monitoring results were provided. In Lake Winnipeg, spiny waterflea and zebra mussel veligers, adults (substrate samplers) and eDNA are routinely monitored. However, because zebra mussels are now well established in the south basin and narrows, only the north basin is being monitored. In the north basin, veligers and adult zebra mussels continue to increase in number and locations detected, and veligers have now been detected in the Nelson River, as far down as Limestone generating station. Of note for spiny waterflea were higher numbers near the outflow of the lake during the fall survey, with many carrying eggs.

Spatial distribution of zebra mussel (*D.polymorpha*) abundance and biomass in Lake Winnipeg

David Depew[1], Emily Krutzelmann[1], Elise Watchorn[2], Eva Enders[3], and Amanda Caskenette[3]

[1]Environment and Climate Change Canada (Burlington), [2]ECCC (Winnipeg), [3]Fisheries and Oceans Canada (Freshwater Institute)

The establishment of dreissenid mussels, notably zebra mussels, in Lake Winnipeg may have profound consequences for energy and nutrient cycling within the lake. In order to understand these potential impacts on the Lake Winnipeg ecosystem, estimates of abundance, biomass on natural substrates, and Information on population dynamics is needed.

This study involves a systematic field sampling survey approach adopted from the Great Lakes to assess the distribution and spread of zebra mussels in Lake Winnipeg in as much of the lake as possible, including the offshore and nearshore environments. The presentation provides an update on this work including preliminary estimates of zebra mussel abundance, biomass, and population dynamics for the 2017 to 2019 sampling period.

This research will be submitted to the Lake Winnipeg JGLR special issue.

Aerobic anoxygenic phototrophs among the bacterial community within zebra mussels of Lake Winnipeg (presentation not available for download)

Steven Kuzyk, Kaitlyn Wiens, Xiao Ma, and Vladimir Yurkov*

Department of Microbiology, University of Manitoba
*Corresponding author

Abstract provided by the presenter. Lake Winnipeg, the 11th largest freshwater lake in the world, has suffered similarly to the Great Lakes from both eutrophication and the introduction of *Dreissena polymorpha,* causing drastic ecological changes. While higher level organisms including fish are eventually impacted, the first effect has been on the microbial community. In our study, we examined the lakes bacteria using

both culture- and sequencing-based strategies to elucidate those in littoral sediment, water and within the gill, gut, and gonad tissues of zebra mussels. Our main focus was on the aerobic anoxygenic phototrophic population, as they usually make up a significant part of the bacterial consortium in aquatic habitats. We discovered that the aerobic anoxygenic phototrophs were in the environmental proximity as well as predominantly in the gut of *D. polymorpha*, compared to other tissues, suggesting bacterial consumption. In addition, phototrophic isolates had cells large enough for predation. According to the elemental atomic analysis of mussels, lake water and sediment, numerous metals bioaccumulated in bivalves. Aerobic anoxygenic phototrophs were capable to resist high levels of tellurite, while reducing tellurite to tellurium intracellularly, and potentially symbiotically associated with mollusk. The confirmation of bacteria as prey or symbionts may be important and useful as future targets of elimination to slow the advance of this invasive species.

Aspects of this research will be submitted in two manuscripts to the Lake Winnipeg JGLR special issue.

Other

Examination of microplastics in our environment

Thomas Gale

Lincoln Middle School

The project described in this presentation stemmed from a science fair project (Manitoba Schools Science Symposium) examining microplastics in wastewater derived from washing a polyester blanket. Thomas won the LWRC's Lake Winnipeg Water Award (among other awards) for that work and decided to continue his research into microplastics by determining if microplastics are present in the food web of Lake Winnipeg, specifically in zooplankton and forage fishes.

Zooplankton and forage fish samples were collected during the 2019 fall research survey on board M/V *Namao.* Fish were dissected in a lab at the Freshwater Institute and the stomachs removed to determine if microplastics were ingested. Similarly, zooplankton samples will be processed with a suitable methodology in order to determine if microplastics are present. Final results were not yet available.

Current state of salinity and salinization in Manitoban surface waters

Braedon Humeniuk

University of Manitoba

This presentation describes a new Master's project from the lab of Dr. Mark Hanson. It is in the early stage of development and aims to determine the possible sources, drivers, and temporal patterns of salinity in the Lake Winnipeg watershed using an established network of community-based monitoring volunteers. In addition, a

strength of methods assessment for freshwater salinity toxicity data will be performed, and a species sensitivity distribution for an ecological risk assessment developed.

Fish

GEN-FISH: Using environmental DNA and transcriptional profiling to improve sustainability of freshwater fisheries

Margaret Docker

Department of Biological Sciences, University of Manitoba

The Genomic Network for Fish Identification, Stress and Health – GEN-FISH – is a national project funded through Genome Canada with 23 principal Investigators from 13 academic institutions and various partners from government, industry, NGOs and indigenous groups. The GEN-FISH team is working toward determining the status of Canada's increasingly threatened fish species using new, innovative approaches in support of freshwater fish management and conservation. This presentation provided an overview of GEN-FISH including its three toolkits – fish survey, fish health, and decision-making toolkits.

Additional information can be found on the GEN-FISH website at https://gen-fish.ca.

Movement patterns and ecology of fishes in the Lake Winnipeg Basin

Doug Watkinson, Colin Charles, Mark Pegg, Tyana Rudolfsen, Colin Kovachik, Doug Leroux, and Eva Enders

Freshwater Institute, Fisheries and Oceans Canada

Fisheries and Oceans Canada is conducting an acoustic tagging fish movement project in order to improve understanding of fish migration and habitat use of seven species of fish in the Lake Winnipeg Basin, including bigmouth buffalo, channel catfish, common carp, lake sturgeon, burbot, freshwater drum, and walleye.

Between 2016 and 2019, a total of 786 fish were tagged with acoustic transmitters for tracking in real time to better understand their distribution, movement rates, habitat selection (spawning, feeding, overwintering) and survival. In addition, 205 receivers were placed within the Lake Winnipeg Basin, including 132 receivers in Lake Winnipeg covering approximately 9,000 km_2 with grid pattern spacing of 5 km in the south basin, 7 km in the narrows, and 14 km in the north basin. An additional 860 km of riverine habitat is monitored by the receivers in the Red River (n = 51), Winnipeg River (n = 10), Assiniboine River (n = 4), and one receiver in the Saskatchewan, Dauphin, La Salle, Rat, Roseau, and Seine rivers and Devils Creek.

This presentation provided details of the telemetry component of the study, including some of the work of graduate student Nicole Turner (Lakehead University)

on walleye movement patterns. Both the telemetry and Turner's work will be submitted to the Lake Winnipeg JGLR special issue.

Identifying fish habitat associations in Lake Winnipeg using large scale depth and substrate data linked with telemetry data

Tyana Rudolfsen, Colin Charles, Colin Kovachik, Doug Watkinson, and Eva Enders

Freshwater Institute, Fisheries and Oceans Canada

The objective of this study is to establish linkages between fish movement patterns of lake sturgeon, walleye, common carp, and freshwater drum and habitat use from fish telemetry information (described above), bathymetry, and substrate maps.

In addition to the telemetry described in the previous presentation, bathymetry and substrate type were determined along an established 7 km grid and two nearshore contours at 3 m and 6 m depth. The echosounder raw data was corrected to standard water elevation and data was then interpolated into bathymetric maps. Substrate maps were also interpolated – cluster analysis produced three different substrate types (clay muck, silt muck, and sand/gravel), which were validated with ponar grabs analyzed for particle size taken on the same 7 km grid. Examples of some of the findings are presented.

Updates from the pelagic fish survey and the nearshoring monitoring program

Eva Enders, Colin Charles, Amanda Caskenette, and Doug Watkinson

Freshwater Institute, Fisheries and Oceans Canada

Two programs are described herein. The first is the Pelagic Fish Survey Monitoring Program and the second, the Littoral Monitoring Program.

The Pelagic Fish Survey Monitoring Program was initiated in 2002 to study the temporal and spatial variation of the prey fish assemblage in the offshore waters of Lake Winnipeg. For this program, fish are collected from offshore waters (M/V *Namao*) at one of three depths – surface, mid-water or deep – during spring, summer, and fall. Smaller fish sorted by species are frozen for further processing and the Incidental catch of larger fish is measured, weighed, and returned to the lake. In the laboratory, specimens are identified, sorted into size classes, measured, and weighed. Changes in the prey fish community are described in the presentation.

In 2018, Fisheries and Oceans Canada initiated a Littoral Monitoring Program in association with ECCC's Nearshore Program (described above) to study the impact of the invasive species zebra mussel on the nearshore food web in the south basin of Lake Winnipeg. The various methodologies being used to sample and analyze water, phytoplankton, zooplankton, zoobenthos, zebra mussels and prey fishes are described. See Appendix A-3 for station locations.

This research will be submitted as two manuscripts to the Lake Winnipeg JGLR special issue.

Metabolites and growth in the Lake Winnipeg walleye (*Sander vitreus*)

Matt Thorstensen[1], L. Wiens[1], J. Jeffrey[1], G. Klein[2], K. Jeffries[1], and J. Treberg[1]

[1]Department of Biological Sciences, University of Manitoba,[2]Manitoba Agriculture and Resource Development

Abstract provided by the presenter. We quantified changing length-mass relationships (≈body condition) and growth rates over time and across a latitudinal gradient in Lake Winnipeg walleye (*Sander vitreus*) caught for a gillnet index data set because several pieces of evidence indicate that the walleye fishery may soon require conservation attention. Walleye showed decreased length-mass relationships and smaller length-at-age in the north basin of Lake Winnipeg in 2017, which may imply decreased food availability, relative to the south basin. We then analyzed a separate group of walleye sampled in 2017 for metabolites in whole blood, after finding a similar slope in length-mass relationship to large walleye caught in that year for the gillnet index data. A panel of 9 blood metabolites consisting of 3 essential amino acids, 3 metabolites of amino acid oxidation, and 3 post-translationally modified amino acids revealed elevated essential amino acids and possible signals of protein degradation in north basin walleye. Patterns for metabolites of amino acid oxidation were inconclusive. Based on these results, we suggest that a possible decreased nutritional status of walleye in the north basin of Lake Winnipeg may be a factor in increased levels of circulating essential amino acids and post-translationally modified amino acid metabolites. With further work, this suite of metabolites may be developed into a method for using non-lethal sampling to assess the nutritional status of wild-caught Lake Winnipeg walleye, in combination with assessing mRNA levels for genes associated with the regulation of protein metabolism.

Aspects of this work will be submitted to the Lake Winnipeg JGLR special issue.

Fisheries Management

Partnering for Indigenous Prosperity – Indigenous Inland Commercial Fisheries Initiative

Bill Galbraith

Indigenous Services Canada

This presentation provided an update on the Indigenous Inland Commercial Fisheries Initiative (IICFI), a multi-year coordinated effort by federal and provincial governments in collaboration with Indigenous organizations, that aims to contribute to the sustainability and growth of the Indigenous commercial fishery in Manitoba. Under its eight categories pertaining to the sustainable operation and development

of Manitoba's Indigenous commercial fishing sectors, a primary focus of the IICFI is now on filling funding gaps that currently exist within provincial and federal programs.

Selection on spawn timing in Lake Winnipeg walleye

Scott Forbes

Department of Biology, University of Winnipeg

Since 1993, the commercial fishing season on Lake Winnipeg opens when 80% of female walleye have spawned as determined in a spring test fishery. This talk describes recent research that examines potential consequences of the compressed spawning season that results from this "80% rule".

Challenges in Lake Winnipeg walleye assessment after smelt collapse (presentation not available for download)

Geoff Klein

Manitoba Agriculture and Resource Development, Province of Manitoba

Lake Winnipeg has three fisheries – Indigenous, commercial, and recreational – and in all three fisheries, walleye is the most highly sought. Walleye have responded to important changes imposed on them, such as eutrophication and invasive species, notably rainbow smelt. This presentation discusses the consequences of the rainbow smelt collapse on walleye condition, compromised stock resilience, and the need to manage these changes in order to sustain profitable fisheries.

The Lake Winnipeg fishery – fishery and management trends (presentation not available for download)

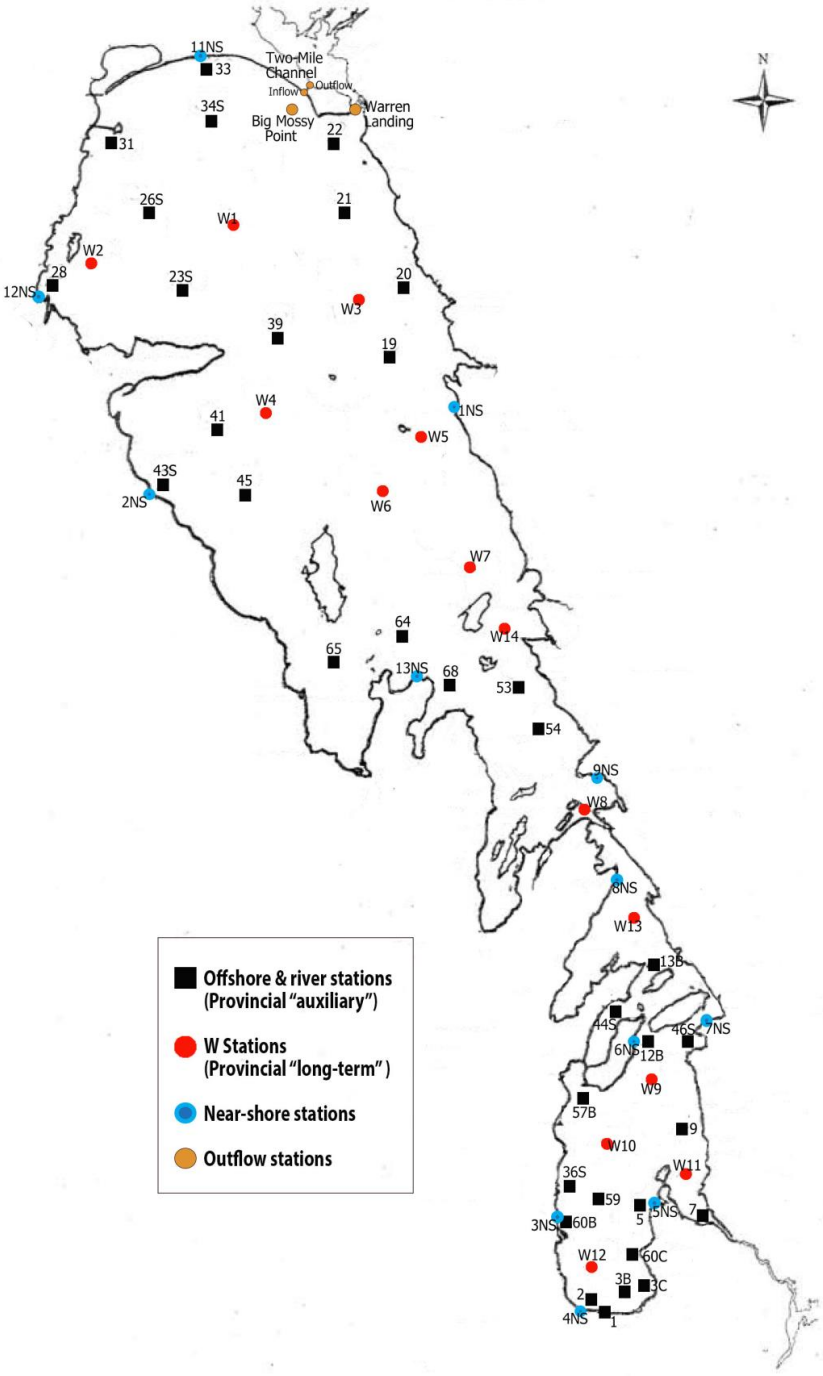
Brian R Parker and Geoff Klein

Manitoba Agriculture and Resource Development

The Lake Winnipeg commercial fishery has a long history dating back to 1881. Since then, many changes have occurred that have impacted the fishery: some of these changes are controlled by fishers and managers, such as mesh size and quotas, while other changes are not. These include a number of aquatic invasive species (most notably rainbow smelt), and excess nutrients leading to eutrophication, both of which have had profound impacts on the landed catch of commercial species over time. The non-stationary nature of the Lake Winnipeg fishery is now something that managers and fishers will need to adapt to. This presentation explores some of the changes occurring in the fishery of the three quota species – walleye, sauger, and lake whitefish – that have impacted stock resilience and yield.

Appendices

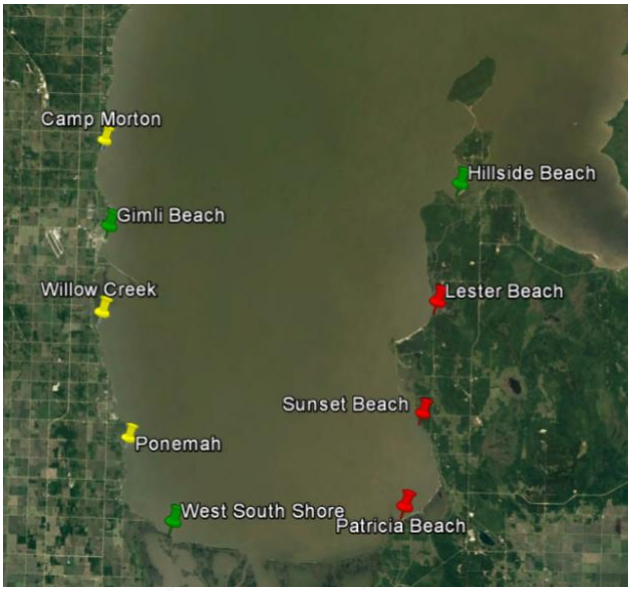
Appendix A-1. LWRC's offshore, nearshore, and outflow stations



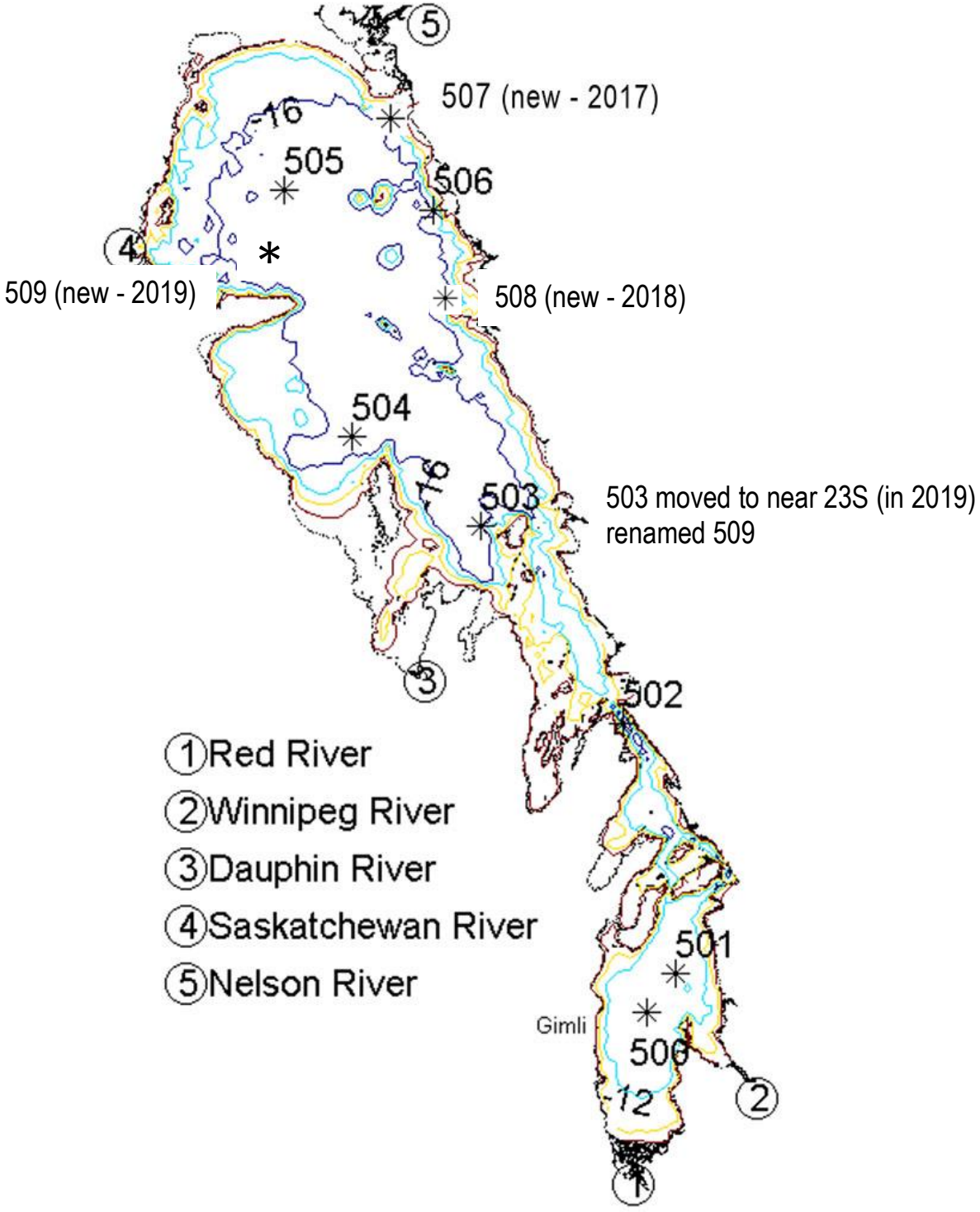
Since 2002, the LWRC has offered three, whole-lake surveys annually aboard the M/V *Namao*—spring, summer and fall—that cover an established network of 65 sampling stations. Due to their shallow nature, most nearshore and outflow stations are accessed by workboat, deployed from the M/V *Namao*.

Appendix A-2. Nearshore stations – Environment and Climate Change Canada

Appendix A-3. Nearshore stations – Fisheries and Oceans Canada



Appendix B. Mooring locations



Appendix C. 2019 Research and monitoring activities (M/V *Namao*)

Agency	Lead	Project	Spring	Summer	Fall	Details
Manitoba Agriculture and Resource Development	Burton	Long-term water quality monitoring of Lake Winnipeg	X	X	X	**All offshore, nearshore and outflow 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** – as above with metals and major ions, mercury, 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). **Blooms** - microcystin-LR and cyanobacterial cell counts
	Burton	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
	Janusz	*Bythotrephes* monitoring		X	X	Two vertical zooplankton hauls taken at all stations - 64 µm mesh size - composited. Samples taken from 1 m off the lake bottom

Agency	Lead	Project	Spring	Summer	Fall	Details
	Janusz	Zebra mussel veligers and adults	X	X	X	Veliger sampling at all narrows and NB stations (14 m) - offshore and nearshore; substrate samplers at Princess Harbour, George Island and Macbeth
Environment and Climate Change Canada	Valipour, Depew, Leon	Physical lake model - assessment of hydrodynamics and model-based nutrient status	X		X	Deploy/recover moorings: 500, 502 (N&S), 503, 504, 507, 508, 509 (new)
	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
	Depew & Leon	Ecological Modelling	X	X	X	Triplicate sediment (ponar) at all stations, 250 µm mesh; surficial sediment at select stations
	Depew	Internal phosphorus loading			X	Sediment cores 2 stations
	Koehler	Changes in foodweb structure & function due to zebra mussels	X	X	X	DIC/DOC/NO3; phytoplankton, zooplankton, benthos; C and N isotopes – all stations
Fisheries & Oceans Canada;	Enders	Forage fish trawl	X	X	X	43 offshore stations
	Stainton	Algal metabolism	X	X	X	Continuous monitoring of net photosynthesis and respiration, chlorophyll, algal group composition, CDOM and transparency (AOA)

Agency	Lead	Project	Spring	Summer	Fall	Details
U. Manitoba	Hann	Zoobenthos	X	X	X	W stations - one sample per site - 200 µm mesh
U. Manitoba	Hann	Zooplankton community	X	X	X	Vertical haul; W stations – 70 µm mesh
U. Manitoba	Kuzyk (student) & Yurkov	Anoxygenic phototrophs – role in biochemical cycling and toxin tolerances	X	X	X	Stations W9, 7NS, W10, W9 and 57B
U. Manitoba	Tim Papakyriakou	Lake carbon dynamics	X	X	X	Characterize components of lake C system - select stations surface & bottom waters
U. British Columbia	Murch	BMAA algal toxin	X	X	X	Water samples from algal blooms (unprocessed)
Manitoba Hydro	Chaze	CAMP		X	X	Warren Landing, Two-Mile Channel (inflow and outflow), Mossy Bay (sediment) and station 22

Appendix D. Science Workshop agenda

FINAL AGENDA
Science Workshop
Lake Winnipeg Research Consortium Inc.

February 4th & 5th, 2020
Qualico Family Centre – Tamarack Room
Assiniboine Park, Winnipeg

DAY 1 – February 4th (Full Day)	
8:00 a.m. to 8:30 a.m.	**Registration & Coffee**
8:30 a.m.	**Presentations**
Welcome – Opening remarks	Karen Scott (LWRC)
Lake and watershed modelling – Update	Reza Valipour[1]
A comparison of the Red Assiniboine Basin SPARROW with a Bayesian approach	(Agnes Richards[1])
Managing wetlandscapes to reduce risk of eutrophication	Forough Fendereski[2]
Update on Netley-Libau Marsh restoration project	Gordon Goldsborough[3]
Mid-Morning Break	
Federal Nearshore Program – Update	Elise Watchorn[1]
Remote sensing products and web tool	Larissa Pizzolato[1]
BMAA toxin study – Update	(Susan Murch[4])
Comparing algal populations in the western Manitoba great Lakes with Lake Winnipeg	Claire Herbert[3]
State of Lake Winnipeg reporting – status & path forward	Sharon Reedyk[1]
Noon	**Lunch (Workshop registrants only)**
1:00 p.m.	**Presentations**
GEN-FISH: Using environmental DNA and transcriptional profiling to improve sustainability of freshwater fisheries	Margaret Docker[3]
Provincial Aquatic Invasive Species (AIS) Program – Update	Laureen Janusz[5]
Lake Winnipeg zebra mussel distribution – Update	(David Depew[1])
What are they consuming? Exploring the zebra mussel associated bacterial community	Steven Kuzyk[3]
Looking for microplastics in zooplankton samples and fish stomachs from Lake Winnipeg	Thomas Gale[6]

Mid-Afternoon Break	
Update: Provincial long-term water quality monitoring of Lake Winnipeg	Andrew Burton[5]
Lake Winnipeg bottom and suspended sediments	Masoud Goharrokhi[3]
Sediment phosphorus flux	(David Depew[1])
Dissolved methane and carbon-dioxide cycling in Lake Winnipeg	David Capelle[3]
Current state of salinity and salinization in Manitoban surface waters	Braedon Humeniuk[3]

DAY 2 – February 5th (Half Day)	
8:00 a.m. to 8:30 a.m.	**Registration & Coffee**
8:30 a.m.	**Presentations**
Summary of fish movements in Lake Winnipeg	Doug Watkinson[7]
Identifying habitat associations for fishes in Lake Winnipeg using large scale bathymetric and substrate data linked with fish telemetry data	Tyana Rudolfsen[7]
Metabolites reflect spatial differences in walleye body condition	Matt Thorstensen[3]
Ongoing challenges with thin fish	Geoff Klein[5]
Mid-Morning Break	
Foodwebs, nutrients and stable isotopes	Geoff Koehler[1]
Update on the Lake Winnipeg pelagic trawling and nearshore sampling programs	Doug Watkinson[7]
Indigenous Inland Commercial Fisheries Initiative (IICFI) – Partnering for Indigenous prosperity	Bill Galbraith[8]
Earlier spawning in Lake Winnipeg walleye: an evolutionary effect of harvesting late spawners?	Scott Forbes[9]
The Lake Winnipeg fishery and its management	Brian Parker[5]
Wrap up	Karen Scott

Affiliations

[1]Environment and Climate Change Canada
[2]University of Saskatchewan
[3]University of Manitoba
[4]University of British Columbia
[5]Province of Manitoba
[6]Lincoln Middle School
[7]Fisheries and Oceans Canada
[8]Indigenous Services Canada
[9]University of Winnipeg

Appendix E. Science Workshop participants and affiliations

Name	Agency
Aminot, Melanie	Fisheries and Oceans Canada
Armstrong, Nicole	Manitoba
Ayles, Burton	Fisheries and Oceans Canada - retired
Budd, Russell	Norway House Cree Nation
Burton, Andrew	Manitoba Sustainable Development
Capelle, David	University of Manitoba
Charles, Colin	Fisheries and Oceans Canada
Chaze, Ainslie	Manitoba Hydro
Crate, Crystal	Norway House Cree Nation
Docker, Margaret	University of Manitoba
Fendereski, Forough	University of Saskatchewan
Forbes, Scott	University of Winnipeg
Galbraith, Bill	Indigenous Services Canada
Gale, Thomas	Lincoln Middle School
Geisler, Marianne	University of Winnipeg
Gladu Kanu, Daniel	Lake Winnipeg Indigenous Collective
Glowa, Sarah	Fisheries and Oceans Canada
Goharrokhi, Masoud	University of Manitoba
Goldsborough, Gordon	University of Manitoba
Hann, Brenda	University of Manitoba
Hanson, Mark	University of Manitoba
Herbert, Claire	University of Manitoba
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Heuring, Laura	Manitoba
Hnytka, Sarah	Fisheries and Oceans Canada
Humeniuk, Braedon	University of Manitoba
Janson, Wolfgang	North/South Consultants Inc.
Janusz, Laureen	Manitoba
Josephson, Rick	Independent
Klein, Geoff	Manitoba

Name	Agency
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Kovachik, Colin	Fisheries and Oceans Canada
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Kuzyk, Steven	University of Manitoba
Lobson, Chelsea	Lake Winnipeg Foundation
Lumb, Chelsey	Fisheries and Oceans Canada
McCullough, Greg	University of Manitoba
Meisenheimer, Peter	Anishinabek/Ontario Fisheries Resource Centre
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Ramlal, Patricia	Fisheries and Oceans Canada
Reedyk, Sharon	Environment and Climate Change Canada, Edmonton
Rodenberg, Andreas	Lake Winnipeg Research Consortium
Rodgers, Katelyn	University of Manitoba
Rodriguez, Jose	University of Manitoba
Rudolfsen, Tyana	Fisheries & Oceans Canada
Scott, Karen	Lake Winnipeg Research Consortium
Stainton, Mike	Fisheries and Oceans Canada - retired
Stratton, Desiree	University of Manitoba
Thorstensen, Matt	University of Manitoba
Trick, Charles	University of Saskatchewan
Valipour, Reza	Environment and Climate Change Canada, Burlington
Van de Vooren, Jennifer	Manitoba Hydro
Watchorn, Elise	Environment and Climate Change Canada, Winnipeg
Waters, Elaina	Fisheries and Oceans Canada
Watkinson, Doug	Fisheries and Oceans Canada