Lake Winnipeg Research Consortium Inc.

2009 Annual Report

Lake Winnipeg Research

April 1st, 2009 to March 31st 2010

October 2010

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INTRODUCTION

The Lake Winnipeg Research Consortium (LWRC) Inc. was founded in 1998 by a group of federal and university researchers to address the need for scientific studies on Lake Winnipeg following evidence of water quality deterioration related to the 1997 Red River flood. Its membership is diverse and includes various government and university departments, corporations, cottagers associations and other groups. The LWRC was incorporated in 2001 and received charitable status in 2008.

The primary goal of the LWRC is to coordinate and facilitate an integrated, collaborative research program that will further the understanding of the state of the health of Lake Winnipeg. To that end, the LWRC plans and conducts three research / monitoring surveys at 60 lake-wide sites annually utilizing the research platform Motor Vessel (M.V.) *Namao*, and provides access to the M.V. *Namao to* University, government and non-government researchers. Moreover, the LWRC organizes and holds an annual Science Workshop where results derived from field activities by scientists are reported with the aim to gain an improved understanding of the health and status of Lake Winnipeg. M.V. *Namao* is also used in the spring and fall for the on-board Lake Ecology Field Program for schools.

The operation of MV *Namao* for scientific research on Lake Winnipeg is funded through cost sharing arrangements with Manitoba Hydro, Manitoba Water Stewardship (MWS), Environment Canada (EC) and the City of Winnipeg. In 2009, the Royal Bank of Canada's Bluewater Fund provided funding for the operation of M.V. *Namao* for the on-board education program. Education programming is supported by public donations. Between 2008 and 2010, funds were received from private and community foundations to support LWRC management, science and education coordination.

The LWRC's on-lake science activities address a number of the recommendations made in the Lake Winnipeg Stewardship Board Final Report, February 2007. In particular:

3.0 - A Scientific Basis for the Protection of Lake Winnipeg including:

3.1 On-going research and monitoring is required on Lake Winnipeg to address outstanding information gaps, to monitor progress towards achieving targets for nitrogen and phosphorus, and to refine these targets. To this end, there is a need for the provincial and federal governments to develop and implement a long-term, collaborative science plan for Lake Winnipeg.

3.4 The Province of Manitoba together with other agencies needs to develop and implement a focused program of applied research aimed at better understanding the human-induced changes in water flows, circulation patterns, seasonal lake residence time, and lake levels on nutrient dynamics within Lake Winnipeg.

3.5 The Province of Manitoba together with other agencies needs to develop and implement a focused program of applied research aimed at better understanding the human-induced changes caused by dams, ditches, and diversions on water flows, in rivers and streams within the Lake Winnipeg watershed.

3.6 The Province of Manitoba and other agencies need to identify the factors responsible for increases in flow on the Red River and the associated increase in nutrients to Lake Winnipeg, and determine the sources of these nutrients.

Lake Winnipeg remains an ecosystem under threat. Eutrophication is currently the biggest threat as the concentrations of phosphorus and nitrogen in its waters continue to increase. Other stressors on the lake ecosystem include climate change, habitat degradation and exotic species. The zebra mussel, which has become recognized as one of the world's worst invaders due to its economic and ecological impacts, has now been documented in the Red River in North Dakota. It is a mere matter of time before it arrives in Lake Winnipeg.

The LWRC is at a critical junction. Many of the scientists who were integral to the formation of the LWRC in 1998 and to its subsequent success in bringing attention to the health of Lake Winnipeg, are retiring. Among this core group of scientists is Alex Salki, who continued with the LWRC as the Science Coordinator following his retirement from DFO in 2008. After 23 seasonal surveys of Lake Winnipeg, spanning 10 years (1999 - 2009), Alex decided to step down as Science Coordinator in November 2009 so that he can devote more time to his consulting work in freshwater zooplankton and his first grandchild. In addition to the loss of these scientists, many of the more recent initiatives being undertaken by Environment Canada are coming to an end in 2011. Thus, the LWRC has a challenging role in proactively attracting new science and scientists to the lake to further our scientific understanding of this threatened ecosystem.

Dr. Karen Scott is the new Science Coordinator of the LWRC. She holds undergraduate degrees in chemistry and physical geography, and a doctoral degree in microbiology, specializing in the biogeochemistry of mercury in aquatic environments. In the coming year, priorities for the science portfolio include:

- Identifying research redundancies and research gaps;
- Improving the exchange of information between lake science and watershed science; and
- The creation of a Lake Winnipeg Graduate Fellowship to support the research of graduate students.

2009 FIELD STUDIES

The 2009 open water research season consisted of three surveys, which occurred between May 27th and October 4th, 2009. On average, 60 stations were sampled and between 57 and 59 trawls were completed during each of the three research surveys (Figure 1; Table 1). During the spring survey, a total of 14 buoys were also placed on the lake. Six days were lost to weather during the open water season.

Government scientists from EC (National Water Research Institute (NWRI) in Burlington and the National Hydrology Research Institute (NHRI) in Saskatoon), MWS, and the Freshwater Institute (FWI) in Winnipeg, as well as researchers and students from the University of Manitoba, University of Regina, and Brandon University participated in 2009 field studies to determine factors responsible for declining Lake Winnipeg water quality (Table 2).

Environment Canada

EC has a mandate to preserve water quality in Canadian lakes. During the 2009 open water season, EC researchers continued to measure a suite of physical, chemical and biological parameters with instruments either moored in Lake Winnipeg or deployed from the *Namao.* Appendix 1 includes details on the chemical and biological parameters sampled and the protocols used. Below is a brief summary of the status of these projects.

Physical Limnology and Models for Assessing and Managing Water Quality in the Lake Winnipeg Basin (Yerubandi)

Physical parameters including currents, water temperature, winds, solar radiation, waves and some water quality parameters were recorded at several fixed moorings in Lake Winnipeg during 2007. In 2008 water temperature and meteorology was measured again at several moorings. Large field program conducted in 2009 (detailed report is still being prepared). A report on Physical Limnology based on 2007 and 2008 measurements is completed. NWRI Report prepared and reported to the State of the Lake report. Ecosystem Model developed for Lake Winnipeg, calibrated and validated with 2002-2007 data. Reported to State of the Lake Report. Lake Winnipeg hydrodynamic model and tracer dispersion is being submitted to JGLR-Lake Winnipeg special issue.

Isotope Hydrology and Geochemistry of Lake Winnipeg (Wassenaar & Yerubandi)

Multi-year lake and watershed sampling is being conducted between the period 2006 to 2011. Complete water chemistry (major minor ions) and stable isotopes (water isotopes, DIC, POM) will be used to develop a Bayesian mixing model of the lake. These data will aid in the calibration of hydrodynamic mixing models (Yerubandi above).

Lake Winnipeg Basin Nutrient Sequestration Study (Parker)

The purpose of this study is to estimate the quantity of phosphorus (P) and nitrogen (N) sequestered, if any, in large lakes and reservoirs in the greater Lake Winnipeg basin.

Water Quality Information Management and Modelling Project (Booty)

The goal of this project is to integrate physical, chemical and biological lake-watershed data in a model for lake management and remediation purposes.

Foodweb Dynamics of Aquatic Foodwebs in Lake Winnipeg (Wassenaar, Hobson & Ofukany)

The goals of this project are to isotopically delineate the Lake Winnipeg foodweb by using the stable isotopes δ15N and δ13C as trophic and benthic/pelagic tracers to define spatio-temporal foodweb relationships for fish and invertebrates in Lake Winnipeg. Samples will be taken over a 7-year period (2004-2011).

Foodweb Dynamics of Hg and Metals in Cormorants in Lake Winnipeg (Wassenaar, Hobson & Ofukany)

Cormorant sampling and isotope analyses are being used to examine the role of water birds on the Lake Winnipeg foodweb. Metals and Hg analyses are being collected to examine spatial patterns of toxins in the lake (2009-2010).

Oxygen Status of Lake Winnipeg (Wassenaar)

In 2006, EC began a study of dissolved oxygen patterns and processes in Lake Winnipeg, using conventional assays and δ18O analyses of DO to assess O_2 dynamics. Spatial and temporal maps of O_2 indicating areas of concern (low O_2) will be produced for the period 2006 to 2011.

Phosphorus Isotopic Source Tracking in Lake Winnipeg (Hiriart-Baer & Wassenaar)

One of the primary factors driving the ongoing eutrophication process in Lake Winnipeg is excess P loading, hence a scientific understanding regarding both the sources and in-lake processing of P are being determined using isotopic analyses to better manage and adapt remediation strategies.

Bioavailable Phosphorus (Watson)

Goal is to address key unresolved questions such as what factors drive algal blooms and what is the nature of the blooms in terms of taxa, toxicity and ecology.

Water Quality Profiling in Lake Winnipeg (Wassenaar & Ofukany)

Detailed water quality profiling will be done at each station in all seasons using sonde and rosette infrastructure installed on the Namao by Environment Canada (2006-2011).

Manitoba Water Stewardship
MWS is the only LWRC member with a mandate to manage Manitoba's water and fish resources and to ensure that people are safe from water hazards.

Lake Winnipeg Water Quality (Shipley)

The goals of the water monitoring program are to determine the impact of anthropogenic activities on water quality and aquatic life, evaluate long-term water quality trends, and provide information to support and protect the health of Lake Winnipeg.

In addition to the chemical and biological parameters described in Appendix 1, MWS and Environment Canada recently completed a joint winter survey of Lake Winnipeg in February and March of this year to assess under ice conditions

Chemical and biological data collected by MWS from 1999 to 2007 is currently being summarized for an upcoming State of the Lake report, which will serve as a baseline for scientific information and investigations on the lake, and is intended to support future development of performance indicators and nutrient objectives for Lake Winnipeg.

Abundance of Small-Bodied Fishes in Lake Winnipeg (Lumb)

The aim of this work is to describe seasonal distribution and abundance of small-bodied fishes, graphically represent geographic patterns of walleye density during spring, summer and fall, and summarize length distribution of walleye.

University of Manitoba (Centre for Earth Observations Science, Department of Environment and Geography) & Fisheries & Oceans Canada

Remote Sensing Cyanophyte Blooms in Lake Winnipeg: A Near Real Time Application (McCullough & Stainton)

The UM Centre for Earth Observation Studies and the Freshwater Institute continue to develop methods to estimate Lake Winnipeg surface algal bloom chlorophyll – *a* concentrations and phytoplankton species assemblages using satellites such as MERIS with continuing funding from the Canadian Space Agency.

The Role of Flooding in Phosphorous Loading to Lake Winnipeg (McCullough & Stainton)

The objective of this study is to investigate the effect of flooding on nutrient concentrations in the lower Red River and on nutrient loading to Lake Winnipeg.

University of Manitoba (Department of Biological Sciences)

In 2009, the LWRC continued to collect sediment samples for benthic invertebrates at all stations in each survey.

Zoobenthos Community in Lake Winnipeg (Hann)

Sample analysis and data interpretation is ongoing.

*Role of Invasive Rainbow Smelt in Lake Winnipeg (*Hann & Sheppard)

Determine the potential impact of rainbow smelt on the zooplankton community and on walleye in the North Basin of Lake Winnipeg through gut analysis of both rainbow smelt and walleye. Fish sampling (trawls at several stations during each cruise, primarily in the North Basin) for rainbow smelt gut contents analysis by Honours student, Katie Sheppard. Sampling for cisco was attempted in spring and summer cruises as part of a summer NSERC student scholarship project (Benoit Carriere), but very few cisco were found in trawls probably because the water temperature was so cold. Ongoing

Role of Commercially Important Walleye in Lake Winnipeg Food Web (Hann & Sheppard)

Walleye sampled as part of index gill-netting program operated by Fisheries Branch (Kevin Casper, Derek Kroeker) and gut contents analyzed by Katie Sheppard as part of her Honours thesis project. Results were reported at CCFFR (conference poster). Rainbow smelt comprised almost 100% of walleye stomach contents, and size of rainbow smelt in the gut increased with size of walleye (as estimated from otoliths in gut contents). Ongoing

In 2010, research will commence to determine the diet of walleye and sauger in the North and South Basins of Lake Winnipeg by gut analysis and carbon and nitrogen stable isotopes.

Brandon University

Algal Neurotoxins (Paton)

The purpose of this study was to prepare axenic cultures of blue-greens and identify and measure algal neurotoxins and other potentially harmful molecules with the potential to accumulate in the food chain. Additional work includes the isolatation and characterization algal toxins in the Hudson's Bay drainage system.

University of Regina

Historical Changes in Lake Winnipeg Trophic Status (Leavitt)

Collaborators: Dr. Kate Laird and Dr. Brian Cumming, Queen's University; Dr. Ann St. Amand, PhycoTech; Dr. Daniel Engstrom, Science Museum of Minnesota; Dr. Brenda Hann, University of Manitoba.

The objective of the study is to collect sediment cores from the North Basin of Lake Winnipeg to establish timing and extent of eutrophication by examining historical changes in sedimentary N and P, algal production, stable isotopes, radioisotopes and algal microfossils. Four sites were collected in 2009. Analyses are ongoing, but all four cores preserved excellent records of algal abundance based on quantification of sedimentary pigments via high performance liquid chromatography (HPLC). All four sites exhibited clear onset of eutrophication, probably ca. 1920-1930, although sediment age determinations are ongoing. As in the south basin, all sites also showed evidence of a state change to modern conditions in the uppermost 10 cm of sediment, suggesting that the rise in N fixing cyanobacteria was coherent throughout the lake. This increase has been established as occurring ca. 1990 in the south basin.

SCIENCE MEETING

The LWRC held its annual Science Meeting on March 24th, 2010 at the Holiday Inn South in Winnipeg. After overview presentations by EC and MWS, the workshop was divided into two sections: the lake and the watershed. There were 17 speakers and about 60 workshop registrants (Appendix 2). The workshop agenda is provided in Appendix 3 and the abstracts are below.

Science Workshop Submitted Abstracts

Manitoba Water Stewardship – Lake Winnipeg Update
Nicole Armstrong (on behalf of Elaine Shipley*) -- MB Water Stewardship

An overview presentation of the Lake Winnipeg Provincial initiatives was given.

Update on the Lake Winnipeg Basin Initiative
Nancy Hnatiuk -- Environment Canada, Winnipeg

This overview presentation reviewed the six overall deliverables of the science plan, as well as the status of the stewardship fund and the Memorandum of Understanding with Manitoba.

Response of Benthos and Zooplankton to Nutrient Enrichment in Lake Winnipeg
Brenda Hann*[1] and A. Salki[2] -- [1]University of Manitoba, Biological Sciences; [2]Salki Consultants Inc., Winnipeg

Trophic Study of Invasive Rainbow Smelt (*Osmerus mordax*) and Native Walleye (*Sander vitreus*) in Lake Winnipeg, Manitoba
Katie T. Sheppard*, B. Hann & G. Davoren – University of Manitoba

Objectives: Determine the potential impact of rainbow smelt on the zooplankton community and on walleye (a potential predator) in the North Basin of Lake Winnipeg through gut analysis of both rainbow smelt and walleye.

Main Findings: Rainbow smelt select for *Daphnia* spp. and *Eubosmina coregoni* in the North Basin of Lake Winnipeg and large rainbow smelt compose 100% of walleye

diets in the North Basin of Lake Winnipeg.

Future Plans: Determine the diet of walleye and sauger in the North and South Basins of Lake Winnipeg by gut analysis and carbon and nitrogen stable isotopes.

Using Mitochondrial and Microsatellite DNA Variation to Investigate Population Structure of Walleye (*Sander vitreus*) in Lake Winnipeg

Stephanie Backhouse* & M. Docker – University of Manitoba, Biological Sciences

Walleye (*Sander vitreus*) are the main contributor to Manitoba's multi-million dollar commercial fishery, with Lake Winnipeg providing the largest and most profitable catch. Walleye spawn in river mouths and lake shoals, and in some systems show evidence of returning to the same spawning site each spring, a behaviour known as natal homing or philopatry. The spatial segregation of gene flow that occurs when philopatry is present provides potential for multiple genetically discrete spawning groups to exist throughout a lake. This study used one mitochondrial restriction fragment length polymorphism (RFLP) assay and nine microsatellite loci and to investigate the degree of genetic differentiation present among 13 spawning sites in Lake Winnipeg, and compared these to walleye collected from two hatchery locations, other locations in northern and eastern Manitoba, Lake of the Woods and the Laurentian Great Lakes, and sauger (*Sander canadensis*). Little population structure was detected with mitochondrial DNA variation, and RFLP haplotypes indicate colonization of Lake Winnipeg by walleye from two glacial refugia (Missourian and Mississippi). Microsatellites also resolved little population structure within Lake Winnipeg at all but two sites (Grand Rapids and Icelandic River; F_{st} = 0.0066 to 0.0457). Slight to moderate genetic differentiation was found between Lake Winnipeg walleye and sampling locations outside of Lake Winnipeg (F_{st} = 0.0037 to 0.1054). The lack of genetic differentiation found in Lake Winnipeg possibly indicates a low degree of natal philopatry, an amount of straying sufficient to obscure genetic structure, or obscured structure as a result of historical and current stocking.

Abundance of Small Fishes in the Offshore Waters of Lake Winnipeg

Chelsey Lumb*[1], W. Franzin[2] and D. Watkinson[2]
[1]Manitoba Water Stewardship, Fisheries Branch; [2]Fisheries and Oceans Canada,

To describe seasonal distribution and abundance of small fishes in offshore waters of Lake Winnipeg and to graphically represent geographic patterns of estimated age-0 walleye densities (No./1000m3)

Main findings: Greatest number of species and greatest biomass in offshore mid-water trawl catches from the south basin compared to the north basin. Offshore forage fish assemblage composed mainly of Emerald Shiner, Rainbow Smelt, Cisco, White Bass, Yellow Perch and Walleye. Emerald Shiner and Cisco biomass were generally greater in the south basin and the channel compared to the north basin Rainbow Smelt biomass was significantly greater in the north basin compared to the channel and the south basin. Greater estimated age-0 walleye densities in all years in the south basin compared to the north basin, during the summer

An assessment of Cyanobacterial Toxins in Lake Winnipeg

Brian G. Kotak*[1], S. Watson[2], H. Kling[3] and C. Herbert[4]
[1]AlgalTox International, Pine Falls; [2]Environment Canada; [3]Algal Taxonomy and Ecology Inc., Winnipeg; [4]Parks Canada

Monitoring of total microcystin (MC), a common cyanobacterial liver toxin produced in eutrophic waters worldwide, has been undertaken in off-shore areas of Lake Winnipeg and at popular beaches periodically for the last decade by Manitoba Water Stewardship, Algal Taxonomy and Ecology, AlgalTox International and Environment Canada.

Data collected from off-shore sites during this time period consistently demonstrate that MC levels in raw lake water or in phytoplankton collected using a net, are usually quite low (less than 1 ug/L) and often times, below detection limits. In 2007 for example, both whole water samples and plankton net samples were collected from open water stations during mid-summer (July-August) and fall (September-October) cruises in the north basin, south basin and narrows of Lake Winnipeg. MC was frequently detected (in 81% of samples) in the net samples (although at low concentrations), but only in 27% the whole water samples. Concentrations in both whole water samples and net samples ranged from below detection limits (<0.10 ug/L) to 2.3 ug/L. While there were some differences in the concentration between the 3 sections of the lake (south, north and narrows), the differences are not likely to be ecologically significant. As the range in MC concentration was not large (relative to concentrations reported elsewhere in the literature), the ability to assess the relationship between phytoplankton species biomass (or water chemistry parameters) and MC was limited. However, examination of phytoplankton samples, which contained the highest MC concentrations in 2007, suggests that there is a limited pool of cyanobacteria likely responsible for producing the MC: *Anabaena ellipsoidea*, *Anabaena lemmermanii, Anabaena mendotae, Anabaena flos-aquae, Pseudanabaena* sp. and *Microcystis flos-aquae*. The only way to conclusively determine which species are producing MC in Lake Winnipeg would be to culture isolates from the lake in the laboratory. There were no statistically significant relationships between various water quality (chemistry) parameters and MC. However, there was a clear pattern of higher MC concentration occurring at low (less than 15:1) N:P ratios compared to higher ratios. This observation is consistent with that reported for other lakes in Alberta.

In contrast to off-shore areas, occasional high concentrations (>100 ug/L) of MC have been detected in whole water samples during intensive off-shore algal blooms and along shorelines during bloom events. Thick blooms occurring along shorelines could potentially represent a serious health threat from recreational contact, or to pets and wildlife, which may drink the water.

Analysis of phytoplankton samples for other cyanobacterial toxins, including neurotoxins, is currently underway by Environment Canada.

Our understanding of cyanobacterial toxins in Lake Winnipeg is rudimentary. Issues that need to be addressed include: What species produce MC? What is the health

risk associated with shoreline blooms? Are cyanobacterial neurotoxins produced in Lake Winnipeg (and if so, by which species and at what concentrations)? Do cyanobacterial toxins accumulate or move up the aquatic food chain?

Determination of Microcystins and Anatoxins in Fish, Plankton, and Water by LC-MS/MS

Gary Neumann*[1], V. Roscoe[1], G. Lombaert[1], T. Rawn[2]
[1]Health Canada, Food Program Laboratory, Winnipeg; [2]Health Canada, Bureau of Chemical Safety, Food Research Division, Ottawa

Summary: Six liver toxins (microcystins) and neurotoxic anatoxin-a were monitored in fish tissue, livers, plankton, and water from Lake Winnipeg, Canada using an LC-MS/MS method. Sample extraction and cleanup were matrix-dependent. Only microcystins were detected and only in plankton samples, where they were found in 10 of 12 (83%) samples.

Objectives: Cyanobacteria (blue-green algae) can produce hepatotoxic and neurotoxic compounds. In collaboration with Department of Fisheries and Oceans, Lake Winnipeg Research Consortium, and Freshwater Fish Marketing Corporation, determine anatoxin-a and microcystins levels in fish tissue, fish livers, as well as water and plankton from Lake Winnipeg to establish if these compounds are present and available for human uptake during fish consumption.
DESIGN: Samples were extracted and cleaned up using commodity-specific techniques. A single chromatographic separation and detection method was developed using reverse-phase HPLC, with detection by tandem mass spectrometry.

Results: Microcystins were detected in 10 of 12 (83%) of plankton samples. No microcystins or anatoxins were detected in fish tissue, liver or water samples tested.

Conclusions: Neither microcystins nor anatoxins were detected in the fish tissue, liver, or water samples analyzed. Microcystins were present in the lake plankton, with MC-LR being the most commonly found, as expected. Recent work by others has revealed that protein-bound microcystins are more toxic than the free molecular forms and may result in underestimation of the microcystin content (F. Jüttner, H. Lüthi, Toxicon 51, (2008), 388-397). This may be an avenue to pursue for further work.

Possibility of Applying a Preliminary Ecopath Model to Lake Winnipeg Ecosystem Using Currently Available Data

M. Yamin Janjua – Fisheries and Oceans Canada, Freshwater Institute

A general presentation to the introduction of using Ecopath modeling, types and forms of data required and output benefits.

The Role of Flooding in Phosphorous Loading to Lake Winnipeg

Greg McCullough*[1], M. Stainton[2]
[1]University of Manitoba, CEOS, Environment and Geography; [2]Fisheries and Oceans Canada, Freshwater Institute, Winnipeg

Objective: to investigate the effect of flooding on nutrient concentrations in the lower Red River and on nutrient loading to Lake Winnipeg.
Study description: We use two data sets: 1) historical discharge and nutrient concentration records for the Red River at Selkirk (data supplied Manitoba Water Stewardship, Environment Canada and the City of Winnipeg) and 2) nutrient concentrations for over 200 samples collected from field runoff, major drains and the main stem of the La Salle River from first runoff to mid-July 2009, used with discharge records (Environment Canada) to calculate loads and export coefficients. Our samples coincided with a major spring flood event in the La Salle basin. Currently, only phosphorous analyses are completed.

Preliminary findings: Phosphorous concentrations in the Red River at Selkirk double during floods (median TP = 526 mg m^{-3} when discharge > 1000 m^3 s^{-1} at Emerson, n = 47; 254 mg m^{-3} when discharge < 1000 m^3 s^{-1}, n = 163; 1990 – 2005 data) Although much of this difference is due to particulate matter, which may be resuspended from the channel and banks by increased turbulent capacity associated with higher flood water velocities, median dissolved phosphorous concentrations are also elevated during floods (median TDP = 230 mg m^{-3} compared to 183 mg m^{-3}), which is more likely due to leaching from flooded soils and vegetation.
In the La Salle basin during the spring flood, TDP ranged from 100 – 2000 mg m-3. Although highest TDP was recorded in field runoff, modal TDP was higher in the main stem of the river than in either initial field runoff or in major drains.
Peak TDP in the main stem of the river (at Elie) occurred not on the rising limb of the hydrograph (traditionally expected result, due to mobilization of suspended materials by rising flood waters) but when flooded fields began to drain back into the river (indicating higher TDP by the process of water rising out of the channel to inundate adjacent fields than by the initial process of snowmelt drainig from the fields).

As in the Red River (1 & 2 above), in the La Salle River near its mouth, mean spring TP and TDP are both positively correlated with total spring runoff ($P < 0.000$, n = 20, 1973 – 2008 data).

Future plans: Repeat an extensive nutrient concentration and loading study of the La Salle basin during a minor flood year. We will analyze spatial/temporal patterns in these data sets in the context of spatio/temporal patterns of appropriate environmental and cultural variables. Analyze spatio-temporal relationships between discharge, flooding and nutrient nutrient concentration and export for monitored sub-basins in the Red River watershed [data supplied by Manitoba Water Stewardship (nutrients), Environment Canada (discharge) and the U.S. Geological Survey (nutrients and discharge)].

Nutrient Sequestration in the Lake Winnipeg Basin
Brian Parker – Environment Canada, Winnipeg

Fish Habitat Management in Three Manitoba First Nations
Bruce Maclean – Centre for Indigenous Environmental Resources, Winnipeg

This presentation is to provide a summary of the activities of the First Nations Fish Habitat Program (FNFHP) and will describe fish habitat management work undertaken in three Manitoba First Nations. The summaries are compiled from reports given to the communities. Specifically the presentation will look at the:

Poplar River First Nation Sewage Lagoon Site Inspection -- A description of the history of the project will be given along with key findings from a site inspection and recommendations for nutrient management;

Hollow Water First Nation Traditional Methods of Resource Management Study Results from interviews and literature will be described with recommendations for greater meaningful involvement of First Nations in the management of Lake Winnipeg;

Birdtail Sioux First Nation Sustainable Cattle Management Model Farm
An examination of work being done by a First Nation in the Lake Winnipeg watershed to reduce nutrient inputs and describes sustainable cattle management in the Birdtail Sioux First Nation. A description of the project will be presented along with macroinvertebrate sampling results.

Beating a Dead Horse Creek: Pharmaceutical and Agrochemical Contaminants in a Lake Winnipeg Watershed

Mark L. Hanson*[1], J. Carlson[1,2], W. Buhay[3], and C. Wong[2].
[1]University of Manitoba, Environment and Geography; [2]University of Winnipeg, Richardson College for the Environment; University of Winnipeg, Geography

The Dead Horse Creek is a small lotic system located in south central Manitoba that flows into the Red River. Two population centres, Morden and Winkler, release their municipal wastewater into the creek after passive treatment in aerated retention ponds. This effluent contains not only a high nutrient load, but possibly other contaminants that could be impacting ecosystem structure and function. Common contaminants found in municipal effluent are pharmaceuticals, personal care products, and agrochemicals. In 2010, the assembled research team will characterize the concentrations of a suite of these compounds using polar organic chemical integrative samplers (POCIS) devices. This presentation will outline the methodological approaches to be taken and how the data will drive future field-level manipulations to assess exposure and effects in the Dead Horse Creek from municipal effluent.

Environment Canada Geoportal Update

Sarah Hall – Environment Canada

An update on the web portal being developed in order to promote data sharing with key partners and ensure consistent, inter-operable and reliable delivery of relevant information.

Environment Canada's National Water Quality Monitoring and Surveillance Office has taken on the role of coordinating partnership based activities, working in partnership with the Water Quality Information Management and Modeling Project

who are developing the information and decision support portal. Data and information leveraged through partnerships will, over the course of the next three years, be integrated into a Lake Winnipeg Basin Initiative (LWBI) Single Window Information Portal. This mechanism will compile and review existing LWBI information on point and non-point sources of pollution, and integrate multi-media (e.g., land and water) and multidisciplinary (e.g., agriculture, fisheries and water quality) data and information using statistical analysis and integrated modeling techniques. This spatially focused information portal will be based on the use of Canadian Geospatial Data Infrastructure standards and will provide varying degrees of access for a number of user groups. Access to both public and secure data, information, models and other tools will be made available through the portal. Its development will take into account the needs and various capacities of its users.

The National Aquatic Invasive Species Database: Data sharing in the Lake Winnipeg Watershed

Lynn Frazer* & L. Wesson – Fisheries and Oceans Canada, Winnipeg

Fisheries and Oceans Canada (DFO) has developed and is maintaining the National Aquatic Invasive Species Database: an online repository for aquatic invasive species (AIS) data. The goal of this web-based application is to provide a centralized location for all AIS data, in order to facilitate the sharing of AIS monitoring and research across Canada and strengthen our ability to assess the threat of AIS to Canadian ecosystems. The database has been relatively underutilized in the Lake Winnipeg watershed; however, from January to March, 2010, DFO has worked to assist partner organizations in updating the database, which now includes AIS data from federal, provincial, non-government agencies and academia in Alberta, Saskatchewan, Manitoba and northwestern Ontario. The database is all encompassing, with the capability of uploading georeferenced locations, publications, reports and photographs, as well as the ability to create species distribution maps, through a portal to DFO's GeoBrowser. Overall, the National AIS database has been designed to be a useful tool to all levels of government, researchers and stakeholders, as well as local residents, cottage owners and school groups. As of April, 2010, the database will be open for public access, to capture not only research but also sightings and opportunistic monitoring on Lake Winnipeg and its surrounding watershed.

Lake Winnipeg Foundation - Project Initiatives

Lyle Lockhart – Lake Winnipeg Foundation

The Lake Winnipeg Foundation is a non-profit, charitable organization of about 400 people devoted to the recovery of Lake Winnipeg to improved health. The Foundation is independent with no affiliation to any government, business or academic institution. Its money comes from fees paid by members, from sales of promotional products, from donations, from grants, and from fund-raising events. The major activities are public education (mainly adult groups) and support of scientific projects aimed at improving the quality of the lake. The Foundation is a member of the Lake Winnipeg Research Consortium and has supported several

research projects. Recently we have joined with Wildsight, a non-profit organization in British Columbia, in bringing the Living Lakes Network, part of the Global Nature Fund, to Canada; Lake Winnipeg was accepted as a full member of the Network at a meeting in Mexico last week. We hope this will bring wider national and international interest and support for Lake Winnipeg. We have become aware of extensive losses of wetlands in the Lake Winnipeg drainage basin and we are becoming better informed about coastal marshes around the lake. We have just passed our first "Position Statement" to support preservation of existing wetlands, restoration of degraded wetlands, and creation of new ones. We have approved funding for aerial photographic work on South-Basin shoreline wetlands and on the analysis of some lake sediment cores. We look forward to cooperating with the International Institute for Sustainable Development with their "Lake Winnipeg Summit" this fall.

Red-Assiniboine Project

Ute Holweger – Agriculture and Agri-Food Canada, Agri-Environment Services Branch

The Red-Assiniboine Project is a multi-year, multi-partner initiative between Environment Canada, Agriculture and Agri-Food Canada, Manitoba Water Stewardship and Conservation Districts of Manitoba that aims to identify and evaluate the impacts of various land-use and land-management scenarios in three watersheds located within the Red and Assiniboine Basins of south-central Manitoba.

The goal of the project is to develop products and tools that will help watershed planners working to identify effective land-use strategies and key beneficial management practices (BMPs) in agricultural landscapes, and to recognize where these measures will have the most impact on the surrounding landscape.

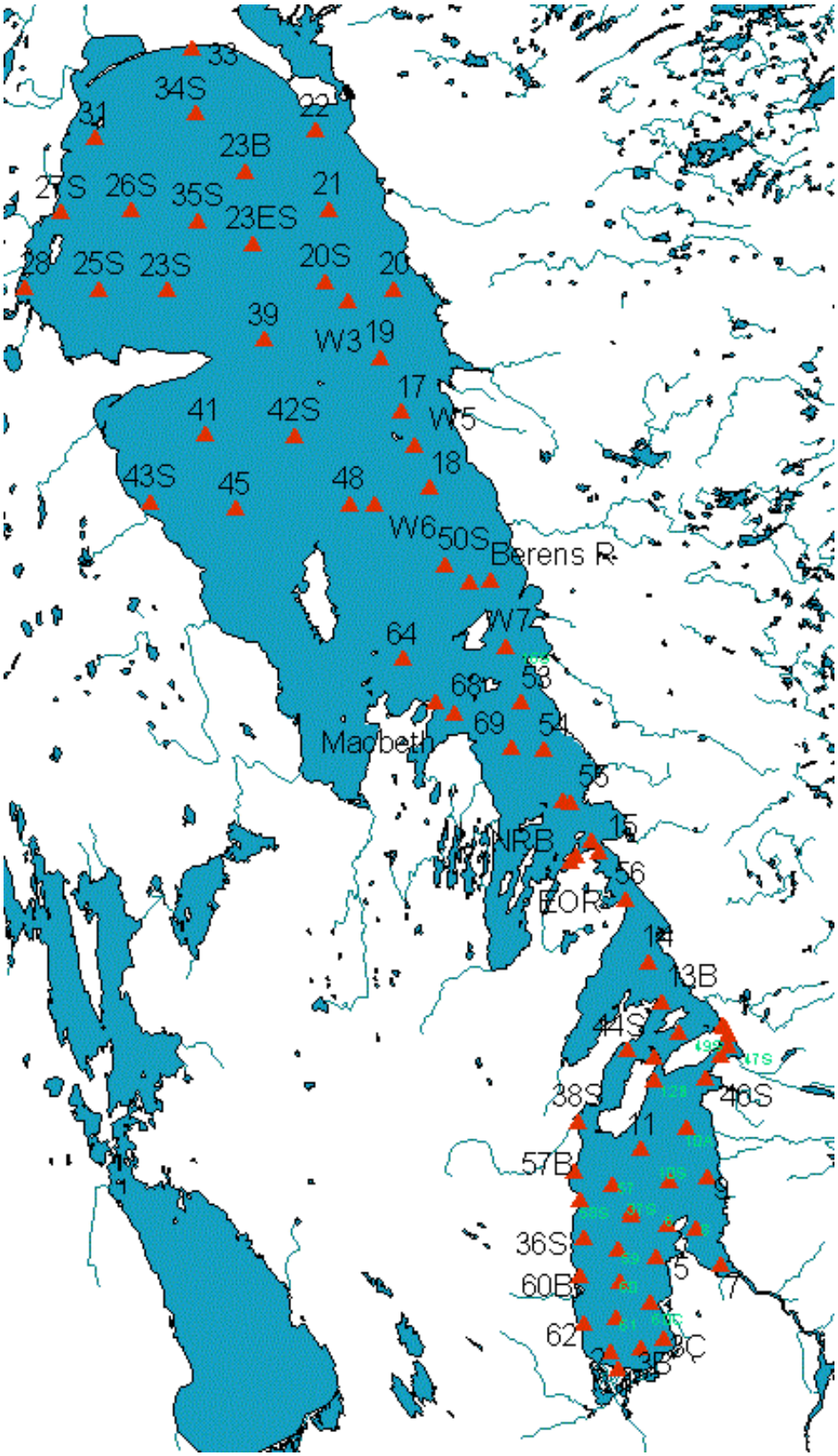

Figure 1. Lake Winnipeg sampling station locations.

Table 1. Breakdown of science activities and agency time on-board M.V. *Namao*, 2009 open water season.

	Spring	Summer	Fall	Total
Dates	May 27 – June 13	July 14 – August 5	Sept 14 – Oct 4	May to October
Days on the lake	21	18	24	63
Education days	6	0	4	10
Weather days	1	1	4	6
Stations sampled	61	57	61	179
Trawls completed	57	57	59	173
Buoys placed	14		16	
Personnel days on board				
EC	44	53	38	135
MWS – Water Qual.	16	17	16	49
MWS – Fish. Branch	18	45	30	93
DFO/U Manitoba		17		17
U Manitoba	6	6		12
U Regina		4		4
U Brandon		1		1
U Saskatchewan		1		1

Table 2. Lake Winnipeg principal investigators and their respective students, 2009.

Agency	Researcher	Title	Affiliation	Research	Field
Environment Canada	Len Wassenaar	Research Scientist	NHRI-NWRI	Saskatoon	Isotope Hydr & Ecol
	Amy	Graduate Student	NHRI-NWRI	Saskatoon	
	Keith Hobson	Research Scientist	NHRI-NWRI	Saskatoon	
	Ram Yerubandi	Research Scientist	CCIW-NWRI	Burlington	Physical Limnology
	Veronique Hiriart-Baer	Research Scientist	CCIW-NWRI	Burlington	Chemical Properties
	Sue Watson	Research Scientist	CCIW-NWRI	Burlington	Algal Nutrients
Fisheries & Oceans	Mike Stainton	Chemist	FWI	Winnipeg	Chemical Properties
University of Manitoba	Brenda Hann	Professor	Bio Sci	Winnipeg	Invertebrates, Food Web
	Katie Sheppard	Honours Student		Winnipeg	
	Andrew Olynyk	Honours Student		Winnipeg	
	Greg McCullough		CEOS	Winnipeg	Remote Sensing
MB Water Stewardship	Chelsey Lumb	Fisheries Biologist	Fisheries Branch	Winnipeg	Forage Fish
	Derek Kroeker	Fisheries Biologist	Fisheries Branch	Winnipeg	Commercial Fish
	Elaine Shipley	WQ Specialist	WQ Branch	Winnipeg	Chemical Properties
U Regina	Peter Leavitt	Professor	Bio Sci	Regina	Historical Nutrients
Brandon U	Bill Paton	Professor	Botany	Brandon	Algal Toxins

APPENDIX 1 – PARAMETERS & PROTOCOLS

CANADA

Rosette Profiles using Seabird Software
At each station, the Rosette was lowered from the surface to just above the sediment, creating a profile for a variety of chemical and physical parameters being monitored. Hexfiles and graphs were saved and data clean-up was carried out by Environment Canada (Saskatoon).

Water and Sediment Phosphates and Isotope Ratios
At each station, water was collected from surface and meter off bottom (MOB) for phosphates, phosphate isotopes, and oxygen isotopes (summer cruise only). During the fall cruise, a ponar sample was used to obtain sediment for phosphate isotope analysis (Environment Canada, Saskatoon). At select stations, sediment from the Ponar samples was also collected and sent to Environment Canada (Burlington) for analysis.

Nutrient Status
At each station, samples from surface and MOB were collected and analyzed within 12 hours for silica- phosphorus-, and nitrogen-debt analysis (Environment Canada, Burlington).

Water Chemistry
From each station, water collected from the top meter was filtered on-board within 8 hour of collection for the following components:

- *Total Suspended Solids (TSS)* – water filtered onto pre-weighed, pre-combusted GF/C filter paper, desiccated overnight and stored at –20°C.
- *Suspended Carbon and Nitrogen (Susp. C/N)* – water filtered onto pre-combusted GF/C filter paper, desiccated overnight and stored at –20°C.
- *Suspended Phosphorus (Susp. P)* – water filtered onto pre-combusted GF/C filter paper, desiccated overnight and stored at –20°C.
- *Chlorophyll a (Chl)* – water filtered onto GF/C filter paper, desiccated overnight and stored at –20°C.
- *Suspended Silica (Susp. Si)* – water filtered onto 0.2µm (or 0.1µm) membrane filter, desiccated and stored at –20°C.
- *Dissolved Organic Carbon (DOC)* – GF/C filtrate collected for clean 175 ml Nalgene bottle, refrigerated.
- *Dissolved Si* – filtrate from 0.2 µm membrane filter collected to 20 ml plastic scint vial (with red lid), refrigerated.

All of the above listed samples were sent to the Freshwater Institute (Winnipeg) for analysis.

Algae Online Analyzer (AOA)
AOA was run continuously between and at station, drawing water from just below the surface. At overnight anchor sites, the AOA was allowed to run overnight in order to monitor diurnal changes in phytoplankton assemblage (Department of Fisheries and Oceans, Winnipeg).

GPS Tracks
A Garmin GPS, coupled with datalogger, was run continuously while cruising and at anchor. The datalogger was downloaded to a dedicated computer, to be extracted upon return to the
Freshwater Institute (DFO, Winnipeg).

Brancker Logger
During the summer and fall cruises, the Branker logger was run continuously between stations, at station, and while at anchor. Logged data are to be extracted upon return to the Freshwater Institute (DFO, Winnipeg).

Phytoplankton and Picoplankton, Bacteria and Heterotrophic Flagellates
At each station, 20 ml phytoplankton samples were collected from the surface (0-0.5 m) and meter off bottom (MOB). A sample, integrated through the euphotic zone, was also collected. These samples were preserved with 0.5 ml Lugol's iodine solution. At each station, 20 ml of water from the integrated sample was preserved using 1.5 ml of formaldehyde for picoplankton, bacteria and heterotrophic flagellates. Where fluorescence peaks were observed, phytoplankton and picoplankton samples were collected at every 1 or 2 meters, capturing the peak. This was done at ≥ 8 stations. Surface, MOB, and profile samples were sent to Sue Watson (Environment Canada, Burlington) for analysis, while those from integrated samples were sent to Hedy Kling (Algal Taxonomy and Ecology Inc.).

Zooplankton
At each station, zooplankton samples were collected by hauling 72 µm mesh-size Wisconsin net (mouth diameter 25 cm) through the entire water column. Samples were preserved with 5 ml formaldehyde (37% solution) and archived for future laboratory analysis. A total of 184 samples were obtained.

Algal Toxins and Bloom Taxonomy
Where substantial blooms were observed in the summer and fall surveys (at or between stations), whole water samples were collected for the following and sent to Sue Watson (Environment Canada, Burlington):

- β-cyclocitral (GF/F filter and filtrate)
- Grazer toxins and Cyanotoxins (GF/C filters)
- Phytoplankton (20 ml whole water, preserved with Lugol's solution)
- Picoplankton (preserved with formaldehyde and frozen in liquid nitrogen)
- Live samples Whole water sample, frozen in liquid nitrogen

At select stations in the spring and where substantial blooms were observed, net haul and whole water samples were also collected for identification, isolation, and culture (Algal Taxonomy & Ecology Inc.).

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ACS (Absorption-Attenuation Meter)

The ACS was run continuously between stations, drawing water from just below the surface. At station, clear water (Gimli or Grand Rapids tap water) was run through the instrument to create a "blank" reference. A net haul sample (70µm mesh) was collected through 2-times Secchi depth and "washed" using clear water to remove residual lake water. The sample was then resuspended in 2 L clear water and run through the ACS. Where algal biomass was low, multiple hauls were done to concentrate algal material. Where algal biomass was high, only a portion of the net haul sample was used, ensuring that the absorption remained below the upper limit of quantification (Greg McCullough, University of Manitoba). Subsamples of the re-suspended net haul sample was run through the Algal Online Analyzer (AOA) and saved for laboratory analysis (algal taxonomy, DOC, TSS and Chl).

Benthos

At each station, one Ekman grab was taken for benthos samples. Sediment was sieved through a 200µm mesh. Cleaned samples were preserved with 5 ml formaldehyde (37% solution) and sent to the University of Manitoba for analysis. Where substrate was excessively sandy or rocky, multiple jars were used to contain cleaned benthos samples (labelled X of Y).

Smelt

Stomachs were collected from trawls in the north basin during the summer cruise. These were preserved in ethanol for analysis of stomach content by the University of Manitoba (Hann).

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In 2009, Manitoba Water Stewardship collected samples from approximately 60 stations during each of the spring, summer, and fall research cruises. In total, more than 500 samples were collected for chemical and biological analysis in 2009.

Sediment Metals and Particle Size

During the summer cruise, a Ponar was used to collect 4 sediment samples at each Provincial monitoring station ("W" stations only). Sediment was sub-sampled for particle size analysis (1 sample) and determination of metal concentrations in sediment (in triplicate) (Manitoba Water Stewardship). Samples were analyzed for metals, nutrients, organic content, and particle size analysis (percent sand, silt, and clay).

Water Quality Monitoring

At each station and where substantial blooms were observed between stations, water samples (integrated through the euphotic zone) were collected for a variety of water quality parameters (Manitoba Water Stewardship). These included both biological (algal taxonomy, chlorophyll, microcystin, and bacteriological sampling) and chemical parameters (dissolved oxygen, nutrients). In 2009, several additional bloom samples were collected during the summer and fall cruises from the north basin of Lake Winnipeg. Additional parameters were analyzed at the 14 long-term stations on Lake Winnipeg including metals and major ions. Pesticides were also monitored at the three stations nearest the inflow of the Red, Winnipeg, and Saskatchewan rivers during the three open water cruises. Biological monitoring included the collection of whole water phytoplankton samples for identification, enumeration, and biovolume estimates at all 14 long term stations during the spring, summer, and fall cruises. Additional water samples were also collected for a nutrient enrichment study, which will provide preliminary information on the seasonal nutrient status of phytoplankton in Lake Winnipeg. Results from the 2009 field season are currently being processed.

Vertical depth profile measurements of light, temperature, dissolved oxygen, turbidity, and conductivity were also recorded at each station.

Benthos

During the spring cruise only, a Ponar dredge was used to collect sediment samples (in triplicate). These samples were washed as above and preserved with ethanol for laboratory analysis (Manitoba Water Stewardship). Macroinvertebrate samples were collected in triplicate during the spring research cruise from the 14 long-term stations and were counted and identified to the lowest taxonomic level possible.

Fish Trawls

Manitoba Fisheries Department conducted trawls at each station, where weather permitted. The trawl net was pulled alongside the ship (10' x 10' opening, pulled at 2 knots for 30 minutes). Fish were sorted according to species, bagged and frozen or preserved in formalin for further taxonomic identification and age determination. During the summer cruise, index netting was also carried out at pre-determined locations throughout the north basin. The species, sex, and fork length of the fish obtained were recorded, and otoliths and scales were collected from all specimens of walleye *(Sander vitreus)* and lake whitefish *(Coregonus clupeaformis).*

APPENDIX 2 - LWRC 2009 Science Meeting Speakers & Attendees

Speakers

Brenda Hann	University of Manitoba
Brian Kotak	AlgalTox International
Brian Parker	Environment Canada
Bruce Mclean	Centre for Indigenous Environmental Resources
Chelsey Lumb	Fisheries Branch, Province of Manitoba
Gary Neumann	Health Canada
Greg McCullough	University of Manitoba
Katie Sheppard	University of Manitoba
Lyle Lockhart	Lake Winnipeg Foundation
Lynn Frazer	Fisheries & Oceans Canada
Mark Hanson	University of Manitoba
Nancy Hnatiuk	Environment Canada
Nicole Armstrong	Water Stewardship, Province of Manitoba
Sarah Hall	Environment Canada
Stephanie Backhouse	University of Manitoba
Ute Holweger	Agriculture and Agri-Food Canada
Yamim Janjua	Fisheries & Oceans Canada

Registrants

Al Kristofferson	Lake Winnipeg Research Consortium
Andrew Olynyk	University of Manitoba
Anne Doherty	Lake Winnipeg Foundation
Bill Crowe	Manitoba Sailing Association
Bryon Oborne	Tobacco Creek Model Watershed
Carl Hrenchuk	Environment Canada
Cynthia Thoroski	Environment Canada
Dan Beveridge	Institut national de la recherche scientifique
Dan Richmond	Lake Winnipeg Research Consortium
Dave Bergunder	Freshwater Fish Marketing Corporation
Derek Kroeker	Fisheries Branch, Province of Manitoba
Derek Smith	Red River Basin Commission
Don Bjornson	LWRC lawyer
Eveline Schroth	Health Canada

Fred Nash	Teacher
Garry Swanson	MB Hydro
Geoff Klein	Fisheries Branch, Province of Manitoba
Glen Koroluk	Beyond Factory Farming
Heather Clark	MWS, Fisheries Branch
Henry Venema	International Institute of Sustainable Development
Herb Lawler	Lake Winnipeg Research Consortium
Hugh Arkley	Thomas Sill Foundation
Iris Griffin	Environment Canada
John Lawrence	Environment Canada
Joseph Smolinski	Selkirk & District Community Foundation
Julie Goehring	Red River Basin Commission
Karen Scott	Lake Winnipeg Research Consortium
Katrina Froese	Fort Whyte Alive
Lance Yohe	Red River Basin Commission
Laurie Wesson	Fisheries & Oceans Canada
Lindsay Smith	Health Canada
Logan Queen	MWS, Fisheries Branch
Loren Remillard	Environment Canada
Lucie Levesque	Environment Canada
Mike James	Teacher
Mike Renouf	Environment Canada
Mike Stainton	DFO
Mirna Wishart	University of Manitoba
Mo Tipples	Grindstone Cottage Owner Association
Neil Williams	FFMC
Paul Kemp	Stornoway Productions
Richard Longley	Stornoway Productions
Richard Moodie	University of Winnipeg
Robert T. Kristjanson	fisher
Sarah Ross	Environment Canada
Sharon Gurney	Water Stewardship, Province of Manitoba
Sharon Ryland	Lake Winnipeg Research Consortium
Sue Cosens	Fisheries & Oceans Canada
Vicki Burns	Thomas Sill Foundation

APPENDIX 3 -- Annual Science Meeting Agenda

Wednesday March 24th, 2010
9:00 AM to 3:30 PM
Holiday Inn South - 1330 Pembina Highway

Chairperson – Dr. Karen J. Scott

MORNING SESSION – 9:00 AM

Manitoba Water Stewardship – Lake Winnipeg Update
Nicole Armstrong (on behalf of Elaine Shipley*) – MB Water Stewardship
(*Elaine.Shipley@gov.mb.ca)

Update on the Lake Winnipeg Basin Initiative
Nancy Hnatiuk – Environment Canada, Winnipeg (Nancy.Hnatiuk@ec.gc.ca)

Response of Benthos and Zooplankton to Nutrient Enrichment in Lake Winnipeg
Brenda Hann*[1] and A. Salki[2]
University of Manitoba, Biological Sciences (*Brenda_Hann@umanitoba.ca)
Salki Consultants Inc., Winnipeg

Trophic Study of Invasive Rainbow Smelt (*Osmerus mordax*) and Native Walleye (*Sander vitreus*) in Lake Winnipeg, Manitoba
Katie T. Sheppard*, B. Hann & G. Davoren – University of Manitoba, Biological Sciences (*umsheppk@cc.umanitoba.ca)

Using Mitochondrial and Microsatellite DNA Variation to Investigate Population Structure of Walleye (*Sander vitreus*) in Lake Winnipeg
Stephanie Backhouse* & M. Docker – University of Manitoba, Biological Sciences (*umbackhs@cc.umanitoba.ca)

Abundance of Small Fishes in the Offshore Waters of Lake Winnipeg
Chelsey Lumb*[1], W. Franzin[2] and D. Watkinson[2]
Manitoba Water Stewardship, Fisheries Branch (*Chelsey.Lumb@gov.mb.ca)
Fisheries and Oceans Canada, Freshwater Institute, Winnipeg

An assessment of Cyanobacterial Toxins in Lake Winnipeg
Brian G. Kotak*[1], S. Watson[2], H. Kling[3] and C. Herbert[4]
AlgalTox International, Pine Falls (*miette@xplornet.com)
AEMRD, Environment Canada
Algal Taxonomy and Ecology Inc., Winnipeg
Parks Canada

Determination of Microcystins and Anatoxins in Fish, Plankton, and Water by LC-MS/MS

Gary Neumann*[1], V. Roscoe[1], G. Lombaert[1], T. Rawn[2]
Health Canada, Food Program Laboratory, Winnipeg (*Gary.Neumann@hc-sc.gc.ca)
Health Canada, Bureau of Chemical Safety, Food Research Division, Ottawa

AFTERNOON SESSION – 1:00 PM

Possibility of Applying a Preliminary Ecopath Model to Lake Winnipeg Ecosystem Using Currently Available Data
M. Yamin Janjua – Fisheries and Oceans Canada, Freshwater Institute (*yaminjanjua@hotmail.com)

The Role of Flooding in Phosphorous Loading to Lake Winnipeg
Greg McCullough*[1], M. Stainton[2]
University of Manitoba, CEOS, Environment and Geography (*gmccullo@cc.umanitoba.ca)
Fisheries and Oceans Canada, Freshwater Institute, Winnipeg

Nutrient Sequestration in the Lake Winnipeg Basin
Brian Parker – Environment Canada, Winnipeg (Brian.Parker@ec.gc.ca)

Fish Habitat Management in Three Manitoba First Nations
Bruce Maclean – Centre for Indigenous Environmental Resources, Winnipeg (bmaclean@cier.ca)

Beating a Dead Horse Creek: Pharmaceutical and Agrochemical Contaminants in a Lake Winnipeg Watershed
Mark L. Hanson*[1], J. Carlson[1,2], W. Buhay[3], and C. Wong[2].
University of Manitoba, Environment and Geography (*hansonm@cc.umanitoba.ca)
University of Winnipeg, Richardson College for the Environment
University of Winnipeg, Geography

Environment Canada Geoportal Update
Sarah Hall – Environment Canada (Sarah.Hall@ec.gc.ca)

The National Aquatic Invasive Species Database: Data sharing in the Lake Winnipeg Watershed
Lynn Frazer* & L. Wesson – Fisheries and Oceans Canada, Freshwater Institute, Winnipeg (*Lynn.Frazer@dfo-mpo.gc.ca)

Lake Winnipeg Foundation - Project Initiatives
Lyle Lockhart – Lake Winnipeg Foundation (llockhart@shaw.ca)

Red-Assiniboine Project
Ute Holweger – Agriculture and Agri-Food Canada, Agri-Environment Services Branch (Ute.Holweger@agr.gc.ca)