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PRAIRIE PROVINCES WATER BOARD

Report #177

Prairie Water Quality Workshop With a Focus on Nutrients

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Recommended by the PPWB Committee on Water Quality
Approved by the Prairie Provinces Water Board

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PRAIRIE WATER QUALITY WORKSHOP

With a Focus on Nutrients

Executive Royal Hotel, Regina, Saskatchewan
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Introduction

The Prairie Provinces Water Board (PPWB) sponsored and organized their first workshop of its kind, focussing specifically on current and emerging water quality issues in prairie water management. The workshop was held in Regina, Saskatchewan on October 4-5, 2016. It provided an orientation and networking opportunity for approximately 50 water quality specialists and managers from participating jurisdictions.

The intent of the workshop was to provide a technical forum and learning opportunity for participants with the key focus on nutrients and emerging chemicals. The workshop occurred over two days. On the first day, participants heard from speakers from each member agency who outlined the nutrient work within their jurisdictions. On the second day, key note speakers discussed trending methods, and nutrient dynamics within the prairies. Workshop participants were later divided into three strategic themes to discuss answers or solutions to crucial questions on nutrient issues within the prairies, and later reported back in a plenary session discussion. Final presentations discussed emerging chemicals with respect to water quality concerns.

Mike Renouf, PPWB Executive Director, introduced the event with a brief history of the PPWB, including past agreements on sharing water, and the current 1969 Master Agreement on Apportionment. This agreement serves as a model for dealing with interjurisdictional issues and has enabled the equitable sharing and protection of interprovincial streams while developing a consensus approach through dialogue and information sharing towards preventing interprovincial surface and groundwater conflicts. In the 1970s, PPWB deliberations were aimed at the apportionment of water quantity flowing across the boundaries between the prairie provinces. However, in 1992, an agreement on water quality was signed and incorporated into the Master Agreement, providing a number of transboundary objectives and a mandate for the Board to address water quality conditions and investigate them.

The Committee on Water Quality (COWQ) is currently involved in investigating a variety of conditions. Specifically, the largest concern across the prairies currently is the increase in nutrient levels in some waterways- the primary reason for organizing this workshop.

Agency Presentations

Environment and Climate Change Canada
Sources and Transportation of Nutrients to Lake Winnipeg
Dr. Jane Elliott and Dr. Chris Spence

Dr. Jane Elliott discussed Environment and Climate Change Canada's Lake Winnipeg Basin Initiative, one that is completing its second phase this fiscal year. Jane's area of research is focused on nutrient sources in watersheds. Most of the prairies surface water recharge comes from snowmelt, with a significant portion of nutrients contributed by agricultural sources. Research has found that more than three-quarters of nitrogen (N) transport is in dissolved forms and mostly in snowmelt. Phosphorus (P) was also transported mainly in dissolved forms. For both nutrients, particulate transport was greater in headwater streams than

in streams in the La Salle basin and Red River flood plain. Testing of crop residues demonstrated that green, actively growing vegetation released more nutrients, with recently-seeded winter wheat having the potential to contribute more nutrients than other residue types tested.

One of many questions considered was whether the residue and soil testing snowmelt simulations could be related to what was seen at the edge of the field? For conservation tillage in field experimentation, it was found that conservation tillage increased dissolved P export and the P was thought to originate in surface residues. Simulations demonstrated that it was this active layer that contributed most nutrients. With respect to forages, both field experimentation and snowmelt simulations indicated elevated P export from the forage material.

Different types of forages from the La Salle basin were screened through snowmelt simulations. Regardless of type of forage, more P and ammonia (NH_3) were released from forages than from cereal stubbles. Residues were found to be the primary source of NH_3 and P, while most nitrate came from soils.

Nutrient source work will continue at all scales, with the key focus on trying to get data incorporated into the models that are in early stages of development., There is a lack of good water quality models for the area. Environment and Climate Change Canada is currently working to develop a decision support system for the region and also collaborating with the University of Saskatchewan to include nutrient modules into their Cold Region Hydrology Model, and working with Agriculture and Agri-Food Canada on predictive models to guide agricultural management practices.

Dr. Chris Spence is currently working on projects funded and supported by the Lake Winnipeg Basin Initiative. Phase II of his project is to identify trends in streamflow, with an attempt at accomplishing two things; 1) applying current generation models to predict the influence of streamflow on nutrient loading reduction scenarios, and 2) building the next generation of models that can properly represent runoff generation. The purpose is to try to better understand where the nutrient sources are in order to determine where we should be focussing Best Management Practices (BMPs).

Some of the issues currently surrounding the project are not software related, but conditions such as the frozen ground and other dynamic contributing areas which are not well captured in the modelling programs. Contributing areas are not static, but are rather dynamic, something that must be understood to comprehend the transport of nutrients across the landscape. To account for this in models, they are using MESH – Environment Canada's Beta Testing Model and its environmental prediction systems. Unfortunately, MESH does not identify where the hot spots of nutrient sources are, but if that were a possibility together with the areas of transport, it would help decide where to focus the BMPs.

Q&A:

None.

Alberta Environment & Parks, Agriculture & Forestry
Initiatives in Environment & Parks, and Agriculture & Forestry
Dr. Gongchen Li and Dr. Barry Olson

Dr. Gongchen Li discussed the *Alberta Wetland Policy*, identifying that as of today, Alberta has lost between 60-70% of wetlands (in number) within settled areas, with losses ongoing. One important policy outcome is for wetlands to be managed by avoiding and minimizing negative impacts, and where necessary, replacing lost wetland value. Mitigation is implemented through three mechanisms: avoidance, minimization and replacement. A phased approach to the Policy's implementation, in conjunction with a series of management tools and guidance, will help ensure seamless introduction of the various Policy components over time.

Gongchen identified some key items nearing completion, such as the Wetland Restoration Design Protocol and a practice standard for Qualified Wetland Science Practitioners in Alberta. Several other items under development include a provincial wetland replacement fund, certification process for wetland replacement agents to act on behalf of the province, and a wetland science agenda for the Province.

Released in 2014, Alberta Environment and Sustainable Resource Development (ESRD) has developed *The South Saskatchewan Region (SSR) Surface Water Quality Management Framework* to ensure current and future water uses are protected. This framework will address both point source and non-point source pollution through a combination of regulatory and non-regulatory tools, in response to any trigger or limit exceedances with respect to surface water quality in the Bow, Milk, Oldman, and South Saskatchewan rivers and their tributaries.

Another initiative is the Bow River Phosphorus Management Plan (BRPMP), which addresses sources of phosphorus in the middle reach of the Bow River between Bearspaw and Bassano dams in response to its heightened nutrient content and anticipated population growth. This initiative is the culmination of work by contributing parties from government and non-government, urban and rural sectors, and a wider constituency of subject matter experts. All parties contribute on task teams to define the issue, establish goals and objectives, and recommend strategies and actions to manage phosphorus in the Bow River. Currently, there are 51 actions in the plan – four of which are completed, with the remainder ongoing.

Dr. Barry Olson discussed the Alberta Nutrient BMP Evaluation Project, a six-year project with objectives to evaluate the environmental effectiveness of nutrient BMPs at the field scale, predict the cumulative effects of BMPs on water quality at a watershed scale using modelling techniques, and assess economic costs of BMPs. The project reports were released in 2015, and found water quality improvement was seen at the small scale/edge-of-field scale, with many of the BMP's implemented. There were, however, no improvements observed at the watershed scale because the number of BMP's that were implemented represented a small area compared to the size of the watershed.

The Alberta Phosphorus Watershed Project was designed to improve water quality at a sub-watershed scale through the wide-spread adoption of BMPs by producers. The short-term plan is to develop a tool called the Alberta Phosphorus Management Tool (APMT), a risk-based assessment tool, which focuses on phosphorus loss from farm operations and provides BMP

options to mitigate risks. With this tool, producers can then prioritize BMP options and apply for funding.

In its first year, the Nutrient Objectives Project is trying to establish a framework for determining achievable nutrient objectives in agriculturally-dominated watersheds, and relate nutrient 'objectives' to regional nutrient 'thresholds' and aquatic ecosystem health/services. Within the two natural regions selected, the Parkland Natural Region and Grassland Natural Region, recent sampling found good a distribution of a range of nutrient concentrations among the 30 different watersheds in both regions. Modelling techniques will be used to determine if reasonable implementation of BMPs in a given watershed will achieve a pre-determined water quality objective.

Q&A:

Q: What is included in the nutrient point analysis?

A: All aspects –Total P, total dissolved P, particulate, nitrates, ammonia, etc.

Saskatchewan Water Security Agency
Saskatchewan Agency/Jurisdictional Update
Dr. John-Mark Davies

Saskatchewan's New Approach to Drainage Regulation
Doug Johnson

Dr. John-Mark Davies presented on the Ministry of Environment's Boreal Project that was conducted over 260 lakes and 200 boreal soil plots from 2007-2014. This project examined long-range aerial transport of various contaminants, including nitrogen emissions from the Athabasca Oil Sands Region. The study also assessed receiving ecosystem sensitivity. To date, it appears the terrestrial environment is largely incorporating nitrogen inputs although spring melt conditions may result in higher nitrogen pulses, plus acidity from SOx/NOx deposition.

Lake Diefenbaker is the largest reservoir in Southern Saskatchewan and a critically important water source to the province. A number of detailed water quality studies were initiated several years ago to review risks to the lake's water quality, notably risks to increased cyanobacterial blooms. Nutrient sequestration, especially phosphorus is high in Lake Diefenbaker. The longer term consequence of this remains an important question, both within the lake and downstream. More nutrients enter Saskatchewan on the Saskatchewan River system then leave it; and the ratio of nitrogen and phosphorus also changes between the Alberta and Manitoba borders. An unanswered question is what proportion of inflowing phosphorus is bioavailable versus the amount that is non-bioavailable.

The Qu'Appelle River Watershed is a low-gradient and relatively low flow watershed. The watershed is highly populated and has high local value. Water quality issues in the watershed are exacerbated by the river's low flow. Its upstream nutrient loads are low, but increases after the river reaches its first major tributary, Moose Jaw Creek. To address point-source loading Regina is presently upgrading its wastewater treatment plant capabilities. The effect of this nutrient management improvement is part of an ongoing study examining nutrient loading in the Qu'Appelle River watershed.

Saskatchewan's Farm Stewardship Program provides eligible Saskatchewan producers with financial assistance to implement Beneficial Management Practices designed to help, maintain or improve the quality of soil, water, air or biodiversity. One of the recognized challenges is understanding how BMP landscape changes affect water quality.

Doug Johnson discussed Saskatchewan's approaches to drainage regulation, starting with its historical approaches – an approach that had compliance focussing on first party damages and resolving neighbour to neighbour conflicts. The new approach directs the Water Security Agency (WSA) to mitigate drainage impacts to water quantity, water quality and habitat. This approach has three components: new regulations, implementation of regulations and development of supporting policies and procedures, and the development of new legislation. At the moment, it is part way into the implementation of the regulations.

As of September 1, 2015, all existing and new drainage works require a permit to ensure project impacts are addressed, including risk, and where mitigation tools may come into play. Some of the knowledge gaps are in understanding the impact of drainage, setting targets/thresholds for mitigating the impact, and developing and evaluating effective mitigation.

In conclusion, the Water Security Agency (WSA) is not developing a provincial wetland policy but is developing the wetland policy component for agricultural lands. The focus is not solely on permanent wetlands, but on all wetlands. Drainage approvals are not on a go-forward basis, but a requirement for all projects; past, present and future.

Q&A:

Q: Is the focus on tile drainage more surface or systematic drainage?

A: Not necessarily systematic drainage, as precipitation increases, typically we have single riser tile pipe, or have a small systematic tile on a 20 acre area and get rid of the water that way, but not 160 acres of systematic tile.

Q: What is the reaction to the land owners having to go going back to the old works and restoration of wetlands?

A: Permanent storage on landscape is where we run into trouble.

Q: Since there is low compliance to the old regulations, what do you see will change this with the new regulations?

A: Need to spend more time talking with farmers, and have to get to a place where we have voluntary compliance. Education is key.

Q: You mentioned the three areas of concern, is it common for the water quality issues to be a major driver in these discussions or is it secondary to the other two?

A: I suspect water quantity, water quality, then habitat with the agriculture producers.

Manitoba Sustainable Development
Nutrient Enrichment Issues and Actions Underway in Manitoba
Elaine Page

Elaine discussed the gradual, but steady increase of N and P pollution contributing to excess algal blooms in waterways in Manitoba. The N and P concentrations are steadily increasing at most rivers and streams across Manitoba, with an almost 200% increase in some smaller streams. Eutrophication and increasing frequency and severity of algal blooms on Lake Winnipeg is a major issue, with many point and non-point sources contributing to the problem. The Province of Manitoba has recently committed to reduce phosphorus in the south basin of Lake Winnipeg by 50 percent or to 0.05 mg/L and actions and nutrient management strategies are underway to achieve that objective.

Actions currently underway include monitoring tributary rivers and streams at a network of approximately 65 sites across the province as a part of the provincial long-term water quality monitoring program. Many of these sites have been routinely monitored since the 1970s and are used to assess trends and impacts to aquatic life and other water uses. The Province has also maintained an active long-term water quality monitoring program on Lake Winnipeg since 1999 and continues to assess changes in chemistry and aquatic ecosystem health each year during the spring, summer and fall at a network of 45 lake wide stations. Samples are also collected during the winter from a reduced suite of sites to characterize under-ice conditions in Lake Winnipeg. In 2011, Manitoba and Canada jointly published a first of its kind *State of Lake Winnipeg* report which described the major physical, chemical and biological patterns from 1999 to 2007 in the lake. An update of the report is planned to assess the state of the lake for the 1999-2016 period.

In recent years, Manitoba Sustainable Development has supported a number of research projects that evaluate the effectiveness of remediation strategies for nutrient-rich prairie lakes. One of the current projects supported by Manitoba is being led by the International Institute for Sustainable Development (IISD) on prairie lake remediation strategies. IISD is currently piloting a project on Pelican Lake in southwestern Manitoba to test remediation strategies for eutrophic prairie lakes. Work has included a literature review of in-lake remediation strategies, development of a mass balance P model and developing a decision support tool for lake managers. Another initiative being undertaken is The Killarney Lake Remediation Project, a three-year pilot project led by the University of Manitoba, aimed at assessing potential remediation options through lab and in-lake mesocosm scale studies to test the effectiveness of several capping technologies. Similar to Pelican Lake, a whole lake P budget is also being constructed to identify and target external P reductions.

To limit the amount of P going into the waste stream, nutrient standards for wastewater in Manitoba changed in 2016, requiring all wastewater treatment facilities serving more than 2,000 people to meet a 1mg/L total phosphorus limit.

Another key program in Sustainable Development involving several departments is the Integrated Watershed Management Planning process; a long-term ‘action plan’ to manage land and water resources on a watershed basis. This is led by Conservation Districts with the goal of no net loss of water retention capacity in watersheds and to protect valuable wetlands.

Lastly, new to Manitoba is the Alternative Land Use Services model to reduce flooding and improve water quality in partnership with agriculture, landowners, non-government organizations, federal, and municipal governments.

Q&A

Q: Have you seen any good news with Lake Winnipeg?

A: No measurable improvements in terms of water quality. Remediation strategies will take decades.

Q: What is the zebra mussel update?

A: Found in a number of locations in the south basin and research shows it is moving up into a few isolated sites in the north basin.

Q: Are there less frequent algal blooms where zebra mussels are found?

A: Too early to determine.

Agriculture and Agri-Food Canada
Projects in Saskatchewan
Dr. Barbara Cade-Menun and Dr. Henry Wilson

Dr. Barbara Cade-Menun discussed two of the studies she has led or collaborated on at the Swift Current Research and Development Centre (SCRDC): In-field winter bale grazing (2009-2013; PI A. Iwaasa), and the Pipestone Creek WEBS project (2009-2016).

In these projects, micro watersheds of different sizes were replicated, with cattle bale grazing entire pastures that had very low nutrient levels in the winter. Several types of samples were collected, with detailed analyses being undertaken on runoff samples to determine what was filtered (dissolved) versus what was in the particulates. In addition to total N and total P analysis, they also conducted P NMR spectroscopy, which identifies specific P forms. This is important because not all forms of P behave the same in the environment. The P forms present varied with treatment, but also from year to year with runoff volumes; this provides reasons why long-term studies are needed. Concentrations of P in fall-spread manure are higher than having cattle graze on top of snow, while N was higher in runoff from bale-grazed sites. This is seen at larger sites as well with a bigger project, so it wasn't just a function of a smaller site.

Bale grazing was found to increase particulate P far more than any other treatment and fall spread manure was higher for the dissolved P. Nitrate (NO_3) was at 4 mg/L, and NH_3 was at 140mg/L during bale grazing, especially during the drier years. P is not the issue with bale grazing, it is N. Also, P was found to vary from one year to the next.

Bacteria were found on the particulates from bale grazing. These particulates are not erosional, but rather, are fine organic matter coming from the bales themselves, to which bacteria attached and move down stream. This study did not assess if these bacteria remain viable downstream; that should be assessed with future studies. There is a need to pay attention to this considering how widespread bale grazing has become. When reviewing cropland versus pasture, the total dissolved P was higher coming off cropland versus pasture, and it was found the particulates

were the reverse, with more coming off of pasture than off cropland. It was also observed that glyphosate and its breakdown product AMPA left fields with snowmelt run-off, with variation among years.

Ultimately, over the course of multiple years, both projects identified that high concentrations of nutrients can move in snowmelt, with variations in which nutrient (N vs. P) and form (dissolved vs. particulate) vary from one year to the next, and between cropland vs. pastures and with treatments (bale-grazed vs. manure spreading).

Dr. Henry Wilson discussed a number of projects he has been collaborating on or leading related to agricultural practices and water quality in the Lake Winnipeg Basin. This research is occurring primarily in watersheds at the regional (200 sq. km and up) or single field scale (in the 2-10ha range). Research by Dr. Wilson and his collaborators also has measured effectiveness of riparian areas at retaining runoff from agricultural fields. Most sites being within driving distance from Brandon and located in the Assiniboine River, Souris River or Red River basins.

Water quality and quantity measurements were completed for field scale watersheds with a range of agricultural management characteristics between 2013 and 2015 (about 39 site years). Soil fertility and crop residue characteristics are important in defining the P concentrations in runoff, while residue also impacts the volume of runoff. When there is more snow retained, there is more water in the field at the time of snowmelt, and there is more runoff. The dominant predictor of P concentration in runoff is soil phosphorus found near the surface (0-15cm), but amount of crop residue remaining in the field each fall was also an important correlate with residual variation in the concentration in runoff. More work needs to be complete to define the mechanism behind the latter correlation since soil moisture and crop residue amount were highly correlated in the dataset. In measuring retention of nutrients in riparian buffers using nutrient release experiments, release or neutral behaviour was often observed rather than retention of N and P during snowmelt, but some potential for retention with rainfall runoff was observed.

In larger regional agricultural watersheds of the Assiniboine and Souris P export appears to be linked to effectiveness of drainage, with greater volume or runoff per unit precipitation being observed where fewer areas of closed drainage exist. The link between elevated P export and drainage is much stronger when increases in drainage effectiveness through surface ditches are accounted for. There are challenges related to the determination of effective drainage area using existing data. Analysis accounting for recent drainage changes or the restoration of prior natural storage are needed.

Q&A

Q: The modification in the effective drainage areas shift everything into a linear, is that a new model that has to do with the drainage area?

A: Yes, most of these watersheds are based on the wetland inventory data.

Q: Are the Phosphodiesters, are they biologically available to organisms like algae?

A: Everything is biologically available.

Environment and Climate Change Canada

Transfer of Nutrients from Closed Basin Wetlands to the Carrot River
David Donald, Scientist Emeritus Associate, Environment Canada

Mr. David Donald presented nutrient data for wetlands in east-central Saskatchewan and for the Carrot River. The wetlands project was a landscape scale study (1996 – 2016) in the Aspen Parkland. Nutrients and water levels were assessed in the wetlands once per year in late June. The Carrot River is currently monitored each month for nutrients by Environment Canada for the PPWB. Nutrient concentrations have increased over recent decades in the Carrot River which is located in the Lake Winnipeg Basin. About 20% of the Carrot River basin is non-contributing and has thousands of wetlands .

Wetlands may be an important source of nutrients for the Carrot River. The wetlands included in the study were mostly situated in crop-lands and these wetlands had mean total phosphorous of 1.02 mg/L or about 10 fold higher than the long-term mean total P concentration for the Carrot River (0.09 mg/L). The last decade has been very wet relative to previous decades. Depending on annual precipitation, between 10% and 60% of the wetlands reached their spill level and discharged water during the last decade of the study. About 33% of the wetlands included in the study were colonized by fish at least once, indicating that some of the wetlands were hydrologically connected to permanent lakes and rivers (such as the Carrot River).

The recent increase of total P concentration in the Carrot River may be related to discharge of high concentrations of nutrients from numerous wetlands in both contributing and normally non-contributing areas to the River.

Q&A

Q: Are all the wetlands surrounded by crop areas or were there different land uses?

A: The ones shown were all surrounded by crop lands.

Q: Is it possible the wetlands are capturing the nutrients coming off the crop lands? Are they acting as a filter as people suggest, or are they acting as sources?

A: Difficult to really determine.

Q: Do these wetlands have drainage?

A: These are all spill level wetlands

US Geological Survey

Trend Analysis for Assessing Variability in Surface Water Quality and Streamflow
Dr. Robert M. Hirsch

Dr. Robert M. Hirsch provided an overview of WRTDS and the EGRET and EGRETci software packages he has been involved with at the US Geological Survey.

WRTDS = Weighted Regressions on Time, Discharge and Season
EGRET = Exploration and Graphics for RivEr Trend
EGRETci = Confidence Intervals for EGRET

The motivation behind this software came from a quote from Ralph Keeling; “The only way to figure out what is happening to our planet is to measure it, and this means tracking changes decade after decade and poring over the records.”

EGRET (Exploration and Graphics for RivEr Trends) was developed to obtain and organize data, use the WRTDS method to explore evolving water quality conditions, explore streamflow trends, and produce graphs and tables. The WRTDS was designed for data sets of >100 water quality samples, uses the sample values to build a statistical model of concentration for any combination of discharge, and uses a model to compute mean values and trends.

The guiding ideas for WRTDS are to describe the evolving behavior of the watershed by providing actual and flow-normalized concentration and flux estimates (without bias), and to be quantitative but also exploratory. Some water quality data analysis issues can tend to be highly related to streamflow and season, and assessments of progress can be easily obscured by the random, but persistent patterns of wet and dry years. Although the history of loadings can be very useful to ecologists studying the drivers of the receiving water body, it is not useful for assessing processes in the watershed.

Analysis issues can be addressed by WRTDS because trends can be different across seasons and flows, and shouldn’t be restricted to be linear or monotonic. What is needed is a highly flexible model of how daily concentration varies as a function of time, discharge, and season.

For this to occur, data requirements would need to include a complete daily discharge record, low streamflow variability. It works best with >100 samples. For trends, 10 or more years of data would be required, and for average flux, five or more years of data will be needed.

To obtain the software, you would need to install R (freely downloaded from: http://cran.us.r-project.org/). Once you start R, you can load the software: install.packages(”EGRET”, “EGRETci”) library(EGRET) library(EGRETci)

For uncertainty analysis, there is the WRTDS Bootstrap Test (wBT) in EGRETci package.

Some anticipated enhancements to WRTDS and EGRET package include dealing with ephemeral streams, estimation of trends in frequency of exceedances of threshold values, dealing with nonstationarity in Q, and improved estimates of yearly fluxes.

For further information and new developments: https://github.com/USGS-R/EGRET/wiki.

Q&A

Q: When will you be working with ephemeral streams?

A: I will need to find a new young programmer for that, but should be less than a year to complete.

Q: How sensitive is the program to missing sample data?

A: A two-year gap will not make a significant difference, but three to five- year gaps means we don’t have confidence in what it is doing, so in that case, we blank out the gap.

Q: Are there guidelines to what you would consider "flashy"?

A: I don't have numbers, but the way I like to think about it is that the concentration is predicted by knowing the mean discharge for the day. If there is an order of magnitude change for discharge within the day, then I would say the assumption is no good.

Q: How much of the work you are doing is driven by the *Clean Water Act*?

A: The *Clean Water Act* is a systematic way of gaining this information and helps to provide the funding for this project, and drives much of this work.

Q: What happens when funding disappears and you have a 10-15 year gap in data?

A: Build a model for each period of time you have continuous data.

University of Regina

Regulation of Lake Production and Composition by Nitrogen Influx – A Synthesis of 20 years of Ecosystem Ecology

Dr. Peter Leavitt

Dr. Peter Leavitt started his discussion by noting how water quality is getting worse at the planetary scale. Currently, changes in algal abundance are often closely correlated with P influx to lakes. Conducting discrete nutrient addition experiments demonstrates how P influx regulates algal production in boreal lakes, however, ancient lakes may not have been limited by P supply.

The human population will increase ~30% in 50 years, and consequently, human use of N is projected to increase ~75% in 50 years. Future N application (and effects) will be greatest in regions with long histories of farming and P accumulation in soils. Differences in the timing of nutrient application to soils may cause lakes to exhibit sequential limitation by P, and then N.

The Qu'Appelle Valley Long-term Ecological Research program (QU-LTER) has conducted comprehensive monitoring from May-Sept, 1994-2016. Diefenbaker Lake, Wascana Lake, Last Mountain Lake, Crooked Lake, Katepwa Lake and Buffalo Pound Lake were a part of this program. During the monitoring period (1994-2016), diverse patterns of synchrony were revealed, suggesting a role for N in regulating production.

The QU-LTER program lakes are P-rich, low N:P ratio, and exhibit N2-fixing cyanobacteria. The N2-fixation adds N to the food web and is spatially-structured, but is usually insufficient to sustain algal production. N2-fixation importance increases downstream but is low in most lakes and years (<5% of phytoplankton demand). Whole-lake mass balances reveal >80% of N is derived from sedimentary sources, including DON.

There is current experimental evidence for water quality degradation by nitrogen influx. Microcosm bioassays estimate productivity (24 h), and instantaneous nutrient limitation (72 h). Those bioassays in shallow lakes reveal ontogeny of nutrient status towards N limitation in summer (and NH4+ toxicity in spring). The Wascana Lake mesocosm experiments (2007-2013) found urea, NH3, and NO3 increase algal biomass up to 400% in warm P-rich lakes, while N increases microcystin production up to 400% in those same lakes.

The city of Regina is an important point source of nutrients, with a majority of nutrients draining into Pasqua Lake. In 1977, tertiary wastewater treatment reduced P influx by 85% but N influx

increased as a linear function from the City. Cyanobacterial abundance increased disproportionately after P diversion due to continued N influx, resulting in no improvement to water quality. The City of Regina upgraded it's WWTP in 2016 to extensively remove N (and very little P). The changes are expected to result in 2-3 fold less algae, more buoyant N2 fixers, increased spring production, and 4-10 fold less algal toxin. These effects are expected to be seen over a period of decades.

The interaction of nutrients, climate and hydrology are important when compiling data. There are no simple linear trends over time, with evident differences among lakes. Climatic factors are best predictors of most bloom conditions and predictive models suggest lakes are sensitive to temperature change and nutrients, but not hydrology.

In conclusion, the production of natural lakes can be regulated by the supply of urea, NH4+ or NO3- when basins are P sufficient. Fertilization with N at <8 mg L-1 wk-1 selectively promotes growth of toxic cyanobacteria, whereas addition of >8 mg L-1 wk-1 favours chlorophytes and heterotrophy. Nitrogen fixation is rarely sufficient to meet phytoplankton demand, and N effects vary seasonally, exhibit decadal-scale ontogeny, and may interact with depth and light regimes.

Nitrogen (and P) effects remain evident with global warming, and findings from all scales of studies (microcosm, mesocosm, whole ecosystem, paleoecology) converge to demonstrate that water quality in P-sufficient ecosystems can be degraded further by N influx.

Q&A

Q: Is Regina the first city to start removing N?

A: It's the last major city.

Q: Any trend with organic matter, or does it matter?

A: Half of our dissolved P is not immediately bioavailable in the scale of months – not sure if it is organic or inorganic.

Global Institute for Water Security
Nutrient Dynamics in Prairie Ecosystems
Dr. Helen Baulch

Dr. Helen Baulch discussed how internal loading (all of the physical, biological and chemical processes which move phosphorus from the benthic environment back up into the water column) is important in supporting algal productivity. There are currently 70 wetlands, lakes and reservoirs in Canada for which there are estimates of internal loading. Rates of internal loading are high in the Prairies, but there is variation. The Prairies are different because of low/poor water iron, sulfate. (This paper will be submitted shortly, and is led by Diane Orihel). Variation in calcium and magnesium across the prairies may also be important.

During several winter periods, three ponds at the St. Denis National Wildlife Area were sampled. The water is anoxic all winter with oxygen dropping under ice cover, causing P to go up due to its sensitivity to low oxygen conditions. If snowmelt is leading to fill and spill, it is coming at the worst time because of the P chemistry. Internal loading may account for that change. Currently it is unknown what happens to P when ice melts and oxygen goes back into system. Total N

(Hampton et al. 2016) and nitrate (Cavaliere and Baulch in prep) is higher in the winter under ice cover. After sampling several lakes in summer and winter, denitrification rates despite cold weather, were equally as high as in the summer (Cavaliere and Baulch in prep).

The Smith Creek Watershed has undergone rapid drainage, and sub catchments in Smith Creek have high and low degrees of drainage. Drainage, which covaries with land use, is associated with higher nutrient concentrations and export (Maria Armstrong masters work, in progress).

Solutions to nutrient pollution are context dependent, with Manitoba work centred around keeping water on the land. Substrate is important in retaining P, and there is a need for more research on that topic. The Prairies are different, and there is a need for some basic comparative hydrochemistry to understand things like snowmelt.

Q&A

Q: Which BMP's are you working on?

A: I have done small reservoir work. I am working with Jane Elliott, Henry Wilson and others on a review of BMPs across the prairies.

Q: Is there a depth or size of the reservoirs that capture the nutrients?

A: There are a lot of questions on that – there are really important scaling questions. There are too many variables to make safe recommendations.

Q: Did you look at N flux, in terms of anoxia?

A: Nitrification rates in winter are important, but the data are not final on it yet.

Breakout Session

This session on Day 2 involved 3 different themes that were further broken down into two tables for each theme. Then two or three questions were asked of each table. The session table assignments are listed in Appendix 2.

A. Theme: Science Needs
Groups A1 & A2

Question 1. *How do the unique prairie hydrological characteristics affect nutrients, their transport and their impact on the aquatic ecosystem and what information gaps need to be addressed? Consider the influence of variable contributing areas, the relative importance of changes in flow versus changes in concentration, wetland drainage, road ditch networks, etc.*

A1:

There was a focus on key gaps, asking the following questions:

- What happens to nutrients in non-contributing areas when they reconnect?
- Are some wetlands more important than others, and what is the interplay between hydrological and chemical function?

- Are BMP's transferrable – why, when and why not?
- How can we better link BMP implementation to monitoring to help answer the questions, and get to attribution in terms of drivers of change?
- Mapping of critical source areas – are they real? Why do they exist? Why do we get false positives? How can we address them and use prairie hydrology to answer them?
- We need snow data, need Lidar everywhere, advocacy of flow and met monitoring, particularly at melt and a need to map contributing areas.
- How does the manipulation of wetland complexes and ditches impact hydrology and chemistry?

Question 2. *What is the in-stream and downstream effect of the incremental increase of nutrients from human activity and what information gaps need to be addressed?*

A2:

The processes are poorly understood.

A1:

There is one answer to this: eutrophication. However, there are still many questions that need to be answered:

- What were the baseline conditions?
- How much is/was too much?
- How long before we start to see recovery?
- N vs P sensitivity – where is the region of N sensitivity and was it always so?

Question 3. *How can we best determine the proportion of non-point source nutrients within river systems that are present as a result of human activity? Consider the effect of land use, soil management, drainage, interaction of various human activities and variability in climate/precipitation. Where are the largest errors in our estimates and how can we reduce those?*

A2:

The best way to approach this is through a multifaceted approach. One method discussed would be to conduct a historic reconstruction according to sediment records, where isotopes could be an indication of source or tracer. Another method could be to implement BMPs and monitor those for effect.

Export coefficients could be improved or refined, and could also be quantified. Modelling would be necessary to pull everything together in the development of policy.

B. Theme: Data and Methods
Groups B1 & B2

Question 4. *In turbid-sediment streams and rivers a proportion of total phosphorus is biologically unavailable. How can we monitor to better understand the bio-available*

phosphorus fraction and its changes through time? How is this fraction affected by variable contributing area, and human activity on the land?

B1:

A question to ask is why is this pertaining only to Rivers? There are other points along the hydrological continuum that need to be considered. Other scales are important and likely more manageable.

All P is available depending on time scale and organism. There are other methods to measure P such as filter pore size < 0.45 µm, better speciation of P types ($), increasing sampling during high flow events and this can be guided by how you do routine monitoring. Isotope tracking is just not as effective for P.

Question 5. *How can we improve the monitoring and tracking of nutrients in prairie rivers? Consider in-stream processes, redistribution of sediment, continuous monitoring, parameter surrogates, etc.*

B1:

We need to understand things like in-stream processes better, and hydrology. Re-evaluating the monitoring network to ensure there is sufficient resolution spatially and temporally to help identify hotspots/sources would be useful. A suggestion would be to develop an ELA equivalent for agriculture where multiple agencies and academia can run tests for longer time periods under controlled conditions, with qualified staff and resources to interpret data.

B2:

Transformation and in-stream processes would improve tracking, and there is a need for technology surrogates (i.e. turbidity) to monitor and help provide insights into the bigger picture.

Question 6. *How can we improve the measurement and/or estimates of non-point source nutrients? How can we measure the incremental increases in nutrients from human activity? Do we need to focus on better tracking of point sources?*

B2:

There is a need for better information on measurements of effective drainage areas/contributing area, specifically with the fill and spill. Groundwater versus surface water inputs require emerging tools/technologies such as:

- Isotopes;
- GIS technology – land use data;
- Tracer tools;
- In-site sensors; and
- Models could have better systems where we can consolidate available data and get point source input regulated into a system that we can all access.

Is it possible to integrate the federal government into the process of the archiving of and providing access to all the data?

Other suggestions for improvement included:

- Water quality monitoring networks need much more sampling over larger geographic areas;
- Better processes to get publicly funded data out into the publics hands;
- Simple things such as wastewater data from treatment plants are typically available for review, but not thought of to access; and
- Assessing information products into a synthesized form as opposed to raw data in order to get out to the public for better understanding.

C. Theme: Management and Policy
Groups C1& C2

Question 7. *What nutrient management approaches best fit the unique prairie hydrological characteristics (e.g. variable contributing areas, drought versus wet years, spill and fill hydrology, etc.). Can we adapt these approaches to take into account temporal and spatial variability? What time frames should be considered for nutrient management actions?*

C1:

Wetland creation and drainage management would be the best approach. Due to prairie pothole wetlands, there is limited incentive for RM's to hold water back. For this reason, we should be promoting holding water on the land by targeting municipalities, land owners and political parties.

To adapt these approaches, we would need to identify and target areas of high risk areas of transport of nutrients.

Question 8. *How do varying wetland drainage policies in the three prairie provinces affect nutrient concentrations in interprovincial rivers?*

C1:

There are different policies between provinces, but they are currently altering them in terms of drainage. It really depends on the success of the provinces regulatory structure. Some challenges seem to be where the focus is in each province.

Question 9. *What changes do you foresee with respect to nutrients and their impacts on aquatic systems in the next 20 years and what could be done in the near future to address these changes?*

C2:

There are differences among regions in reporting. One question to ask is how to improve point source data tracking? At the moment, data maintenance is a big deal, so the question is who will do this? It is our recommendation that centralization within the federal government take place to ensure management of this information.

Question 10. *How do we improve point source reporting/tracking so that the information that is reported is useable?*

C2:

There is an expectation there may be a change, possibly a decline in point sources from the urban centres because of licencing and regulations. However, with population increasing, the issue may become mainly non-point/agricultural source issues. It is unclear what the positive impact of BMP's will be, but we need to improve communications to the public. There is also a need to move for assessing cumulative effects needed to address interprovincial transport effects.

One of the challenges is how to aggregate risks, mitigation, damage?

Emerging Chemicals of Concern and Non-Targeted Screening

University of Saskatchewan
Dr. Paul Jones

Dr. Paul Jones discussed mass spectrometry and how we can screen for emerging chemicals of concern. If the chemical is known, it can be measured; the unknown unknowns is the concern. There is a need to focus on the occurrence and concentrations of chemicals, effect levels/targets, production use/trends, and concerns expressed by practitioners. The three main approaches used in looking for chemicals of concern are: Effects Directed Assessment, "Semi-targeted" Analysis, and Non-Targeted Analysis.

Effects Directed Assessment utilizes cell bioassays as indicators of specific biological endpoints and identifies potential impacts, not specific chemicals. It can be used to direct a chemical-specific analysis.

In 2006, a new mass spectrometry instrument, the Orbitrap, became available. It provides a very quick accurate measurement of the mass of chemicals in question for identification purposes. Resolution is an important factor because it can clearly identify individual chemicals through their mass, and then a chemical formula can be extracted from there.

A semi-targeted screening of natural and synthetic organobromine compounds was conducted to review its very complex mixture of unknown compounds. Different ionization techniques are tested, and a characteristic fragment tracking approach searched for the Br- fragment ion to identify compounds. This same approach is applied to iodinated compounds. A large amount of data has come out of this system, and they are presently working with the Orbitrap manufacturer to make this database available to researchers.

The aim of non-targeted screening is to collect a sample and identify and measure absolutely everything in it. Some problems associated with this are the different detectors for different chemicals. Sample preparation removes some chemicals, but there is a need to minimize interference – although some might be important. The data processing can include several thousands of features per sample and each need to be identified by its formula, structure and comparison to data bases. There is currently work being done with instrument vendors to develop databases and software algorithms to help with these challenges.

With very good accuracy, a formula prediction can be conducted through accurate mass determination (< 0.001 mu) allowing determination of chemical formulae. There are only a finite number of atom combinations that will yield a specific accurate mass.

The Orbitrap technology has opened a new frontier in chemical analysis with resolution and sensitivity. Workflow paradigms need to be developed to handle the data generated. Computer tools for peak picking and molecular formula identification that can be automated are needed since there is no system available right now. Stemming from that, toxicity prediction can then be done to focus on candidates with potential effects.

The establishment of comprehensive databases for mass spectra (particularly LC-HRMS/MS) of environmental pollutants is key to moving forward.

Q&A

Q: How do you identify metabolites from the parent compound from the orbitrap?

A: If I saw a parent compound, I would have to figure out what the common metabolites are, and then screen the data that way.

Q: If you have multiple compounds interacting together, is there a way to tease out what the interactions are between those compounds, and their toxicological effects?

A: Toxicology hasn't gotten there yet.

Q: How do you prioritize where to go with that much data?

A: If I can electronically archive all the information that is in a water sample, I can go back to that archive 20 years from now, for example, and ask the questions – "is chemical x there", "was it there 10 years prior to that?" – and "how much".

Lightning Talks – Emerging Chemicals

Saskatchewan Water Security Agency
Dr. Arasu (O.S.) Thirunavukkarasu

Dr. Arasu discussed how Pharmaceuticals and Personal Care Products (PPCPs) and Endocrine Disruptive Compounds (EDCs) are important classes of emerging substances of concern (ESOC) that have been detected in wastewater effluent, drinking water and surface water worldwide.

The public of Canada including Saskatchewan expressed their concern regarding implications of Emerging Substances of Concern (ESOCs) in water. Regulatory agencies worldwide working on developing guideline/objectives for some of the selective ESOCs in surface and drinking water.

Recently, the Canadian Council of Ministers of the Environment (CCME) has published an interim guideline of 10 µg/L for Carbamazepine in surface water and there may be guideline for many of the ESOCs in the future. The Water Security Agency (WSA) conducts this study focusing on determining concentrations of particular group of ESOCs (34 compounds) from selective drinking water treatment plants, wastewater treatment plants and surface water in Saskatchewan. The results are useful in determining the exposure levels, treatment efficiency of water and wastewater treatment plants, impacts on the receiving environment, and for a possible guideline/and or objective development for these ESOCs, if any in future for water and wastewater.

The WSA continues to collect samples from the water and wastewater treatment plants from many of the cities and towns in Saskatchewan including the cities of Regina and Saskatoon, and upstream and downstream locations of receiving environment. The results of first set of samples collected showed that there are no ESOCs present in the drinking water, the results also showed that many of the PPCPs are detected in both raw and treated wastewater and activated sludge process (ASP) was good in removing many of these PPCPs. The study will complete in 2017 and the final report will be available to public once the study is complete.

Manitoba Sustainable Development

Andrew Burton

Andrew Burton discussed estrogens in Manitoba surface waters and wastewater treatment plant (WWTP) effluents. Estrogens have become 'contaminants of emerging concern' after being found widely distributed in lakes, rivers, streams, tap water, and groundwater. Estrogens in the aquatic environment have become a topic of international concern evidenced by its endocrine disrupting characteristics in conjunction with increased public awareness and pressures. The major sources of estrogens in surface waters include direct discharge from WWTP's and/or indirect surface runoff from industry and agriculture (e.g., livestock, cropland fertilizers). In addition, disposal of products in landfills can result in estrogens entering surface waters via runoff and/or ground waters via leaching.

Since 2012, Manitoba Sustainable Development has been sampling and testing surface water and wastewater treatment plant (WWTP) effluents for 17 different estrogenic compounds.

There are several challenges associated with detecting estrogens in aquatic environments. For example, estrogens in aquatic environments often exist in very low concentrations (i.e. ng/L to low µg/L), and because of this, are difficult to detect. Nevertheless, even minute concentrations can pose a serious health risk to humans, livestock, wildlife, and aquatic organisms. In addition, the lack of water quality standards, objectives, and guidelines for estrogens can complicate interpretation of results. The Canadian Council of Ministers of the Environment (CCME) currently do not have set standards, objectives, or guidelines for the protection of aquatic life, agriculture, sediment and/or tissue residue for the 17 estrogenic compounds measured in Manitoba waters.

The objective of the monitoring design for estrogens in Manitoba waters aimed to detect the upstream versus downstream effects of WWTP's nearby the towns of Brandon, Portage La Prairie, Selkirk and the City of Winnipeg. In total, 127 samples from 8 sampling locations in the Red, Assiniboine and Winnipeg rivers were analyzed for estrogenic compounds between 2012 and 2016. In general, concentrations of estrogenic compounds in Manitoba rivers are low (i.e. almost always below detection limit). However, five out of the 17 estrogenic compounds were detected in river samples. The most frequently detected estrogen was 17-ALPHA-DIHYDROEQUILIN (primarily in the Red River near the Selkirk Bridge). The estrogens detected in the highest average concentrations include ESTRIOL and ESTRONE, which were 10 orders of magnitude higher than all other detected compounds.

With regards to wastewater, 43 samples from 11 WWTP effluents were analyzed for estrogenic compounds in 2013, 2015, and 2016. Seven out of the eight estrogens were detected in effluent

samples. In general, the concentrations of estrogenic compounds in WWTP effluents are low (i.e. frequently below detection limits), but were found in higher rates of detection and concentrations compared to river samples. In addition, the average concentrations of estrogens in WWTP effluents were higher than river sample concentrations for the majority of detected compounds. Similar to the river samples, ESTRIOL and ESTRONE were detected to be the highest concentrations (approximately 10 orders of magnitude higher than all other compounds. ESTRONE was detected in six out of the 11 WWTP effluents.

Additional long-term monitoring is required to better understand the spatial and temporal variability of estrogens in aquatic ecosystems in Manitoba. Future monitoring to detect upstream versus downstream effects of WWTP effluents would be helpful since the current dataset is too sparse to see any differences. Manitoba Sustainable Development plans to continue the estrogen monitoring efforts in surface waters and WWTP effluents into the future. For future monitoring, the analyses of WWTP influents for estrogenic compounds will be added to the monitoring design. Manitoba Sustainable Development plans to publish a technical report on estrogens (and pharmaceuticals) in aquatic environments in 2017.

Alberta Agriculture and Forestry
Dr. Barry Olson

Dr. Barry Olson discussed the awareness of a few areas of concern. Veterinary pharmaceuticals are a concern, especially with the livestock industry in Alberta. Through the Irrigation District Water Quality Project, led by Alberta Agriculture and Forestry, Agriculture and Agri-Food Canada has been measuring different compounds in irrigation source and returned water.

A recent steering committee has been developed to tackle the following questions surrounding water re-use, with identification of chemicals of concern to be reviewed later:

- Under what conditions can water be re-used?
- What are the associated risks?
- How can risks be minimized or mitigated?
- For what areas is there zero tolerance?
- Where and what are the opportunities?

A concern of food safety/security is the antimicrobial resistant bacteria associated with beef production, with an interest related to water quality. A study of this by Agriculture and Agri-Food Canada has been conducted over the last 2 years and is almost complete, and Alberta Agriculture and Forestry has been leading the water component.

Irrigation water quality and food safety regulatory demands are surfacing in the United States and Canada. A study being conducted in the Taber Irrigation District is looking at generic *E. coli* together with microbial source tracking methods. There is a need to review this with Canada's regulatory demands.

Environment and Climate Change Canada
Paul Klawunn

Paul Klawunn discussed the monitoring of chemical substances in Canadian Municipal Wastewater (CMP) completed by Shirley Anne Smyth under the Science & Risk Assessment Directorate.

The CMP Wastewater Monitoring Program looks at wastewater effluents and residuals (solids) that may be important routes of entry of a variety of chemical substances, something the wastewater sector has no control over. Components of this program include temporal trends (warm, cold), the fate of compounds during wastewater treatment, and the concentrations entering the environment.

The following products have been monitored since 2009:

- Pharmaceuticals and personal care products (PPCPs);
- Polybrominated diphenyl ethers (PBDEs) and 4 other brominated flame retardants;
- Bisphenol A;
- Nonylphenol and ethoxylates;
- Volatile methyl siloxanes;
- Perfluorinated compounds; and
- Other compounds.

Agriculture and Agri-Food Canada
Dr. Claudia Sheedy

Dr. Claudia Sheedy discussed emerging priorities surrounding water quality guidelines, chemical mixtures and urban inputs. Water quality guidelines are often outdated, fragmentary and incomplete, leaving the question of their viability for practical/policy use.

Water contains several contaminants with varying concentrations. There are several modes of action that are seen, leaving us with the question of how we can assess toxicity and impacts.

Agriculture is a major contributor of pesticides and some emerging chemicals by volume, however the highest concentrations of pesticides, antimicrobials and estrogens are generally found in urban storm waters and WWTP effluents. There is a need to better understand the relative contribution of these chemicals from different sources and the impacts from these sources.

Q&A:

None.

Prior to the closure of the event, participants were asked about their perspectives on the strengths and weaknesses of the workshop, and how they would like to see any subsequent workshops focussed. Responses can be found in Appendix 1.

Appendix 1

Workshop Assessment

A short debriefing was held with the workshop participants before adjournment. The following emerged from that discussion:

Positives:

- Participants appreciated the generous breaks as the networking which that encouraged was very important.
- Participants learned from their colleagues in other jurisdictions and those lessons will enable them to be more efficient in their work. They can avoid having to re-invent the wheel or from exploring areas which have been proven to be dead-ends in other jurisdictions.
- Participants were grateful that the workshop was managed well time-wise and stayed on schedule.

Opportunities for Improvement:

- There were times when refreshments ran out. This sometimes lessened the energy in the room.
- Many would have preferred having a room with natural light.
- The need for back-up equipment (a projector bulb in this instance) was demonstrated.
- The facilitator's approach to informing speakers of their approaching their time limit was disrupting at times.

Suggestions for a Next Event:

- More use of break-out sessions on specific topics of interest.
- One such topic could be the monitoring of pesticides.
- Another is the need for a central repository of data.
- Continue an element of exchange among the jurisdictions so that learning opportunity continues.
- It was also suggested the COWQ do a Doodle poll on the focus on any subsequent workshops. It was acknowledged that at this point in the event, energy was low and people did not have their best ideas top-of-mind.

Appendix 2

Agenda

Prairie Provinces Water Board (PPWB)
Committee on Water Quality (COWQ)
Prairie Water Quality Workshop – With a Focus on Nutrients

October 4-5, 2016

Executive Royal Hotel
4205 Albert Street
Regina, Saskatchewan

AGENDA

Day 1:

12:00 – 13:00 Lunch to be provided

13:00 – 13:15 Sheldon McLeod, *Facilitator* and Mike Renouf*, PPWB Executive Director* - Welcome and Introduction to the Scope and Purpose of Workshop

Agency Reports - Each agency will report on one or two key initiatives, issues, successes or lessons learned within its jurisdiction related to nutrients

13:15 – 13:45 Dr. Chris Spence and Dr. Jane Elliott (Environment and Climate Change Canada)

13:45 – 14:15 Dr. Gongchen Li and Dr. Barry Olson (Alberta Environment and Park and Alberta Agriculture and Forestry)

14:15 – 14:45 Dr. John-Mark Davies and Doug Johnson (Saskatchewan Water Security Agency)

14:45 – 15:15 *Health Break*

15:15 – 15:45 Elaine Page (Manitoba Sustainable Development)

15:45 – 16:15 Dr. Henry Wilson and Dr. Barbara Cade-Menun (Agriculture and Agri Food Canada)

16:15 – 16:45 David Donald, (Environment and Climate Change Canada) - Transfer of Nutrients from Closed Basin Wetlands to the Carrot River

16:45 – 17:00 Sheldon McLeod, Wrap up and introduce Day 2 plan

Day 2:

08:15 – 08:30	Sheldon McLeod, – Highlights from Day 1 and Breakout Session Introduction
08:30 – 10:00	Dr. Robert Hirsch (USGS) Trend Analysis for Assessing Variability in Surface Water Quality and Streamflow
10:00 - 10:30	*Health Break*
10:30– 11:15	Dr. Peter Leavitt (University of Regina) Regulation of Lake Production and Composition by Nitrogen Influx - a Synthesis of 20 Years of Ecosystem Ecology.
11:15 – 12:00	Dr. Helen Baulch (Global Institute for Water Security) Nutrient Dynamics in Prairie Ecosystems
12:00 – 13:00	*Lunch break*
13:00 – 13:15	Breakout Session instructions
13:15 – 14:00	Breakout Session - What makes the prairies unique in terms of hydrology, nutrient dynamics?
14:00 – 14:30	Report Back on Breakout Session
14:30 – 15:00	*Health Break*
15:00 – 15:30	Dr. Paul Jones (University of Saskatchewan) Emerging Chemicals
15:30 – 16:00	Lightning talks on emerging chemicals from the agency representatives: Dr. Arasu (O.S.) Thirunavukkarasu (Saskatchewan Water Security Agency) Andrew Burton (Manitoba Sustainable Development) Dr. Barry Olson (Alberta Agriculture and Forestry) Paul Klawunn (Environment and Climate Change Canada) Dr. Claudia Sheedy (Agriculture and Agri Food Canada)
16:00 -16:15	Sheldon McLeod, Workshop Wrap Up/Outcomes/Deliverables Summary

Appendix 3

Break-out Session Table Assignments and Questions

Breakout Session Table Assignments

Themes:

A = Science Needs
B = Data and Methods
C = Management and Policy

	Table
Larry Braul	A - 1
Chris Spence	A - 1
Erin Zoski	A - 1
Gongchen Li	A - 1
Biplob Das	A - 1
Cory Wensley	A - 1
Helen Baulch	A - 1
Les Rutherford	A - 1

	Table
Henry Wilson	A - 2
Jane Elliot	A - 2
Barry Olson	A - 2
John-Mark Davies	A - 2
Darren Stovin	A - 2
Elaine Page	A - 2

	Table
Barbara Cade-Menun	B - 1
Paul Klawunn	B - 1
Michael Badger	B - 1
Nathan Ballard	B - 1
Glen McMaster	B - 1
Cara Drury	B - 1
David Donald	B - 1

	Table
Claudia Sheedy	B - 2
Joanne Sketchell	B - 2
Vanessa Swarbrick	B - 2
David Vandergucht	B - 2
Bryan Gourlie	B - 2
Daniel Rheault	B - 2
Robert Hirsch	B - 2

	Table
Sharon Reedyk	C - 1
Andrew Burton	C - 1
Arthur Friesen	C - 1
Jennifer Kerr	C - 1
Sam Ferris	C - 1
Lorelei Ford	C - 1
Ron Eley	C - 1
Paul Jones	C - 1

	Table
Jason Vanrobaeys	C - 2
Marie Hyde	C - 2
Andrea Czarnecki	C - 2
Arasu Thirunavukkarasu	C - 2
Corie White	C - 2
Kelly Farden	C - 2
David Hay	C - 2
Peter Leavitt	C - 2
Doug Johnson	C - 2

Breakout Session Questions

A. Theme: Science Needs

1. How do the unique prairie hydrological characteristics affect nutrients, their transport and their impact on the aquatic ecosystem and what information gaps need to be addressed? Consider the influence of variable contributing areas, the relative importance of changes in flow versus changes in concentration, wetland drainage, road ditch networks, etc.

2. What is the in-stream and downstream effect of the incremental increase of nutrients from human activity and what information gaps need to be addressed?

3. How can we best determine the proportion of non-point source nutrients within river systems that are present as a result of human activity? Consider the effect of land use, soil management, drainage, interaction of various human activities and variability in climate/precipitation. Where are the largest errors in our estimates and how can we reduce those?

B. Theme: Data and Methods

4. In turbid-sediment streams and rivers a proportion of total phosphorus is biologically unavailable. How can we monitor to better understand the bio-available phosphorus fraction and its changes through time? How is this fraction affected by variable contributing area, and human activity on the land?

5. How can we improve the monitoring and tracking of nutrients in prairie rivers? Consider in-stream processes, redistribution of sediment, continuous monitoring, parameter surrogates, etc.

6. How can we improve the measurement and/or estimates of non-point source nutrients? How can we measure the incremental increases in nutrients from human activity? Do we need to focus on better tracking of point sources?

C. Theme: Management and Policy

7. What nutrient management approaches best fit the unique prairie hydrological characteristics (e.g. variable contributing areas, drought versus wet years, spill and fill hydrology, etc). Can we adapt these approaches to take into account temporal and spatial variability? What time frames should be considered for nutrient management actions?

8. How do varying wetland drainage policies in the three prairie provinces affect nutrient concentrations in interprovincial rivers?

9. What changes do you foresee with respect to nutrients and their impacts on aquatic systems in the next 20 years and what could be done in the near future to address these changes?

10. How do we improve point source reporting/tracking so that the information that is reported is useable?

Appendix 4 – Persons Attending

PARTICIPATION LIST WATER QUALITY WORKSHOP

AGRICULTURE AND AGRI-FOOD CANADA

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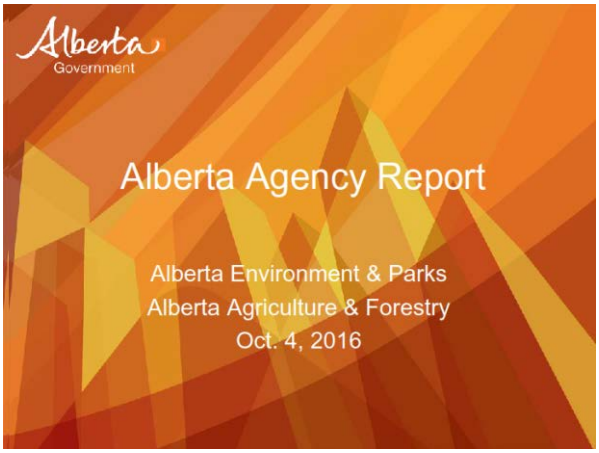
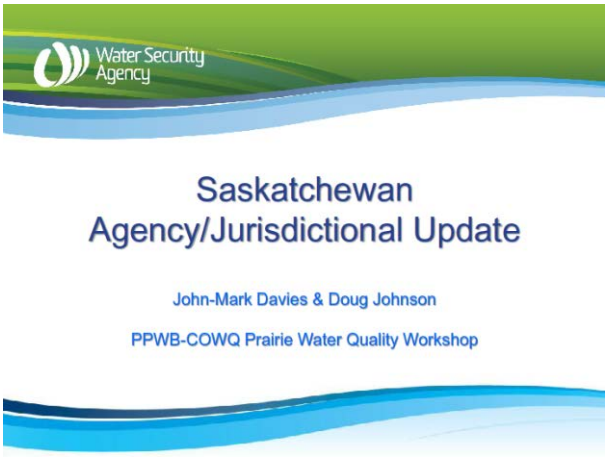
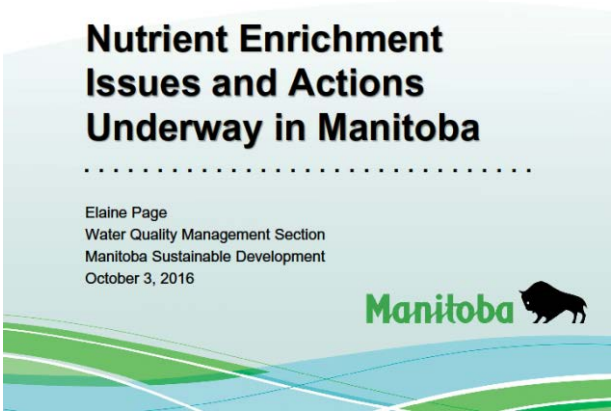
Appendix 5

Presentations

Please click on presentation, and a PDF file will open to view.







Transfer of Nutrient from Closed Basin Wetlands to the Carrot River

Environment and Climate Change Canada

Special thanks:
Gail Gray
Jim Syrgiannis
Bill Aitken
Lynne Quinnett Abbott
and
Canadian Wildlife Service
Pest Fund
Pesticide Science Fund
National Laboratory for Environmental Testing

USGS
science for a changing world

Overview of WRTDS and the EGRET and EGRETci Packages

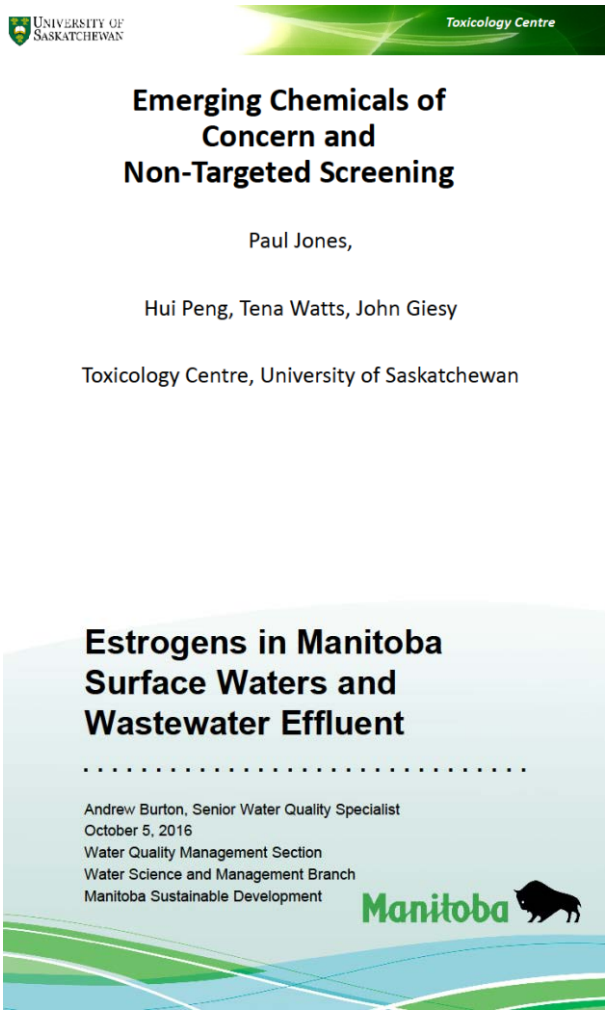
WRTDS = Weighted Regressions on Time, Discharge and Season
EGRET = Exploration and Graphics for RivEr Trend
EGRETci = Confidence Intervals for EGRET

Robert M. Hirsch, Research Hydrologist
US Geological Survey
2016-10-05

Regulation of lake production and composition by nitrogen influx – a synthesis of 25 years of ecosystem ecology

P.R. Leavitt, R.J. Vogt, S. McGowan, R.I. Hall, J.A. Rusak, A. Patoine, K. Finlay, L. Bunting, G. Simpson, V.J. Swarbrick, D.B. Donald (x 2), M.J. Bogard, and UR Field Team members

Limnology Laboratory, University of Regina, Canada


University of Saskatchewan
Toxicology Centre
Emerging Chemicals of Concern and Non-Targeted Screening
Paul Jones,
Hui Peng, Tena Watts, John Giesy
Toxicology Centre, University of Saskatchewan

Estrogens in Manitoba Surface Waters and Wastewater Effluent
Andrew Burton, Senior Water Quality Specialist
October 5, 2016
Water Quality Management Section
Water Science and Management Branch
Manitoba Sustainable Development
Manitoba


Alberta Government
Agency Reports — Alberta
Barry Olson
Water Quality Section
Alberta Agriculture and Forestry
COWQ-PPWB
Prairie Water Quality Workshop — Focus on Nutrients
Regina, Saskatchewan
October 4–5, 2016

Monitoring Chemical Substances in Canadian Municipal Wastewater

PPWB Workshop
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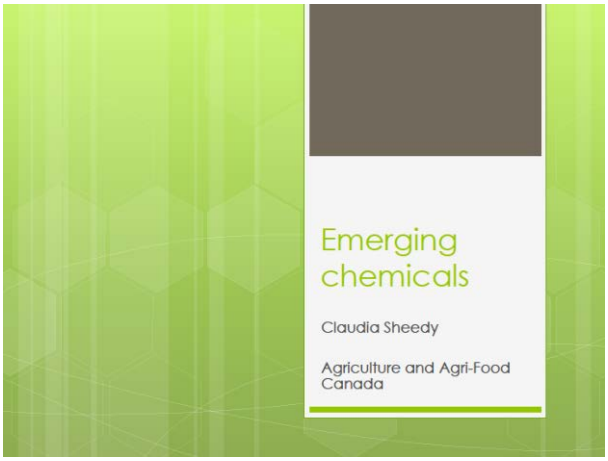
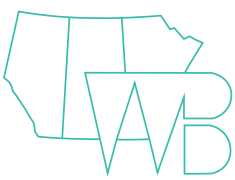
3,4 Oct 2016





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