Section 1

Research & Monitoring

1.1 Agriculture and Agri-Food Canada

1.1.1 Identifying the capacity to improve soil and nutrient management in agricultural production systems of the Canadian Lake Erie basin

Location

Lake Erie basin focus, production system analysis for province and Lake Erie.

Funders

AAFC

Transferability

The results from the project are for applicable use across the Lake Erie basin and Ontario. The approaches developed might be transferable to other parts of Canada.

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Project Goals

Under the Canada-United States Great Lakes Water Quality Agreement and the Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health (COA), a Canada-Ontario action plan to reduce phosphorus (P) loading to Lake Erie was developed by February 2018. It was important to have the best available information for devising the plan, so that Canadian farmers in the basin were accurately and fairly represented.

The goal of this project was to use nationally available AAFC data, methods and models to provide a relative regional and production system scale assessment of agri-environmental risk associated with phosphorus use efficiency and potential losses from the agricultural landscape in the Canadian Lake Erie basin.

Project Description

The project had 3 main components:

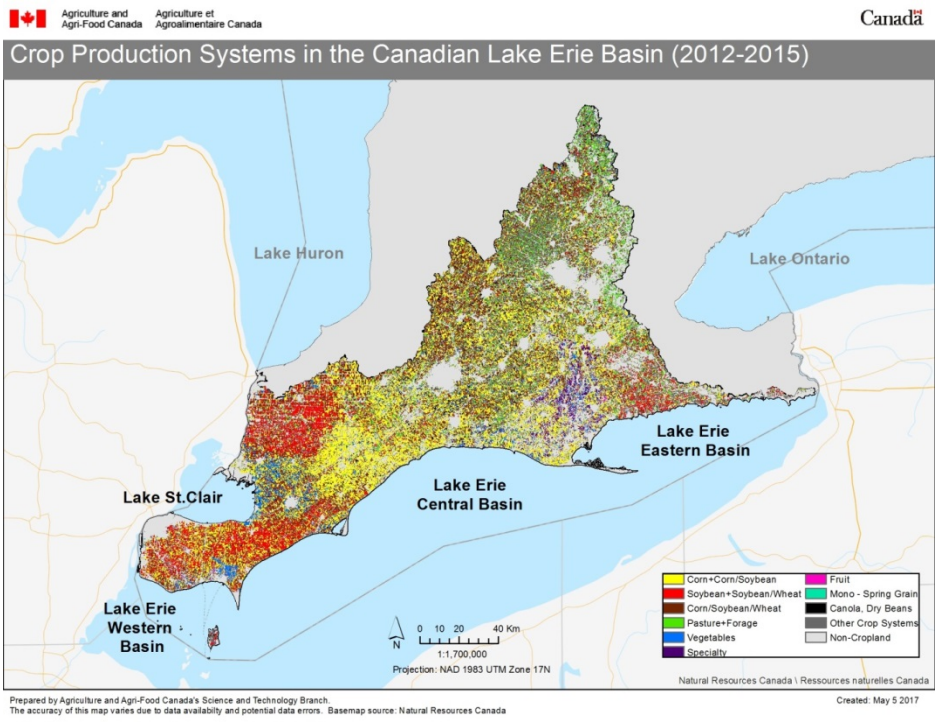
1. *Defining a Production System Framework* – A definition ruleset was applied to the Census of Agriculture to create a hierarchical framework of farming systems in Ontario. The ruleset was applied to 1981, 1991, 2001 and 2011 census years to allow a decadal analysis of change in agricultural systems in the basin. A partial nutrient balance, looking at the balance between manure nutrients and removal by field crops, was also applied to each farm. The results are compiled at county, provincial and custom Lake Erie geographies. The association among farm types, their land base and their farming practices, and the relative comparison among farm types, helps to identify appropriate soil and nutrient management practices for a given farm system, and thereby the focus with which to engage different agricultural sectors. Additionally, crop rotation analysis using the AAFC remotely-sensed Annual Crop Inventory was also conducted to help identify locations of different production systems
2. *Analyzing Agri-Environmental Indicator and Farm Environmental Management Survey components* – Key indicators from the suite of AAFC national agri-environmental indicators considered important for P losses to the Great Lakes were selected to be analyzed at a regional scale. These included the Water Erosion Indicator (WatERI) and the Indicator of the Risk of Water Contamination by Phosphorus (IRWOC-P). Indicator components such as runoff and cumulative P were used to characterize relative differences in source and transport across the Lake Erie basin for Soil Landscapes of Canada and quaternary watersheds. The fertilizer and tillage questions of the Farm Environmental Management Survey were analyzed for the whole country; more detailed analyses of nutrient management practices in Ontario and the Lake Erie Lowlands Ecoregion were conducted.

3. *Developing remote sensing methods*–This project utilized AAFC satellite remote sensing research methods to determine crop residue levels at the field scale to develop an approach to monitor soil cover, both green or crop residue, in the non-growing season in the Lake Erie basin. Satellite imagery and corresponding field calibration data were collected over three non-growing seasons to test this approach.

Results Summary / Expected Outcomes

Examples of the results produced:

- In the Canadian Lake Erie basin, commercial livestock production systems (as defined by having greater than 25 animal units) manage 33% of the cropland compared to field crop and vegetable production systems which manage 43% and 10% of the cropland, respectively (Census 2011). Thus livestock operations have a significant role in managing land application of phosphorus in the Lake Erie basin.
- The amount of no-tillage area in a production system is directly related to the amount of soybean and winter wheat grown in a production system, with about 60% of that area being no-till seeded. Capacity for more no-till acres is greatest in the corn-soybean-winter wheat production system as they manage the most soybean and winter wheat in the basin (Census 2011).
- Farm environmental management survey data (FEMS 2011) indicate that 14% of annual crop acres receiving commercial fertilizer in the Lake Erie Lowland Ecoregion receive fall broadcast fertilizer that is not incorporated into the soil. Nine per cent, 16% and 15% of commercially fertilized winter cereals (winter wheat), oilseeds (soybeans) and corn acres, respectively, have fall broadcast and not incorporated applications. These applications are particularly susceptible to P loss in the non-growing season.



Crop production systems in the Canadian Lake Erie Basin (2012-2015)

Next Steps

- A project proposal has been submitted to continue the creation and analysis of the time series of data which could be used in the adaptive management process for the Canada-Ontario Lake Erie Action Plan.
- Publish the results and datasets so they can be more easily utilized by agencies and researchers in the Lake Erie basin.

Lessons Learned

To annually conduct an assessment of soil cover using remote sensing methods, a widespread and robust field calibration (groundtruth) data collection network needs to be established, and human resources need to be dedicated to groundtruth data compilation, satellite image analysis, data interpretation and reporting.

For More Information

- Using agri-environmental indicators to track changes in the risk of nutrient and sediment losses in the Lake Erie basin: II. Application from watershed scale to the Lake Erie Basin
- Defining and analyzing Agricultural Production Systems to determine the Capacity to make Soil and Nutrient Management Improvements in the Canadian Lake Erie Basin
- Characterization of Canadian watersheds in the Lake Erie basin

1.1 Agriculture and Agri-Food Canada

1.1.2 Improve and integrate soil information to support the Domestic Action Plan for the Lake Erie Basin

Location

Upper Medway Creek

Partners

UTRCA

Funders

ECCC

Transferability

- While these soil test results are not directly transferable to other areas, the message that management needs to occur on a field by field basis using soil tests from that field, can be universally applied.
- The results are being used to calibrate the watershed model for the Upper Medway creek.

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Project Goals

- Provide spatial information on soil phosphorus levels in the Upper Medway watershed to calibrate a phosphorus (P) loss model for the watershed.
- Provide information to help farmers manage their P applications.

In addition, the degree of stratification of P in the soils in the watershed was of interest, as higher P concentrations can arise in the surface inch (2.5 cm) of soil due to practices such as no-tillage or surface broadcast application of nutrients, and can lead to higher surface P concentration losses than what would be predicted from a standard 0-6" (0-15 cm) depth soil sample.

Project Description

- Soil samples were collected and analyzed during the fall of 2016.
- Sampling included:
  - Standard 0-6" depth soil samples taken from 81 subfields (approximately 25 acres (10 ha) each) in 37 different fields. Subfields often represent zones of different management history or soil types.
  - A sub-set of these 37 fields also had a 0-1" depth sample taken (22 subfields from 10 different fields) to include a range in tillage from no-till fields (maximum potential for P stratification) to conventional moldboard tillage (complete inversion of P every few years).
  - A "precision management" approach using Normalized Difference Vegetation Index values calculated from four years of satellite imagery was used to define sampling zones. A subset of 2 fields (3 zones each) were sampled at 0-6" depth using this approach.
- Soil samples were air dried and analyzed for: soil test phosphorus (Olsen P, sodium bicarbonate extract, OMAFRA accredited test that farmers use for fertilizer recommendations); potassium (ammonium acetate extract, OMAFRA accredited); soil test magnesium (ammonium acetate extract, OMAFRA accredited); organic matter; pH; total phosphorus (perchloric acid digestion); and, organic phosphorus (B. Cade-Menun, AAFC method).
- Digitized sampling paths and field outlines were created and saved so that soil test results could be mapped and field areas determined.

Results Summary / Expected Outcomes

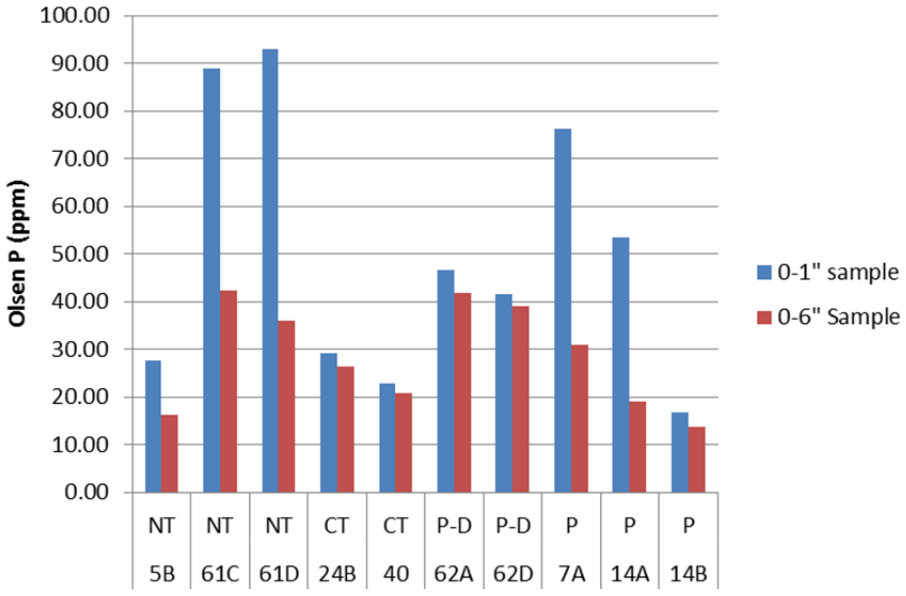
- Sub-field soil test values are typically averaged to come up with one P application rate recommendation for a field. Comparing the average field values for soil test P to either of the more spatially explicit sub-field or satellite defined zone levels, indicates there is potential to miss areas in a field that would benefit most from P additions (soil tests less than 15 ppm) and to apply to parts of a field where applications are unnecessary (>30 ppm) for most field crops, if average field levels are used.
- Based on OMAFRA fertility recommendations 63% of the sub-field area sampled would have P fertilizer recommended and 37% would have no P fertilizer recommended. Twelve percent of the area sampled had > 50 ppm Olsen P, which could be considered at higher risk of soluble P losses.
- The presence of stratification was tested using non-parametric statistical tests. Soil test P values were significantly greater in the 0-1" depth samples compared to the 0-6" depth samples but there was no significant difference due to degree of tillage disturbance.The significant difference between soil depth P values seem to be influenced by two ploughed fields which had fertilizer broadcast and then winter wheat planted. It is thought that fertilizer prills (small granules of dry fertilizer) were still present >5 weeks after application and were included in the soil sample. This result points to the importance of placement and timing of nutrient applications relative to timing of sampling and periods of loss.
- There was insufficient replication to statistically test the significance of management practices (tillage, 3 year total amount of P applied, manure use) on soil P levels.

Next Steps

- Collect soil samples from more fields in the watershed to get closer to 75% coverage for modelling purposes and to increase the number of replicate fields in order to statistically test management effects on soil test P levels.
- To re-test fields where high surface P values were thought to be related to fall fertilizer applications and not tillage

Lessons Learned

- Additional P form analyses confirmed that only total P and Olsen P need to be analyzed in future soil sampling campaigns for modelling purposes.
- The results highlight that there is no one factor that drives soil P levels (or losses) and that management needs to occur on a field by field basis using soil tests from that field



Olsen soil test P sampled from two depths in same fields
(NT= no-tillage, CT= Conservation tillage, P-D = aggressive disking, P=mouldboard plough)
(photo credit: AAFC)

1.1 Agriculture and Agri-Food Canada
1.1.3 Indicator of risk of water contamination by phosphorus (IROWC-P)

Location
National coverage, including Lake Erie basin.

Funders
AAFC

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Project Goals
IROWC-P is part of the Sustainability Metrics suite of national agri-environmental indicators (AEI), which are being updated and aligned for better sharing of input data and more timely reporting of results. Past AEI reports have been used primarily to guide policy decisions at the federal, provincial and municipal levels, but the current amendments will expand the utility of the information to commodity groups and non-governmental organizations. This project aimed to make the following improvements to the IROWC-P:

- Update the calculation of risk of P losses to account for new scientific knowledge;
- Improve accounting for the changes in risk of P losses over time, and across different areas, by adding evaluation of:
  - Bioavailable portion of particulate P;
  - Direct losses of P from applied fertilizer and manure;
  - P losses during snowmelt from frozen plant residues;
- Develop computer code so calculation updates can be performed more quickly and easily; and
- Allow for the calculation of P losses relative to crop or livestock productivity (intensity based measures)

Project Description
A key part of the IROWC-P model, because field level data is not available, is to estimate P soil test values using the cumulative P balance, calculated from crop inputs and outputs reported in the Census of Agriculture. This, in turn, is used to predict risk of losses of both particulate and dissolved P to surface water, and how this has changed over time. This project will help make IROWC-P more accurately reflect farm practices and P loss processes.

Results Summary / Expected Outcomes
- The P balance (P inputs minus crop removal of P) for Ontario counties has been calculated for the period from 1961-1980, to account for fertilizer and manure applications during the beginning of agricultural intensification in this province. These calculations modify the starting point for predicted soil test P values in Ontario for IROWC-P.
- The cumulative P balance calculations for the period from 1981-2011 have been modified to better reflect the actual use of fertilizer in mixed crop-livestock systems, by using the relative fertilizer expenses in different farming systems rather than assuming that fertilizer P is displaced by manure P.

Next Steps

As soon as data is available from the 2016 Census of Agriculture, the Sustainability Metrics reports, including IROWC-P, will be updated and available on the Government of Canada website. The first set of reports will be on a geographic basis (Soil Landscapes of Canada polygons), similar to prior reports. Once this is complete, the data will be parsed into different production systems (beef, dairy, swine, poultry, grain crop and field horticulture) to summarize the risk of P loss from these systems, and in some cases to present the risk in terms of P loss per unit of production. There are also plans to include methods so individual farmers could compare their P use with that of other farms within their commodity group. We anticipate that most of the intensity based calculations for individual commodities will be available through the commodity groups.

For More Information

The report #4 of the Agri-Environmental Indicator for Canadian Agriculture series is available online.

1.1 Agriculture and Agri-Food Canada

1.1.4 Integrated nutrient management and multi-scale BMP assessment for priority Canadian agricultural landscapes

Location

Upper Medway Creek, Lake Erie Basin

Partners

UTRCA

Funders

AAFC

Transferability

The decision support tool to be developed will allow farmers, land managers, or consultants across eastern Canada to match the most appropriate BMPs for P loss reduction to conditions in individual fields (including impact of stacked BMPs)

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Project Goals

The Lake Erie components of this project provide datasets that can be used for validating field scale models, such as the phosphorus (P) Index, and for analyzing watershed and agricultural production features across a range of conditions and scales to determine driving process of P loss to which appropriate BMPs can be directed.

- Quantify and predict dissolved and particulate P losses, and their partitioning between surface runoff and tile drainage at field scale under a range of agricultural management scenarios.
- Establish a paired, edge-of-field monitoring site, integrated with Canada Ontario Agreement on Great Lakes Water Quality and Ecosystem Health (COA) partner watershed activities, to quantify BMP effectiveness on dissolved and particulate P losses and their partitioning between surface runoff and tile drainage.
- Characterize the agricultural landscape of watersheds being studied by partner COA agencies to develop relationships that will help explain dominant pathways and drivers of P delivery to streams under different landscapes and agricultural production systems.
- Develop a decision support tool for BMP selection and adoption through integration of research results into a framework that combines P source and transport components.
- The project is also looking into nitrogen and carbon cycling, and soil microbial and physical characteristic dynamics with corn stover removal in Ontario and on long-term manure-applied land in Alberta

Project Description

1. *Tile water partitioning:* Electrical conductivity meters have been placed within tile monitoring equipment at AAFC and the Universities of Guelph and Waterloo field sites across a range of soil and climate conditions. Changes in electrical conductivity from rainfall events can be used to determine the proportion of water flowing through the tile that is filtered through the soil, versus diverted from the surface through large cracks and earthworm burrows (macropores). This information is being used to weigh the proportion of particulate and dissolved P loss to tile drains for both field scale (P Index) and landscape scale (Indicator of Risk of Water Contamination by P) risk assessment models.
2. *Edge-of-field monitoring*: A site was selected in the Upper Medway creek watershed that enables a paired, edge-of-field design. Monitoring equipment was installed in two fields at the site to measure both surface and tile water flow and water quality year round. The two fields will be monitored through one crop rotation (at least 2 years) to provide baseline information. After the baseline period, one field will have a BMP installed and the monitoring will continue for another crop rotation to determine the impact of the BMP on P losses from the field. The BMP to be implemented is yet to be finalized with the cooperating farmer.

3. *Agricultural landscape analysis:* Several AAFC datasets on soil cover, production systems, nutrient balance, soil properties, and terrain analysis are being compiled for the Lake Erie basin. Multivariate statistical analysis will be conducted to determine which agricultural landscape variables are most important to predict P delivery to streams.
4. *Decision support tool for BMP selection*: A suite of BMPs will be assessed for their impacts on individual source and transport components, using data from existing studies and this project. The knowledge will be combined in a decision support framework which considers the net impact of each BMP across all of the components, i.e. particulate and dissolved P, surface and tile transport pathways

Results Summary / Expected Outcomes

Project still in progress.

1.1 Agriculture and Agri-Food Canada

1.1.5 Mitigating nutrient losses through tile drainage by developing and transferring AAFC's research in controlled drainage

Location

Upper Thames Upper Medway subwatershed; Holland Marsh; Southern Manitoba; Municipality of Essex in Essex County.

Partners

- McGill University
- OMAFRA
- University of Manitoba
- University of Waterloo
- UTRCA

Funders

AAFC and support from the UTRCA through the Great Lakes Agricultural Stewardship Initiative

Transferability

There is a unique opportunity to work with OMAFRA and Land Improvement Contractors of Ontario to potentially amend the Drainage Guide for Ontario to include a more in-depth design standard for controlled drainage.

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Project Goals

Subsurface tile drainage continues to be viewed as a contributing source of nutrient loading to surface water in the Great Lakes-St. Lawrence River Basin. This project looks at the impact of controlled drainage as a best management practice to reduce phosphorus loading and its potential impact on yield through:

- Monitoring phosphorus loading between a free tile drained field and a controlled tile drained field;
- Monitoring the difference in volumetric discharge between a free tile drained field and a controlled tile drained field;
- Providing more information on the practice of controlled drainage in conjunction with provincial and industry partners; and
- Predicting the performance of controlled drainage under different climatic conditions using calibrated models (Hydrus)

Project Description

Studies have shown that the adoption of controlled tile drainage as a best management practice has the potential to reduce nutrient loading of nitrogen and phosphorus from tile drains and increase producer profit margins through increased yields. However, the ability for controlled drainage to reduce nutrient loading under different climate and soil conditions has not been thoroughly investigated. Year-round monitoring has also been a challenge, especially when trying to capture the significant contribution of the spring thaw event. A field study will be conducted to provide year-round measurements of nutrient loading to compare the results between controlled drainage and free drainage sites. This project will monitor sites within different watersheds across Canada, including the Thames River watershed.

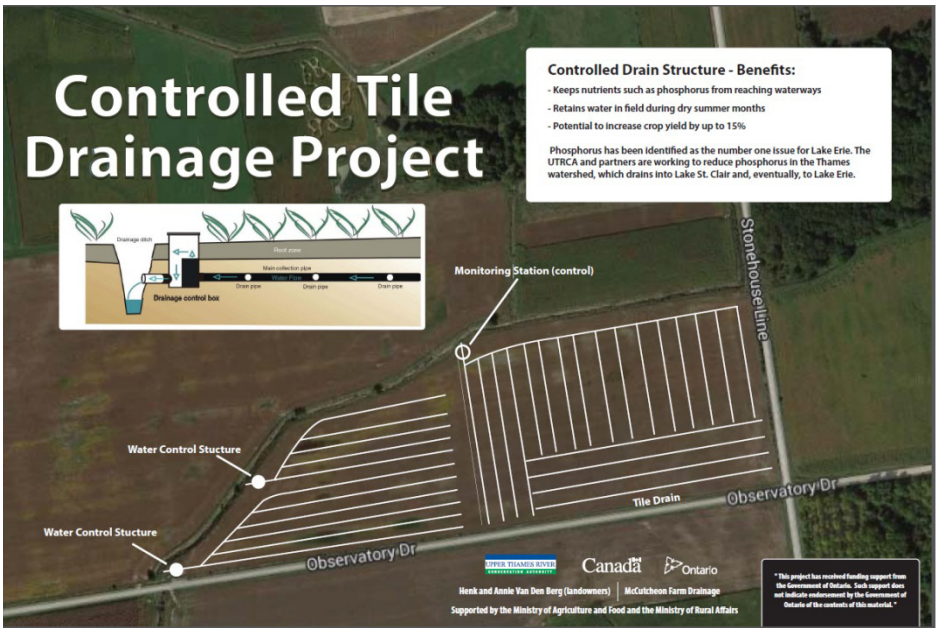
In collaboration with the Upper Thames River Conservation Authority, controlled drainage structures were installed on a farm near Lucan, ON. This site provides an excellent opportunity to extend the assessment of yield and nutrient loss to a working farm. This site was split into three sections; one half of the field was set-up for free drainage, while the other half was split into two separate controlled drainage fields. This site was equipped with edge-of-field monitoring equipment to measure volume of tile discharge, nutrient concentrations and water table depth for each site

Results Summary / Expected Outcomes

- Preliminary results show over 20% reduction of phosphorus exports in controlled drainage compared to free drainage;
- Based on the flow discharge rates, control structures were able to hold back tile water for precipitation events < 50 mm; and
- Based on the results of three growing seasons, there has been no significant impact to crop yield observed.

Next Steps

Controlled drainage has primarily been examined in corn-soybean production systems because these systems generally cover the majority of acres across the Mid-West US and Eastern Canada. Conversely, horticultural production systems cover fewer acres but are often located in areas that have good potential for the installation and success of controlled drainage, e.g., flat land and medium to coarse textured soils. Since horticultural production systems have higher N & P requirements than field crop production systems, the potential for nutrient loss through tile runoff is increased. Testing the applicability of controlled drainage in these production systems is key to developing useful economic and environmental performance criteria to fully operationalize this as a BMP.



Controlled Drainage Project (photo credit: AAFC)

Lessons Learned

Controlled drainage is limited in applicability as it requires relatively flat land and medium to coarse soil type to succeed. Although controlled drainage has been found to be more effective at reducing phosphorus loading under excess moisture conditions, there are situations where a lack of precipitation will show no tile flow, therefore there is no observable difference.

1.1 Agriculture and Agri-Food Canada

1.1.6 Mitigating phosphorus loss from agricultural lands in the Lake Erie watershed

Location

Western basin, Lake Erie.

Partners

- ERCA
- OMAFRA
- USDA
- University of Guelph

Funders

AAFC

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Project Goals

- Investigate the effects of P-based application of various forms of cattle manure and triple superphosphate in fields that are tiled; and
- Assess P loss in tile drainage water under long-term conventional- and non-tillage as influenced by yard waste leaf compost application

Project Description

Many fields in southern Ontario are tiled. This project examines how different farm practices and nutrient sources affect the amount of phosphorous lost from soil through tiles. Information discovered through this study will be used to develop BMPs. The project consists of two studies:

1. A four-year field experiment that looked at the effects of P-based application of various forms of cattle manure (liquid cattle manure, LCM; or solid cattle manure, SCM) and triple superphosphate (inorganic P) on soil P losses from tiled fields; and
2. A three-year farm field trial that looked at the effects of yard waste leaf compost (LC) addition on soil P loss under long-term conventional-(CT) and non-tillage (NT) practices.

The test fields for both experiments were clay loam soil with a corn-soybean rotation located in the Lake Erie basin. Phosphorous loss was measured by using state-of-the-art automated field water discharge flow monitoring and sampling systems

Results Summary / Expected Outcomes

Study 1 – Nutrient source effect

- Liquid manure increased dissolved P loss immediately following application.
- Solid and liquid manures had long-term dissolved P loss similar to the same amounts of fertilizer P applications.
- Solid manure reduced particulate P and total P loads over the long term.
- Solid cattle manure is less prone to phosphorus loss in tile drainage water.

Study 2: Compost effects under NT and CT

- Dissolved reactive P loss with NT was solely driven by its concentration in drainage water.
- Dissolved reactive P loss with CT was collectively driven by its concentration and flow volume.
- Compost addition did not affect particulate P loss, regardless of tillage practices.
- Compost addition enhanced dissolved reactive P loss under NT.

Next Steps

Soil P loss increases with the level of soil test P, but losses increase much more quickly above a certain point. The soil tests currently used to determine P fertilizer requirements were not designed to identify this change point (the maximum soil P retention capacity) and it is not known how this will vary between soils. In addition, the regular soil tests do not tell us about the size of the P pool that could potentially be released over time. For instance, two soils with the same value of soil test P but with contrasting soil textures, a clay soil and a sandy soil, can have different amounts of stored P. Another soil P test is needed to determine the risk of P loss over a broad range of soil types and time scales so we can predict how quickly changes in P use on farm will result in water quality improvements. In order to guide farmers' fertilization practices to fundamentally reduce non-point source P loss from agricultural lands to Lake Erie while maximizing farmers' income, it is essential to develop environmental soil testing methods to complement the agronomic ones.

Lessons Learned

1. Factors controlling soil P loss vary depending on the nutrient source and how it is managed. Truly understanding the contributing factors is needed to develop and evaluate BMPs and P loss risk assessment tools.
2. NT in combination with compost addition enhances soil P loss, which is contradictory to what we used to believe, i.e. as a surface runoff-focused BMP NT should reduce P loss. Management practices can have a different effect on soil P losses between tile drainage and surface runoff.

For More Information

- https://www.researchgate.net/profile/Tq_Zhang

1.1 Agriculture and Agri-Food Canada

1.1.7 Use of cover crops to reduce agricultural pollution of the Great Lakes and improve field-crop productivity

Location

Essex County, Southwestern Ontario. One field site on Harrow sandy loam soil at Harrow, ON, in the Lake Erie watershed (Cedar Creek sub-watershed); other field site on Brookston clay loam soil at Woodslee, ON, in the Lake St. Clair watershed (Belle River sub-watershed).

Partners

Grain Farmers of Ontario

Funders

AAFC

Transferability

The results are expected to be applicable to all watersheds in the lower Great Lakes region, including the Thames.

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Project Goals

Cover crops are becoming a significant component of Ontario nutrient management plans, as well as a popular management practice to reduce soil erosion, improve soil health and increase crop productivity in southwestern Ontario. This study tests some traditional southwestern Ontario cover crops (red clover, crimson clover, hairy vetch) and some new cover crops (sesbania, phacelia, nitro radish) for their ability to:

- germinate in the summer and fall;
- collect and store post-harvest soil nitrogen in their biomass over the fall-winter-early spring period;
- re-release biomass nitrogen back into the crop root zone during the following growing season thereby reducing the amount of synthetic fertilizer required for the next crop; and
- improve or maintain overall soil quality and health.

Project Description

The field experiment has been ongoing since 2013, on a sandy loam soil and a clay loam soil at the Harrow Research and Development Centre, Agriculture and Agri-Food Canada, Harrow, ON. On each soil, a corn-soybean-winter wheat rotation was established in three adjacent fields so that each crop in the rotation is grown every year.

After winter wheat harvest (late July), various cover crops are planted into the wheat stubble, including crimson clover, red clover, hairy vetch, sesbania, phacelia (clay loam soil only), nitro radish and several combinations of the above, plus a control (no-cover crop). Soil cores (36 mm diameter by 900 mm long) were collected after winter wheat harvest (late July) to determine the post-harvest or residual concentrations of soil mineral nitrogen (RSN) residing in the soil at the time of cover crop planting.

Cover crop biomass samples and a second set of soil cores (0-900 mm depth) are collected at fall freeze-up to determine the amount of nitrogen stored in above-ground biomass, as well as soil RSN when the cover crop becomes dormant or winter-kills. It is critical that soil RSN is minimized in the fall, as this nitrogen is very vulnerable to over-winter leaching into tile drainage and ground water.

Yield and nitrogen nutrient content of the corn crop are measured annually to determine the "nitrogen credit" provided by the cover crops to corn. This nitrogen credit can be used to reduce nitrogen fertilizer applications without losing corn yield. Intact soil core samples are collected annually to assess soil physical quality.

Results Summary / Expected Outcomes

- Sesbania and phacelia do not function well as post winter wheat cover crops, neither singly nor mixed with other cover crops, in southwestern Ontario due to poor establishment and limited fall growth.
- Nitro radish after winter wheat provides good land cover and excellent scavenging of residual root-zone nitrogen in fall in southwestern Ontario, thereby reducing risk for nitrogen loss over the non-growing season. Nitro radish provided little nitrogen credit or protection from early-spring erosion, however, as much of its biomass decomposed rapidly at spring thaw and most of its accumulated nitrogen is lost as ammonia gas.
- Red clover and hairy vetch are viable post winter wheat cover crops as they establish reasonably well when planted after winter wheat harvest, and they regenerate well in the following spring. Although crimson clover establishes very well when planted after winter wheat harvest, it is not as winter-hardy as red clover and hairy vetch.
- Terminating red clover and hairy vetch shortly before planting (early May) can supply a substantial nitrogen credit to a following corn crop. If fall termination is needed, crimson clover is a better cover crop than red clover.
- Relative to no-cover crop, red clover, hairy vetch and crimson clover reduce post-harvest residual soil nitrogen in the soil profile by up to 50 kg N ha^{-1}.
- Red clover, hairy vetch and crimson clover can provide substantial nitrogen credits to corn on Harrow sandy loam (100-150 kg N ha^{-1}), and modest nitrogen credits to corn on Brookston clay loam (40-90 kg N ha^{-1}).
- Cover crops in southwestern Ontario deliver immediate reductions in wind and water erosion, with efficacy directly related to the degree of cover crop establishment and amount of ground cover provided by fall-winter-spring growth.
- Cover crops in southwestern Ontario do not provide appreciable short-term improvements in soil physical quality or carbon sequestration.

Crimson clover cover crop, Harrow, ON (photo credit: AAFC)

Next Steps

- Intercropping as a method of establishing an additional cover crop into corn in the corn-soybean-winter wheat rotation; and
- Testing the effects (e.g. nitrogen credit) of different cover crop termination methods (plow-down, vertical tillage, chemical burn-down) on the subsequent corn crop.

The test crops will be hairy vetch, red clover and crimson clover, as these crops were the best performers in this study.

Lessons Learned

In fine textured soils, drilling or incorporation of cover crop seeds improved crop emergence and crop establishment relative to surface broadcasting of seeds.

For More Information

- Boosting nitrogen in organic systems article
- 19th Nitrogen Workshop: Efficient use of different sources of nitrogen in agriculture
- Yang, X., Drury, C., Reynolds, D., Yang, J., & Reeb, M. A. SIGNIFICANCE OF LEGUME COVER CROPS AS NITROGEN SUPPLY FOR CORN IN AN ORGANIC MANAGED SOYBEAN-WINTER_WHEAT-CORN SYSTEM IN SOUTHERN ONTARIO, CANADA. *Efficient use of different sources of nitrogen in agriculture–from theory to practice Skara, Sweden 27 June–29 June 2016*, 84.

1.2 City of London
1.2.1 Enhanced wastewater treatment

Location

- Located in the City of London; Upper Thames River Watershed
- Four of the City's Waste Water Treatment Plants, including Pottersburg, Vauxhall, Adelaide and Greenway Waste Water Treatment Plant

Funders

- Clean Water and Wastewater Fund
- City of London

Transferability

Technologies evaluated under the Vauxhall Class EA will have transferability to other wastewater treatment plants, and in many cases are easily scale-able to other plants within the watershed and the Province at large.

Contact Information

- Kirby Oudekerk, P.Eng. (Environmental Services Engineer), Wastewater Treatment Operations, City of London koudeker@london.ca (519) 471-1537

For More Information

- City of London website's City Wastewater Treatment page

Project Goals

- The five City of London wastewater treatment plants are responsible for approximately 10% of the total phosphorus load to the Thames Rivers. Achieving a 50% reduction in that total loading could eliminate 5% of the phosphorus entering Lake Erie from the Thames River via Lake St. Clair. This is estimated to be between 15 and 20 tonnes/ year. Achieving a phosphorus load reduction in the Thames River would contribute directly to phosphorus load reduction in Lake Erie.
- The City of London is targeting a 50 to 70% reduction in total phosphorus contained in wastewater treatment plant effluent.

Project Description

- London's Wastewater Operations is examining options for improved treatment processes at its plants, including ballasted flocculation or filtration.
- Upgrade projects would also include overflow and bypass mitigation to reduce the occurrence and volume of plant bypass flows, although the portion of total phosphorus that enters the Thames through overflows and bypasses is relatively small.

Results Summary / Expected Outcomes

Preliminary pilot testing with ballasted flocculation at Vauxhall WWTP has demonstrated the technical feasibility of that technology in achieving low total phosphorus effluent (<0.3 mg/ L, potentially to 0.1 mg/ L). The feasibility of implementation at all plants has been confirmed at a high level, but more evaluation will be required through the respective Class Environmental Assessments.

Next Steps

Municipal Class Environmental Assessments (EAs) will be undertaken as a first phase. Each plant will be considered and studied individually. A Request for Proposals for the Vauxhall Wastewater Treatment Plant Upgrades Class EA will be issued in Winter 2018

Lessons Learned

Technical feasibility has been established. Introduction of new technologies with non-standard operating parameters is one challenge currently being evaluated, in consultation with the MOECC

1.2 City of London
1.2.2 Surface water quality monitoring

Project Goals

- To track background amounts of nutrients in the Thames River and other City of London urban waterways.
- Monitor wastewater treatment plant (WWTP) effluent from five plants to determine impacts by sampling both upstream and downstream locations.
- Assess changing stream and river conditions in order to better understand the systems and inform wise decision-making

Project Description

- There are thirty permanent sites monitored covering over 40 years of continuous water quality data (being the longest data set for Thames River water quality in the watershed).
- Of the permanent sites, 15 sites exist on the Thames River and 15 sites on adjacent urban subwatersheds; six temporary locations also augment supporting data specific to ongoing studies.
- Benthic samples are also taken in compliance with MOECC approvals for WWTP certificates of approval.
- A network of nine precipitation gauges have been installed across the city to augment the only Environment Canada gauge in the city located at the London International Airport located in the northeast quadrant of the city; these gauges provide the background data to explain basement flooding, localized waterway flooding as well as subsequent erosion events.
- Under development – online tools to provide on-demand monitoring data to agencies and the public.

Results Summary / Expected Outcomes

- The data set continues to provide baseline data and trend analysis for the City of London which is the geographic centre of the watershed.
- Total phosphorus is measured in addition to 12 other parameters and the complete data set is available online from continuous sampling since 1978.
- As phosphorus management becomes more critical and reductions required to meet DAP criteria, this baseline information will become more critical.
- As stormwater management ponds become more intensely monitored, this information will also help populate the data base and inform future decisions

Location

Located in the City of London; Upper Thames River Watershed

Partners

- Several divisions within the City of London including Wastewater Treatment, Wastewater Operations, Stormwater Engineering, formerly the Public Utilities Commission.
- UTRCA
- Seeking new partnerships with Western University and Trojan Technologies

Funders

- Clean Water and Wastewater Fund
- City of London

Transferability

The data and approach is transferable to all urban waterways within southern Ontario.

Contact Information

- Tony VanRossum, P.Eng. (Environmental Services Engineer),
  City of London
  tvanross@london.ca
  519-661-5701
- Patrick Donnelly, M.Sc. RPP, (Watershed Program Manager),
  City of London
  pdonnelly@london.ca
  519-661-2489 x 0418

Lessons Learned

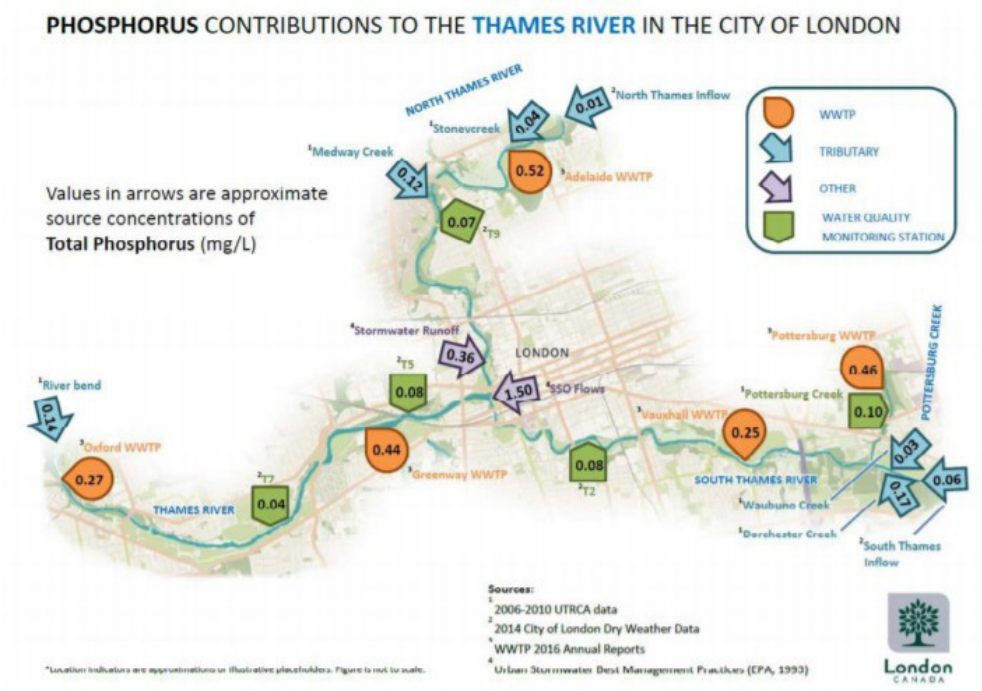
- The importance of continuous, reliable water quality monitoring should not be understated given the tendency to reallocate funding and discontinue operation of individual site when budgets are reviewed and constrained.
- Heritage/ legacy phosphorus needs to be considered if total phosphorus contribution to the Lake Erie watershed is to be accurately assessed

For More Information

- City of London website's Creeks and Thames River Water Quality page.

Next Steps

- Developing an enhanced database reporting system which will enable the quick production of standardized reports as well as enabling the ability to populate data to the website for easy access.
- Enhanced database reporting software will permit quick production of standardized reports for the various City facilities (i.e., wastewater treatment, wastewater collection, water distribution, and stormwater engineering).
- Establish an on-going waterway database to provide trend analysis regarding urban waterway conditions and channel movement (i.e., channel erosion, deposition, modes of sediment transport) and inform waterway improvements.



Possible Sources of Phosphorus in the City of London (photo credit: City of London)

1.3 Environment and Climate Change Canada

1.3.1 Investigating drivers of harmful algal/cyanobacterial blooms in Lake Erie and Lake St Clair

Project Goals

The main goals of the study are to:

1. develop and evaluate tools and parameters to support a harmful alagal bloom (HAB) monitoring program for Lake Erie, Lake St. Clair, and the Thames River,
2. analyse spatial/temporal patterns in plankton community composition/biomass in relation to toxins and metabolic inhibitors, light regime, nutrient loadings and nutrient speciation, with a particular focus on the western basin of Lake Erie and Lake St. Clair, and
3. apply genomics tools to characterize spatial/temporal shifts in plankton and toxigenicity in response to nutrient loadings.

Project Description

This project is linked to two other genomic projects, namely the interdepartmental EcoBiomics Project under the federal government's Genomics Research & Development Initiative and the Rapid assessment of algal community composition and harmful blooms using DNA barcoding and Remote Sensing project under the Strategic Application of Genomics to the Environment program. It is being conducted in collaboration with water quality monitoring programs in Environment and Climate Change Canada, the Ontario Ministry of Environment and Climate Change and the University of Windsor and University of Guelph. We have initiated a biweekly water sampling program in the Lake St Clair, linked to some additional water sampling in the Thames watershed and Limnos research cruises in Lake Erie. We are adding analyses of molecular, chemical, and genomics parameters to more comprehensively characterize water samples being collected for nutrients, toxins and other standard water quality parameters. This includes metabarcoding of DNA sequences to characterize bacterial (cyanobacteria especially) and algal communities. This genomics data is being collected by Environment and Climate Change Canada (CCIW-Burlington) and is being analyzed along with phosphorus, nitrogen and other water chemistry parameters including toxins. Ultimately genomics data will be combined with remote sensing data in order to forecast the composition of cyanobacteria and algal blooms and the associated potential for toxin production and risks for water quality.

Results Summary / Expected Outcomes

Data collection and analyses ongoing. Expected outcomes to include better understanding of HAB dynamics in the study area, and information on sources of HAB, toxins and nutrients for water quality monitoring programs.

Lessons Learned

Still learning.

Location

Sampling sites in the Lake St Clair nearshore between the Thames River mouth and Detroit River. Sampling sites as part of Lake Erie long term water quality monitoring sites

Partners

- AAFC
- ECCC
- National Research Council of Canada
- MOECC
- University of Guelph
- University of Windsor

Funders

ECCC and the Freshwater Great Lakes Program

Transferability

Opportunities for knowledge transfer.

Contact Information

- Dr. Jerome Comte (Water Science & Technology Directorate),
  ECCC,
  Burlington, Ontario
  (905) 336 4531
  jerome.comte@canada.ca

Next Steps

Continue with regular water sampling program in 2018.

1.3 Environment and Climate Change Canada

1.3.2 Exchange of nutrients between groundwater & surface water in the Thames River watershed

Location

The field sites are located in the Nissouri Creek and Cedar Creek subwatersheds in Oxford County, which are in Norwich and Zorra Townships respectively.

Partners

- MOECC
- Oxford County (access to sites)
- UTRCA

Funders

ECCCC (Great Lakes Nutrient Initiative).

Contact Information

- Dale Van Stempvoort,
  ECCC
  Burlington, Ontario
  905-319-6917
  dale.vanstempvoort@canada.ca

Project Goals

- To develop a better understanding of the variations in groundwater – surface water interaction in the Thames River Watershed, and how these in turn affect water quality (esp. nutrients) in this priority watershed.
- To provide field data for input and updating of the parameters used to model nutrient fluxes from groundwater to the Thames River system, including modeling using the CanSWAT watershed model.

Project Description

Water quality and hydrometric data are being collected at ten surface water sites, with a focus on baseflow conditions in headwater streams and drains; shallow groundwater is being sampled at seven locations.

Results Summary / Expected Outcomes

- In the first year of study (2017/18) the first phase involved the screening, selection and establishment of field sites. For sampling of shallow groundwater, drive points were installed in riparian settings.
- Surface water and groundwater samples and hydrometric data have been collected at two to three week intervals from June 2017 to present

Next Steps

- Ongoing collection of samples and hydrometric data (through 2019/20)
- Establishing an additional groundwater sampling site
- Interpretation of data and modeling applications

1.3 Environment and Climate Change Canada

1.3.3 Great Lakes Nutrient Initiative: Nutrient enrichment studies on small tributaries

Project Goals

The goal of the Government of Canada's Great Lakes Nutrient Initiative (GLNI) is to address the problems of recurrent toxic and nuisance algae, and nearshore water quality and ecosystem health in the Great Lakes. Under GLNI, studies have been and continue to be undertaken in streams in south-western Ontario to improve understanding of the sources, fate and effects of nutrients. The specific goals of these studies are to:

1. develop an approach for setting scientifically-credible nutrient targets to protect ecological condition of rivers flowing to Lake Erie,
2. recommend phosphorus targets for Lake Erie tributaries to ensure good water quality and protect aquatic life, and
3. improve understanding of the effects of agricultural beneficial management practices on water quality at a watershed scale.

Project Description

- For the field component of the study, up to 29 tributary sites were sampled 10x between May-Nov 2012 and 2013 to assess associations between land use activities and water quality. Samples collected included measures of chemistry (N & P forms, etc.), physical variables (turbidity, TSS, temp, DO, conductivity), biology (sestonic chl-a, benthic algal & benthic invertebrate composition & abundance), stream metabolism, land use measurements, and sewage treatment plant metrics. These data formed the basis of analyses to define scientifically-credible nutrient targets for south-western Ontario streams.
- Artificial stream (mesocosm) experiments were conducted in 2015 to validate proposed P criteria. Experiments included dosing trials in which artificial streams were enriched with P so as to span a gradient found in local streams (0.005 – 0.15 ug/L SRP). The artificial streams were seeded with algal and invertebrate communities from a local stream (Medway Creek) prior to P enrichment. Measurements of biological activity (benthic chl-a, photosynthetic pigments, algal composition and abundance) were taken every 3-4 days from the start of the experiment until its conclusion 4 weeks later.
- In association with the Upper Thames River Conservation Authority and Western University, field investigations are being initiated in 2018 to investigate the effect of land management practices on stream nutrient chemistry and ecological condition. Two watersheds in the Thames River basin (Upper Medway and Kintore) and one watershed in the Kettle Creek basin (North Kettle Creek) have been identified for routine and event water chemistry sampling and for assessment of ecological condition. Each of the three watersheds has one sub-watershed that is receiving (or has received) encouragement to implement beneficial management practices whereas the other sub-watershed has not received such encouragement.

Location

Sites are located in southwestern Ontario, in watersheds draining to Lakes Erie (via the Thames, Lynn, and Grand rivers and Kettle Creek) and Huron (via the Ausable, Bayfield, and Maitland rivers).

- Brant County
- Elgin County
- Huron County
- Middlesex County
- Norfolk County
- Oxford County
- Perth County
- Regional Municipality of Waterloo
- Township of Woolwich
- Wellington County

Partners

- Western University
- UTRCA

Funders

ECCC through Great Lakes Nutrient Initiative.

Transferability

The methodologies used to determine the effect of land use activities and practices are broadly applicable to streams and rivers. Results from our current research on effects of land use practices and activities on water quality and ecosystem condition will be relevant to streams throughout south-western Ontario.

Contact Information

- Dr. Patricia Chambers
  ECCC
  905-336-4529
  patricia.chambers@canada.ca

Next Steps

Identify the effectiveness of land use practices and activities in reducing agricultural inputs of nutrients at a watershed scale.

Lessons Learned

- Both urban and agricultural land use influences nutrient concentrations in tributaries, reinforcing the need to reduce point and non-point inputs to mitigate eutrophication of downstream lakes
- Biologically meaningful thresholds are potentially 2 – 5 fold higher than those identified by water chemistry alone.

Results Summary / Expected Outcomes

Results of field studies:

- Sewage and agricultural cover are important predictors of watershed nutrient concentrations (particularly P).
- Threshold values calculated using only water chemistry data indicated a split in the data at 0.027 mg/L TP.
- Threshold values calculated for P using biological community metrics indicate change in ecosystem condition over a range of P concentrations (0.04 – 0.1 mg/L TP depending on season and metric).

Results of mesocosm experiments:

- Mesocosm trials revealed strong responses of benthic algal biomass and biological community metrics (photosynthetic pigments) to addition of P.
- Algal biomass (chl-a) and biological community metrics (photosynthetic pigments) showed the greatest change between 0.05 – 0.1 mg/L SRP, consistent with the range observed for biological metrics sampled from field sites

1.3 Environment and Climate Change Canada

1.3.4 Integrated modelling of the Thames River, Sydenham River and Lake St. Clair

Project Goals

The reduction in Thames River and Sydenham River nutrients will be modelled for BMPs and climate change scenarios and will be optimized against targets. The effects of reduced loadings on Lake St. Clair will then be evaluated.

Project Description

- Thames River and Sydenham River watersheds are being modelled with CanSWAT, Canadian version of SWAT
- BMPs will be modelled in the watershed, e.g. vegetative filter strips, nutrient management in support of 4R, grassed waterways, cover crops and conservation tillage
- Combinations of BMP will be optimized
- Loading hot spots will be identified in the watershed
- Watershed model data sources include Greenland Consulting Engineers, the Upper Thames River Conservations Authority and Lower Thames Valley Conservation Authority, St. Clair Region Conservation Authority, Ontario Ministry of the Environment and Climate Change, Agriculture and Agri-Food Canada and Ryerson University
- Hydrodynamic data including velocity profiles, temperature profiles and meteorological forcing are collected. Data will initially be stored internally and will be shared in the Government of Canada Open Data Portal after QA/QC
- The project began in 2016, with expected completion in 2020
- Loadings from Thames River and Sydenham River modelling will be used as inputs to the Lake St. Clair Elcom-Caedym (ELCD) model - Hi-Res 3D water quality model for Lake St. Clair to resolve main physical processes

Results Summary / Expected Outcomes

- Calibrated/validated CanSWAT and ELCD models
- Impact of various BMPs on watershed nutrients and options for meeting target levels
- Model output discharge to Lake Erie via Detroit River to evaluate ecosystem objectives under load reduction strategies.
- Impact of BMPs on Lake St. Clair nutrient levels and blooms and subsequent impact on Lake Erie loadings via Lake St. Clair outflow

Lessons Learned

- Thames River watershed modelling is a complex task (e.g., relatively flat landscape in lower watershed compared to the upper)
- Some BMPs appear to provide more nutrient reduction
- Source tracing can be used to identify hot spots for targeting BMP placement

Location

Thames River Watershed, Sydenham River Watershed, and Lake St. Clair

Partners

- University of Guelph
- University of Windsor

Funders

ECCC

Transferability

Lessons learned and watershed modelling calibration and BMP applications should be relevant to the future modelling of Lake Ontario watersheds.

Contact Information

- Luis Leon,
  ECCC,
  Burlington, ON
  905-336-4620,
  Luis.Leon@canada.ca

Next Steps

- Complete BMP and climate change scenario watershed modelling.
- Prove scenario loadings to lake model for evaluation of impacts in the lake and loading to Lake Erie western basin

1.3 Environment and Climate Change Canada

1.3.5 Metagenomics profiling and microbial source tracking to characterize microbial communities and identify sources of microorganisms and nutrients in the Thames River to Lake St. Clair to Lake Erie corridor

Location

Sampling sites in the Lower North and South Thames Rivers, Fanshawe Reservoir, Nissouri Creek, and the Lower Thames River watershed. Sampling sites in the Lake St Clair nearshore between the Thames River mouth and Detroit River. Sampling sites as part of Lake Erie long term water quality monitoring sites.

Partners

- AAFC
- ECCC
- National Research Council of Canada
- MOECC

Funders

ECCC and funding from the federal government's EcoBiomics Project under the Genomics Research and Development Initiative.

Transferability

Opportunities for knowledge transfer.

Contact Information

- Dr. Tom Edge (Water Science & Technology Directorate), ECCC
  Burlington, Ontario
  (905) 319-6932
  thomas.edge@canada.ca

Project Goals

Investigate applications of metagenomics, microbial and chemical source tracking techniques for characterizing cyanobacteria, algal and other microbial communities being seeded into Lake St Clair and Lake Erie, and for identifying sources of microorganisms and nutrients in the study area.

Project Description

This is a genomics research project being conducted (2016-2019) as part of the interdepartmental EcoBiomics Project under the federal government's Genomics Research & Development Initiative. It is being conducted in collaboration with water quality monitoring programs in Environment and Climate Change Canada and the Ontario Ministry of Environment and Climate Change. We have initiated a biweekly water sampling program in the Thames watershed, linked to some additional water sampling in the Lake St. Clair nearshore and Limnos research cruises in Lake Erie. We are adding analyses of molecular, chemical, and genomics parameters to more comprehensively characterize water samples being collected for nutrients and other standard water quality parameters. This includes metabarcoding of DNA sequences to characterize bacteria, algae, and fungi communities, PCR assays to detect human and cattle fecal pollution, and some wastewater chemical analyses to detect human fecal wastes. This genomics and microbial source tracking data is being collected by Environment and Climate Change Canada (CCIW-Burlington) and is being analyzed along with phosphorus, nitrogen and other water chemistry parameters.

Results Summary / Expected Outcomes

Data collection and analyses ongoing. Expected outcomes to include better understanding of microbial community dynamics in the study area, and information on sources of microorganisms and nutrients for water quality monitoring programs.

Next Steps

Continue with regular water sampling program in 2018.

Lessons Learned

Not yet fully formed; still in learning stages.

For More Information

Federal government Genomics R&D Initiative webpage.

1.4 Essex Region Conservation Authority

1.4.1 In-depth understanding of phosphorus losses under true no-till and current typical tillage practices

Project Goals

To determine the real-time trend and the seasonality of soil P loss under true no-tillage and current typical tillage systems; To determine the surface and sub-surface pathway distribution of various P forms; To establish relationships between soil P loss and soil test P determined using the technology most recently developed; To validate and show-case the new soil environmental soil P testing method that was recently developed by our AAFC research teams with financial support from OMAFRA and MOE Joint Research Program on Nutrient Management.

Project Description

We have established a field site equipped with a world-class auto-sampling system for water discharge monitoring and sample collection on the ERCA demonstration farm. For the past several years the site has been under a true no-till practice. We have collected and established a full package of data bases on soil, plant, water flow and nutrient (P, N) loss. The site offers an excellent opportunity for us to characterize seasonal surface and sub-surface pathway distribution of various P forms under true no-till, and then the impact that soil disturbance (current typical tillage) would have on these losses.

Results Summary / Expected Outcomes

Please contact the ERCA for more information.

Next Steps

Continue with yearly crop rotation.

For More Information

Essex County Demonstration Farm Annual Report 2017

Location

Holiday Beach Conservation Area, Amherstburg; Big Creek watershed.

Partners

- AAFC
- ERCA

Funders

- AAFC
- ERCA
- MOECC
- OMAFRA

Contact Information

- Michael Dick (Agricultural Technician),
  ERCA
  mdick@erca.org

1.4 Essex Region Conservation Authority
1.4.2 Kingsville Leamington Nutrient Project

Location

Several watersheds in the Kingsville and Leamington area. Area watersheds drain directly to either the western or central basin of Lake Erie.

Partners

- MOECC West Central Region, Operations Division
- Ryerson University
- University of Windsor

Funders

COA

Contact Information

- Katie Stammler (Water Quality Scientist), ERCA
  kstammler@erca.org

Project Goals

The goal of this project is to monitor nutrients and metals in greenhouse and non-greenhouse influenced streams in the Kingsville and Leamington area. Water chemistry of the selected watercourses has been assessed since 2012 and has provided a strong foundation for a long-term analysis of the water quality in these watercourses to track whether new actions taken by the greenhouse sector successfully reduce stream nutrient concentrations. Data are also being collected to be able to calculate nutrient loads from some streams. This is necessary work to understand the contribution of the 'Leamington tributaries' to the western basin of Lake Erie.

Project Description

When the study began in 2012, there were 14 sampling locations. Of these, nine were greenhouse influenced and five were not. In 2016, three additional sites were added and one was removed. Grab samples are taken biweekly and lab analysis is conducted by the MOECC lab at Resources Road. Instantaneous flow is also measured and level loggers have been added to all sites with substantial flow. Three stations now have ISCO automated samplers for event based sampling.

Results Summary / Expected Outcomes

Please contact the Essex Region Conservation Authority for more information.

Next Steps

Sampling will continue at these sites for several years to track changes in nutrient concentrations and to be able to adequately calculate and track nutrient loads.

1.4 Essex Region Conservation Authority
1.4.3 Wigle Creek GLASI Priority Subwatershed Project

Project Goals

Wigle Creek is one of six watersheds in the GLASI Priority Subwatershed Project network. This purpose of this project was to evaluate the effectiveness of reducing phosphorus in agricultural streams using a targeted stewardship approach. The ultimate goal is to determine the cost of phosphorus reduction.

Project Description

This project began in the Fall of 2015 and continues at least to March 2018. Wigle Creek was selected because it is physically representative of watersheds throughout the Essex Region – clay soils, flat topography, predominantly agricultural land use, and high stream phosphorus concentrations. The farmers in the watershed were also already receptive to participating in this study. A comprehensive suite of BMPs was offered to the farmers in this watershed with a high level of cost-share to incentivize participation. Water quality is monitored at several stations. Routine samples are taken every two weeks and event based samples are also taken. Land management and water quality data is being used by researchers at the University of Guelph to model the potential impacts of the BMPs implemented. A consultant is also collecting information to evaluate the true cost of phosphorus reduction, both monetary and in-kind. The Wigle Creek project is running simultaneously with five other subwatershed projects.

Results Summary / Expected Outcomes

Please contact the ERCA for more information.

Next Steps

The Wigle Creek watershed is being modelled to determine impact of BMPs on water quality, as well as to assess future impacts of expanded work. We continue to monitor water quality, flow and land use practices.

Lessons Learned

Determining phosphorus reduction as a result of BMP implementation is a complex task that requires several years of data to account for seasonal and annual variability. Farmers responded better to one-on-one or small group meetings held in their watershed. Having access to our Agricultural Technician, who is a CCA, as well as the partnership with a local agricultural co-op proved invaluable in helping to develop strong relationships and trust.

Location

Wigle Creek, Kingsville.

Partners

- ABCA
- Agris Co-op
- LTVCA
- MVCA
- OMAFRA
- OSCIA
- University of Guelph
- UTRCA
- Wigle Creek landowners and farmers

Funders

AAFC and OMAFRA through Growing Forward 2.

Transferability

The Priority Subwatersheds were selected to be representative of different areas throughout southwestern Ontario. Each PSP reported successes and challenges with different BMPs, leading to a better understanding that BMP solutions must be tailored to each region. The results of these projects are expected to be applicable in other, similar watersheds

Contact Information

- Katie Stammler (Water Quality Scientist),
  ERCA
  kstammler@erca.org

1.5 Great Lakes Commission
1.5.1 ErieStat

Location
Western and Central Lake Erie Basin.

Partners
- AAFC
- ECCC
- EPA
- ERCA
- Great Lakes Observing System
- Indiana Department of Environmental Management
- Indiana State Department of Agriculture
- Michigan Department of Agriculture & Rural Development
- Michigan Department of Environmental Quality
- Michigan State University, Institute of Water Research
- National Center for Water Quality Research, Heidelberg University
- NOAA, Great Lakes Environmental Research Lab
- Ohio Department of Agriculture
- Ohio EPA
- Ohio Lake Erie Commission
- Ohio Sea Grant College Program, F.T. Stone Lab
- OMAFRA
- MOECC
- USDA, NRCS
- USGS
- University of Michigan Water Center

Funders
Fred A. and Barbara M. Erb Family Foundation and Joyce Foundation.

Contact Information
- Nicole Zacharda (Program Manager),
  Great Lakes Commission
  734-396-6084

Project Goals
ErieStat's goal is to aggregate information from the five states, two countries, and one province into a cohesive platform, sharing information on phosphorus control efforts aligning with commitments under the Great Lakes Water Quality Agreement.

Project Description
ErieStat is an online platform that will track trends in total and dissolved phosphorus entering Lake Erie's western and central basins. It also shares information on each jurisdiction's strategies and investments intended to achieve the shared goal of phosphorus reduction in the Lake Erie basin.

Results Summary / Expected Outcomes
The federal, state, and provincial partners have been active in helping develop the website. It is anticipated that the site will be used by government and the interested public to track progress on phosphorus reduction in Lake Erie once it is released on www.eriestat.org in phases early in 2018.

Transferability
ErieStat partners include municipal, state, provincial, and federal entities, and we expect the use and applicability of the site to be equally broad. Contents on the site can be filtered to include specific jurisdictions, geographies, or activities, so that users can tailor the site to their needs or interests.

Next Steps
- The site will publicly launch in March 2018 with initial content. From March to June, content will continue to be built, with increased detail and results added as information becomes available.
- ErieStat will work to engage broader stakeholders – including industry and environmental nongovernmental organizations – to better inform future development of the site.

Lessons Learned
Aggregating information across jurisdictions is challenging, so communication between parties is critical. Multiple iterations may be necessary to build consensus across a wide partner base, especially when those partnerships cross an international boundary.

For More Information
www.eriestat.org

Blue Accounting
ErieStat
Tracking Progress Toward a Healthier Lake Erie

1.6 Lower Thames Valley Conservation Authority

1.6.1 Agricultural Subsurface Phosphorus Treatment Tank Project

Project Goals

- To create and verify the efficacy of a subsurface edge of a field phosphorus treatment tank at reducing nutrient loads from agricultural tile drainage systems.
- Analyze the effectiveness of phosphorus binding products at reducing phosphorus loads in agricultural drainage system.
- Determine if this concept is a cost-effective solution to address agriculturally sourced phosphorus loading on soils with high soil P test values

Project Description

The LTVCA will be working alongside project partners to monitor the phosphorus treatment tank application to determine if it is an effective practice that can be implemented to reduce phosphorus loads from subsurface tile drainage systems on fields with high soil P test values. A tile main was installed at the edge of a field to direct subsurface tile flow for a 25 acre catchment area to the phosphorus treatment. Once the water enters the tank from the systematic field drainage system, it will flow through the Filtrexx NutriLoxx P sorption text material before exiting the tank and discharging into the adjacent municipal drain. The LTVCA and OMAFRA will be installing ISCO auto-samplers and transducers to calculate nutrient loads at the inlet and outlet of the tank to determine how effective the applications is at reducing subsurface nutrient loads from agricultural operations.

Results Summary / Expected Outcomes

The tank was installed by Gillier Drainage during November of 2017.

Next Steps

- Install Filtrexx NutriLoxx P sorption text material
- Install monitoring instrumentation and equipment
- Begin monitoring during flow events.

Installation of the Phosphorus Treatment Tank in November of 2017 photo credit: LTVCA)

Location

LTVCA Watershed (Chatham-Kent)

Partners

- BabCock Supply
- Filtrexx Canada
- Gillier Drainage
- Louis Roesch (OFA)
- OMAFRA
- TRPRC

Funders

- OMAFRA
- OFA
- TRPRC
- Gillier Drainage
- LICO
- ADS Canada
- Filtrexx Canada

Transferability

If the application proves to be effective, it could be a new method that could be used to reduce agricultural nutrient loads across the Great Lakes Basin.

Contact Information

- Kevin McKague,
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- Colin Little,
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  Colin.Little@ltvca.ca
- Austin Pratt,
  LTVCA,
  Austin.Pratt@ltvca.ca

1.6 Lower Thames Valley Conservation Authority
1.6.2 Baseline agricultural nutrient loading data collection

Location
LTVCA Watershed (Rondeau Bay and Dover Township)

Partners
- OFA
- OMAFRA
- SCRCA
- TRPRC

Funders
- OFA
- OMAFRA
- TRPRC

Transferability
The data collected from the two unique sites/operations will assist producers and researchers with identifying the systems contribution to nutrient loading within the Lake Erie basin. Furthermore, BMPs may be implemented and evaluated at the sites in the future, which could provide valuable information to the agricultural sector when addressing water quality challenges.

Contact Information

- Kevin McKague,
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- Colin Little,
  LTVCA,
  Colin.Little@ltvca.ca
- Austin Pratt,
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Project Goals
- Construct water quality and quantity monitoring stations to collect baseline nutrient loading data from agricultural land, prior to testing BMPs, on fields where unique soil, hydrology, and cropping practices are present.
- In future years, implement BMPs at the fields with the producers to verify their effectiveness at reducing nutrient loads if necessary.

Project Description
There are two edge of field agricultural monitoring sites where the LTVCA will take this monitoring approach to evaluate BMP effectiveness with project partners. The purpose of the monitoring site in the Rondeau Bay subwatershed is to collect baseline data for nutrient loads from a field pump that drains land that is conventionally farmed. This second site in Dover Township, which drains directly into Lake St. Clair, will be monitored to collect baseline water quality and quantity data from a field's subsurface tile system. The field consists of alluvial soils that have high soil P test values. This second site is located in a unique area of the Lower Thames watershed, where many high value crops are grown, which leads to a variety of different cropping practice. In future years, BMPs may be implemented and analyzed to verify their effectiveness at reducing nutrient loads.

Results Summary / Expected Outcomes
- Monitoring equipment has been installed and is operational at the Rondeau Bay site.
- Subsurface tile drainage flume has been installed at the Dover Township site. Monitoring equipment and instrumentation will be installed during the spring of 2018.

Next Steps
- Install monitoring equipment at the Dover Township site.
- Begin and continue to monitor the sites during flow events

1.6 Lower Thames Valley Conservation Authority
1.6.3 Gap analysis and pump station monitoring

Project Goals

- To increase the LTVCA water quality monitoring on tributaries, creeks, streams and the Rivard Pump Station
- Calculate nutrient loadings on Thames River, Lake St. Clair and Lake Erie tributaries
- Gain a better understanding of the nutrients leaving the landscape and entering watercourses across the watershed

Project Description

There are significant gaps in the water quality monitoring program for the Lower Thames River watershed that make it difficult to determine nutrient loadings. Given recent government targets to reduce phosphorus loadings in Lake Erie, a more robust water quality monitoring program is needed to address these gaps. A gap analysis was conducted on the monitoring in the watershed which included recommendations. This project will implement the recommendations from the gap analysis.

1. The project will increase sampling frequency of the Provincial Water Quality Monitoring Network (PWQMN) sites and new sites in the winter with additional samples targeting high flow events year round.
2. The continuous sampling program (including continuous flow data collection) will be completed in the key areas (McGregor Creek and Rivard Pump Station) where equipment purchased in 2016-17 was successfully installed and is being maintained.

The sampling data will continue to be reviewed and ongoing research conducted to determine information to understand the impacts of the backwater effect from Lake St. Clair into the Thames River and the resulting impacts on nutrient loadings.

Results Summary / Expected Outcomes

- Increased monitoring/sampling across the watershed to 22 sites, up from eight
- Year round sampling – as most of the nutrients leaving the landscapes are in the winter/spring and fall season
- Gain a better understanding of areas with high nutrient input that will need to be targeted to implement BMPs
- ISCO autosampler installed at Water Survey of Canadas Gauge house on McGregor Creek
- ISCO autosampler installed at Rivard Pump Station, draining approx. 22,000 acres into Lake St. Clair.

Next Steps

Create rating curves for each creek/stream and eventually calculate nutrient loadings.

Location

LTVCA Watershed

Partners

- EC
- MOECC

Funders

MOECC

Transferability

Results from the water quality/quantity monitoring can be used to identify priority subwatersheds that need to be targeted for increased BMP implementation and education/outreach initiatives

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Water Samples taken at Big Munday Creek in March of 2017 (photo credit: LTVCA)

1.6 Lower Thames Valley Conservation Authority

1.6.4 GLASI Priority Subwatershed Project: Jeannettes Creek Phosphorus Reduction and Monitoring Program

Location

LTVCA Watershed (Jeanettes Subwatershed – Chatham-Kent)

Partners

- OMAFRA
- AAFC
- OSCIA
- Agricultural Producers
- Regional Agricultural Retailers/CCAs
- University of Guelph
- Municipality of Chatham-Kent

Funders

- OMAFRA
- AAFC
- OSCIA

Transferability

Results from the project can be used across the Great Lakes region to identify what BMPs are effective at reducing agriculturally sourced nutrient loads.

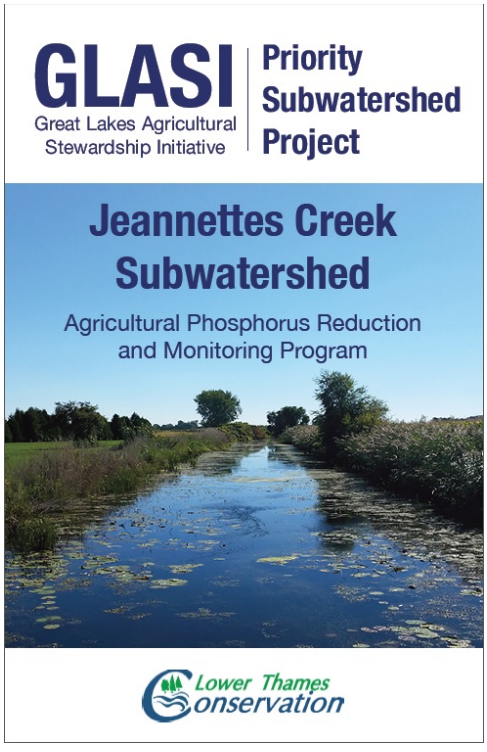
Contact Information

- Colin Little, LTVCA, Colin.Little@ltvca.ca
- Austin Pratt, LTVCA, Austin.Pratt@ltvca.ca

Project Goals

- Improve soil health, pollinator health, and water quality within the Great Lakes Basin, with a specific focus on the Jeannettes Creek PSP study area.
- Provide regional producers with financial and technical support to increase the implementation of agricultural Best Management Practices (BMPs) within the Jeannettes Creek study area.
- Evaluate the effectiveness of a targeted stewardship approach at achieving measurable improvements to soil health and water quality within the 20km2 Jeannettes Creek study area.
- Gain a better understanding of how costal engineered dyke/pump drainage systems may be affecting nutrient loading within Thames River Basin

Project Description



The GLASI Jeannettes Creek PSP program was designed to provide funding and technical support to agricultural producers within the Jeannettes Creek Subwatershed to implement a "suite" of Best Management Practices (BMPs) that may reduce phosphorus loading in Lake Erie. The LTVCA, has created a network of monitor stations and instrumentation within the 20km2 subwatershed to determine the effectiveness of the implemented BMPs at reducing agriculturally sourced nutrient loads. The collected data from the network will be used to create a model for the subwatershed. The modeling exercise is being completed by the University of Guelph. Furthermore, a Cost Benefit Analysis (CBA) will be performed to determine what the cost is to reduce phosphorus loss from the agricultural landscape (in $/kg of reduction) when using a targeted stewardship approach. The project began in 2015 and is ongoing at this time.

Results Summary / Expected Outcomes

- Since 2016, the LTVCA has installed and continuously collected water quality and quantity data from eight ISCO auto-sampling stations.
- The LTVCA has collected extensive agricultural land use/activity data with the participating producers in the Jeannettes Creek study area.
- The LTVCA and University of Guelph are currently in the process of creating a model with all of the collected data from the subwatershed to evaluate the effectiveness of the implemented BMPs.

Jeannettes Creek Boudreau Pump Station operating during a melt event in March of 2016 (photo credit: LTVCA)

Next Steps

The next steps for the project are to complete the preliminary subwatershed model, complete the CBA, and secure long term funding to continue the program.

1.6 Lower Thames Valley Conservation Authority
1.6.5 Rondeau Bay Wetland Monitoring Project

Location
Chatham-Kent in the Rondeau Bay watershed.

Partners
- OMAFRA
- MNRF
- LTVCA

Funders
- OMAFRA
- MNRF
- LTVCA

Transferability
Sub-watershed must be large enough to facilitate enough consistent wetland scenarios for best results. Enough willing landowner participants need to be recruited.

Contact Information

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- Austin Pratt,
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Project Goals
To assess the efficacy of nutrient capture and retention from agricultural runoff.

Project Description
Within the sub-watershed known as the Rondeau Bay a series of nine wetlands ranging in age from 1 year to 10 years are being monitored on inlet and outlet for various parameters including flow rate, nutrient analysis, dissolved oxygen, turbidity, ph, and temperature. Additionally, sediment analysis will be examined. Data is being stored within the LTVCA data banks. We are still in preliminary stages of this project however; we do know that flow is slowed considerably by wetland cells. During growing seasons even in large rain events, little to no flow is exiting the wetlands indicating high nutrient retention.

Results Summary / Expected Outcomes
- A proven case that illustrates a better use for marginal agricultural lands to provide ecological goods and services.
- Reduce algal blooms and overall nutrient contributions from agriculture.
- Retain a better standard of source water in our Great Lakes and communities

Next Steps
Complete installation of weirs for more accurate flow rate calculations and nutrient loading data. Continue monitoring all parameters to gain base data and develop trends.

Lessons Learned
Each wetland has unique drainage and each farm has unique practices so monitoring sites must be chosen carefully to acquire unbiased results.

Newly constructed wetland being monitored for phosphorus capture & retention (photo credit: LTVCA)

1.6 Lower Thames Valley Conservation Authority

1.6.6 Verifying the efficacy of cover crops and no-till BMPs at reducing agriculturally sourced phosphorus loads

Project Goals

- Evaluate the effectiveness of a no-till cover crop system at reducing agriculturally sourced phosphorus loads on brookston clay soils in the Jeannettes Creek subwatershed.
- Monitor water quality and quantity from subsurface tile runoff during flow events from two agricultural fields to determine the implications each farming system has on phosphorus loads.
- Preform a comparative analysis between the data collected from the conventionally managed field to the field that is managed under a no-till and cover crop system

Project Description

In partnership with two agricultural producers, Dr. Merrin McRae, Dr. Ivan O'Halloran, and OMAFRA, the LTVCA is conducting a study at two agricultural fields in the Jeannettes Creek subwatershed to evaluate the effectiveness of a no-till cover crop farming system at reducing phosphorus loads on brookston clay soils. The LTVCA has constructed and is monitoring two ten acre subsurface tile drainage plots at two fields to collect water quality and quantity data. The two fields operate under different farming systems. One field is managed using a no-till cover crop system. The other field, which is located within 1km of the cover crop field, is managed using conventional tillage practices. The collected water quantity and quality data will be used to calculate phosphorus loads for each field. Water samples are taken at the monitoring stations during flow events using ISCO auto-samplers. The water samples are being analyzed for TP, SRP, TSS, and NO3 by the University of Guelph. The comparative analysis of the farming systems will be conducted by the University of Waterloo to determine the efficacy of the practices at reducing phosphorus loads.

No-Till Cover Crop Research Site during January 2018 snowmelt, (photo credit: LTVCA)

Results Summary / Expected Outcomes

- Since 2017, the LTVCA has been continuously monitoring 2 subsurface tile drainage plots at each field to collect flow and water quality data.
- The University of Waterloo will use the collected data to perform a comparative analysis of the two farming systems, to determine the efficacy of a no-till cover crop system at reducing phosphorus loads.

Location

LTVCA Watershed (Jeanettes Subwatershed – Chatham-Kent)

Partners

- AAFC
- Bill Stevenson
- Blake Vince
- OMAFRA
- OSCIA
- University of Guelph (Dr. Ivan O'Halloran)
- University of Waterloo (Dr. Merrin McRae)

Funders

- OMAFRA
- AAFC
- OSCIA

Transferability

The results from the study can be used to determine what agricultural systems and management practices are effective at reducing phosphorus loads from brookston clay soils.

Contact Information

- Colin Little, LTVCA, Colin.Little@ltvca.ca
- Austin Pratt, LTVCA, Austin.Pratt@ltvca.ca

Next Steps

- The LTVCA will continue to maintain and monitor the 2 research sites.
- The University of Guelph will continue to analyze the results.
- The University of Waterloo will release report on the comparative analysis by 2019 to disseminate the preliminary results.

1.7 Ministry of the Environment and Climate Change

1.7.1 Designing an urban stream monitoring network to estimate phosphorus loads from non-point sources

Location

Urban areas in the Lake Erie and Lake Ontario Basin, urban areas in the Thames River watersheds are included in the study.

Partners

- Conservation Authorities
- Municipalities within study watersheds
- Provincial ministries

Funders

MOECC

Transferability

Findings will be applicable to other urban areas in the Great Lakes basin

Contact Information

- Pradeep Goel, MOECC
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- Jenny Winter, MOECC Jennifer.winter@ontario.ca

Project Goals

Development of provincial routine surface water monitoring program focused on urban areas.

Project Description

The MOECC has recently begun to explore options for the development of a routine surface water monitoring program focused on urban areas. The first phase of the work was to assess the relative magnitude of non-point phosphorus loads from urban areas and to identify priority watersheds for monitoring using a ranking system. The second phases focused on assessment of existing monitoring programs, and prepare initial estimates of the resources required to establish the monitoring program. The second phase been completed.

Results Summary / Expected Outcomes

The program is being developed to improve our understanding of phosphorus loading to streams from urban non-point sources, and to assess the impact of stormwater management practices on water management and phosphorus loads. A number of potential sub-watersheds to establish an urban monitoring program have already been identified.

Next Steps

Initial work related to prioritization of watersheds and identification of potential sub-watersheds have already been completed. The plan is being formulated to further identify specific objectives, establish collaboration, and to explore options to begin to implement the program.

Lessons Learned

Limited information is available related to non-point phosphorus management and effectiveness of stormwater management in urban areas.

1.7 Ministry of the Environment and Climate Change
1.7.2 Great Lakes Nearshore Monitoring and Assessment Program

Project Goals

- To identify temporal trends in sediment and water quality in the nearshore Great Lakes and to use these findings to support Ministry and inter-agency efforts to identify lake-wide or regional changes in environmental conditions.
- To establish sites in each of the Great lakes removed from major point-source influences such that the data collected at the sites may be used as points of comparison when assessing environmental conditions at physically similar sites.
- Deploy high resolution real-time monitoring sensors to track water quality changes to allow for a faster identification of problems, a better understanding of in-lake conditions leading to algal blooms, to help in developing predictions as to when blooms will occur, and to guide actions that need to be taken to prevent them.

Project Description

- Each station is monitored for concentrations of chemicals in water, surficial sediment and in suspended particulate material; the composition of benthic invertebrates living in bottom sediments; and physical measurements including thermal and optical profiles of the water column and physical characterization of the lake bottom.
- Reference stations are locations in areas where background conditions for a lake sub-area prevail and index stations are locations in areas where there is a natural integration of the stressors from a larger area (delta zones of rivers, depositional zones of embayments, and areas where prevailing water circulation patterns focus stressors).
- Approximately 10-20 stations are surveyed annually. Sampling occurs every three years in Lake Ontario and Lake Erie and every six years in Lake Superior and Lake Huron.
- The sampling protocols employ standard MOECC methodology, thereby permitting comparisons with historical and ongoing data collections elsewhere in the Ministry and by ECCC

Results Summary / Expected Outcomes

This longterm monitoring program first started in 1988 resulting in 30 years of chemical, biological and physical data for Ontario's nearshore area of the Great Lakes

Location

Index and Reference Stations are located in the nearshore of all the Great Lakes.

Funders

MOECC

Transferability

MOECC nearshore monitoring and assessment program uses standard methods and protocols to monitor the nearshore of Lake Superior, Lake Huron, Lake Erie and Lake Ontario and their connecting channels.

Contact Information

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- Mary Thorburn
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Lake Erie water samples (photo credit: MOECC)

Next Steps

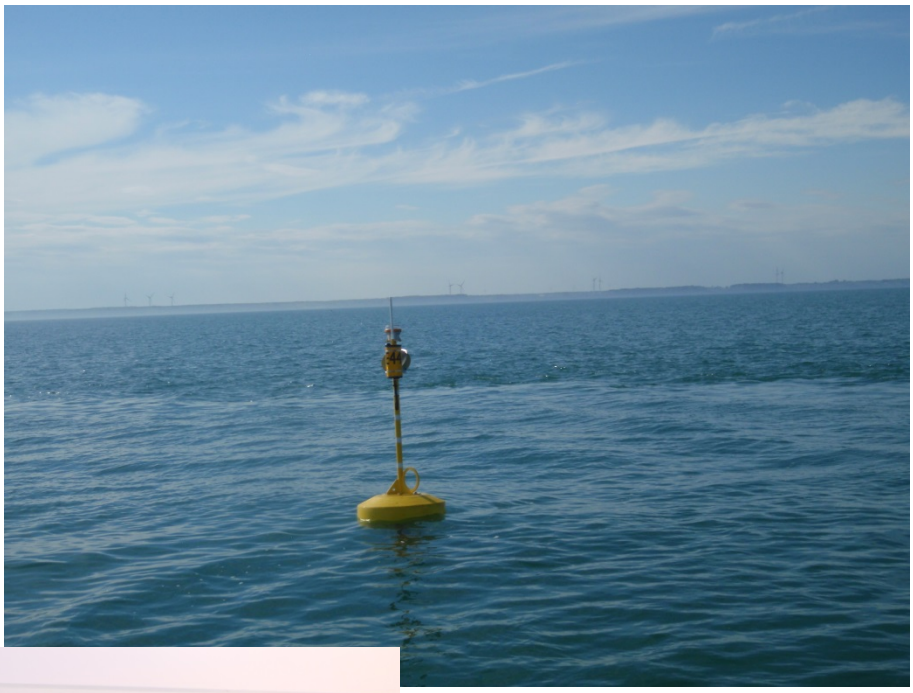
Continue to implement MOECC Great Lakes Nearshore Monitoring and Assessment Program.

Lessons Learned

This long-term nearshore monitoring program has used to identifying spatial and temporal trends, and it provides the larger context/comparison for local issues and concerns. Data and information from the program has been used to guide policy and programs to protect our Great Lakes.

For More Information

- Information on Benthic invertebrate (such as: snails, worms and mussels) data are collected as an indicator of nutrient and organic enrichment and more generally as biological indicator of environmental quality
- Sediment Chemistry data
- Water Chemistry data
- Real-time water quality data can be found for Lake Erie islands and for Port Glasgow



(photo credit: MOECC)

Lake Erie (photo credit: MOECC)

1.7 Ministry of the Environment and Climate Change
1.7.3 Lake St. Clair/Thames River Water Quality and HAB Assessment

Project Goals

Objectives of the Lake St. Clair/Thames River Water Quality and HABs Assessment project include:

- Assessment of the range of water quality conditions in Lake St. Clair Canadian nearshore with emphasis on the Thames River area
- Assessment of the extent, occurrence and frequency of potential harmful algal blooms (HABs) in Lake St. Clair and the Thames River
- Determine the potential drivers and causal linkages underlying water quality patterns and potential cyanobacterial blooms in Lake St. Clair
- Determine the linkages between discharges from the Thames River on the water quality conditions of Lake St. Clair and its relative contribution to Detroit River and Lake Erie west basin

Project Description

- To capture the key limnological features, multiple sampling platforms were used concurrently to track water quality conditions:
  - Spatially from Chenal Ecarte to Detroit River, Thames River mouth to Chatham and continuous mapping of water quality conditions using geo-referenced real-time sensors
  - Temporally: real-time sensors deployed across Lake St. Clair and the mouth of the Thames River to capture temporal water quality trends over the ice-free season
  - Across habitat types: water quality sampling across Lake St. Clair at tributary, inshore (1 – 3 m) and nearshore (> 3 m) locations
- Using predictive tools: 3D hydrodynamic model to inform survey design and future modelling of Lake St. Clair system
- In 2016, field-based monitoring of 96 water quality stations was conducted over three field surveys.
- In 2017, field-based monitoring of 191 water quality stations was conducted over two-week field campaigns, monthly from May to October.
- Water quality parameters include: total phosphorus, total nitrogen, soluble reactive phosphorus, ammonia/nitrite/nitrate, conductivity, alkalinity, chloride, chlorophyll, phycocyanin, suspended solids, turbidity, dissolved organic carbon, anions and cations
- This is a four-year project: 2016 - 2019

Lessons Learned

A key observation from the 2017 field campaign is that while we observed a wide-scale harmful algal bloom in western basin Lake Erie in late September, there was no corresponding bloom along the Canadian shores of Lake St. Clair. The absence of a wide-scale algal bloom in both 2016 and 2017 in Lake St. Clair highlight the need to better understand both the underlying water quality patterns and their drivers as well as conditions that may be conducive to potential HABs in Lake St. Clair.

Location

Lake St. Clair, lower Thames River and upper Detroit River.

Partners

ECCC

Funders

MOECC

Contact Information

- Ngan K. Diep,
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- Alice Dove,
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Next Steps

We are coordinating and planning the 2018 MOECC/ECCC field campaign in Lake St. Clair and the Thames River. We are continuing our work on an ECCC/MOECC model for Lake St. Clair and will continue to collaborate with our NOAA colleagues to assess the utility and development of remote sensing tools for Lake St. Clair.

1.7 Ministry of the Environment and Climate Change
1.7.4 Multi-Watershed Nutrient Study

Location

11 sentinel watershed locations, including Thames River Watershed sites (Big Creek and Nissouri Creek watersheds).

Partners

- Provincial Partners
  - OMAFRA
  - MNRF
- Academic partners
  - University of Waterloo
  - University of Windsor
  - Ryerson University
- Federal Partners
  - AAFC
  - ECCC
- Conservation Authorities
  - UTRCA
  - LTVCA

Funders

Federal and Provincial funding through Canada-Ontario Agreement/Ontario's Great Lakes Strategy.

Transferability

Results will be applicable to broader watersheds in Southern Ontario.

Contact Information

- Ryan Sorichetti (Senior Surface Water Scientist), MOECC
  Ryan.sorichetti@ontario.ca
- Janis Thomas (Research Scientist), MOECC
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Project Goals

- Examine the relationship between agricultural land-use/management and nutrient loading to streams, and if this relationship has changed over time.
- Examine if seasonal patterns of nutrient loading, and the type of nutrients forms, have changed over time.

Project Description

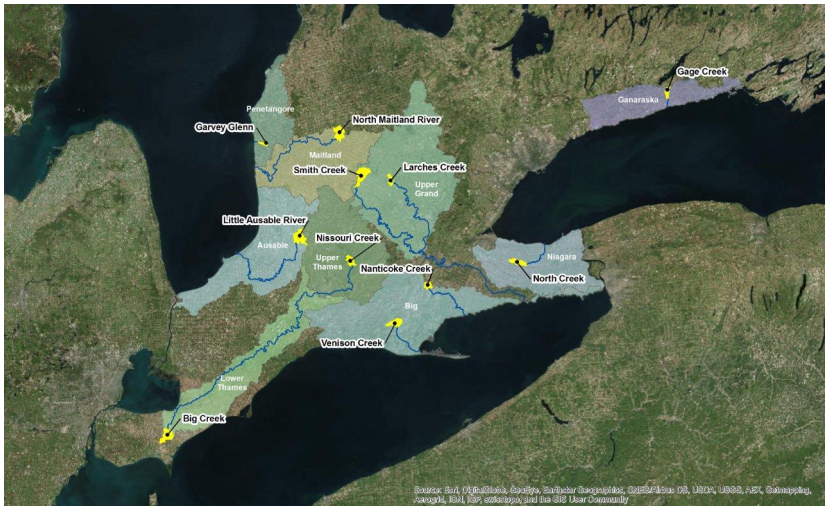
The MWNS is an Ontario Ministry of the Environment and Climate Change (MOECC) led research study initiated in 2014. We are examining how agricultural land management and features of the landscape relate to nutrient losses in agriculturally dominated areas of the Canadian Great Lakes basin. Eleven headwater sentinel watersheds in the basins of Lakes Huron, Erie, and Ontario, have been selected for detailed study, including two in the Thames River Watershed. These watersheds are representative of the range of agricultural areas in Southern Ontario. Study of the MWNS watersheds includes monitoring of stream discharge, water quality, and weather. An associated effort exists to survey the land management in these watersheds and conduct regional-scale modelling is underway to support this work (led by University of Windsor and Ryerson University, Dr. C. Wellen).

Results Summary / Expected Outcomes

Project is currently in data acquisition stage

Next Steps

Project will be collecting data for a minimum of four years.



11 sentinel watershed locations (photo credit: MOECC)

1.7 Ministry of the Environment and Climate Change
1.7.5 Provincial Water Quality Monitoring Network (PWQMN)

Project Goals

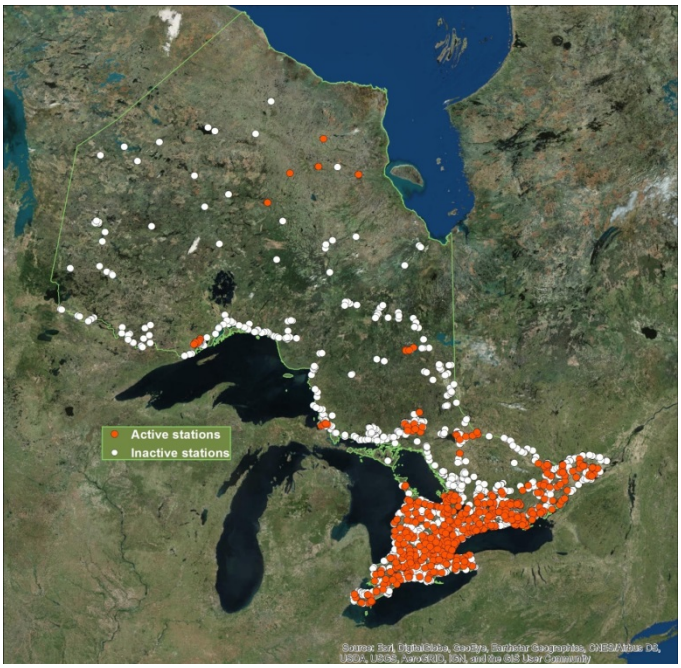
- The PWQMN collects information about water quality from streams and rivers across the province, and has been successfully operating since 1964.
- The PWQMN plays a key role in providing information on how water quality varies across the highly varied geography and land uses in Ontario, as well as how water quality, including nutrients, has changed over time.
- Information from the PWQMN is used to support the development of policies, standards, and decision-making for land-use planning.
- Additionally, the PWQMN provides baseline information for more focused studies of water quality, such as studies on emerging contaminants and nutrient-related issues.

Project Description

Water samples are collected at PWQMN stations approximately monthly from April to November. Some measurements are taken on-site during sample collection, including pH, conductivity, temperature, and turbidity. Water samples are also shipped to the MOECC laboratory in Toronto and analyzed for a range of chemical parameters, including total and dissolved nutrients.

Results Summary / Expected Outcomes

PWQMN is an on-going long-term monitoring network/program. Data are available through the Ontario Open Data Catalogue, and scatter plots of raw data for selected parameters or each station are available through an interactive online environment map. This includes all the active stations in the Thames River Watershed and other tributaries that drain to Lake St. Clair and Lake Erie.



Active stations (red) and inactive stations (white) monitored for stream water quality under the Provincial Water Quality Monitoring Network (photo credit: MOECC)

Location

There are over 400 active PWQMN stations across Ontario (2018).

Partners

PWQMN is Canada's only long-term water quality monitoring program delivered through partnerships.

- Conservation Authorities
- Federal Agencies
- MOECC
- Municipalities
- Provincial Agencies

Transferability

Results are applicable to other watersheds in Ontario.

Contact Information

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Next Steps

The PWQMN will continue monitoring water quality in Ontario watersheds.

Lessons Learned

This long-term monitoring program has been used to identifying spatial and temporal trends, and it also provides the larger context/ comparison information for local issues and concerns. Data and information from the program has been used to guide policy and programs to protect our streams.

For More Information

Online interactive map of sampling sites

1.8 Ministry of the Environment and Climate Change; Environment and Climate Change Canada

1.8.1 Lake St. Clair Canadian Coordination Council Management Plan

Location

Thames River watershed, Sydenham River watershed, Essex Region CA (Pike Ck, Puce River, Belle River, Ruscom River).

Partners

- ECCC
- ERCA
- LTVCA
- OMAFRA
- MOECC
- MNRF
- SCRCA
- UTRCA
- Walpole Island First Nation

Funders

- ECCC
- MOECC

Contact Information

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- Ted Briggs
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Project Goals

- Integrate Canadian tributary watershed programs and Great Lakes basin-wide initiatives.
- Facilitate cooperation and collaboration towards environmental improvements and provide a forum to address issues and share information specifically in the context of Canadian Lake St. Clair watershed.
- Support existing resource allocations, and encourage the allocation of new resources to address issues on local, national, and international scales.

Project Description

The Canadian Watershed Management Plan provides a framework to encourage cooperation and collaboration. It is the link between local tributary watershed programs and Great Lakes basin-wide initiatives. The Plan:

- Identifies management issues, and sets goals to address them; (the land use management section identifies a variety of actions for nutrient reduction),
- Recommends actions to address issues affecting the Canadian portion of the Lake St. Clair ecosystem;
- Provides a common vision, principles and goals for the lake; and
- Includes input from Lake St. Clair partners and the public. The Plan's authors, the Lake St. Clair Canadian Watershed Coordination Council, recognize that communication and partnerships with U.S. counterparts are vital to ensuring that the Lake St. Clair ecosystem is effectively managed.

Results Summary / Expected Outcomes

An accomplishments report summarizing the work completed on the 2011-2016 work plan is currently being drafted for completion in 2018.

Next Steps

Update LSC work plan, continue to collaborate with partners on priority issues and actions impacting Lake St. Clair, next binational conference on Lake St. Clair to be held on US side potentially in 2018

For More Information

Lake St. Clair Canadian Watershed Management Plan

1.9 Ontario Ministry of Agriculture, Food and Rural Affairs

1.9.1 Adapting SoilCalculator for use in Ontario

Project Goals

The objective of this project is to develop protocols that farmers and their advisors can use to better understand how to test for soil health in precision management zones and how to remediate degraded soils.

Project Description

This project will:

1. Determine the optimum way to sample a precision agriculture field for soil health;
2. Remediate an eroded area of a field by restoring the A horizon;
3. Remediate an area of a field with low organic matter using organic amendments.

Results Summary / Expected Outcomes

Project is in preliminary stages.

Location

Ontario

Partners

OSCIA

Funders

OMAFRA BMP Verification and Demonstration Initiative

Contact Information

- Adam Hayes, OMAFRA
- Andrew Graham, OSCIA

1.9 Ontario Ministry of Agriculture, Food and Rural Affairs

1.9.2 Chemical characterization of sediment legacy P in Grand River watershed streams: Implications for phosphorus loading under land management

Location

Grand River Watershed

Partners

University of Guelph

Funders

OMAFRA BMP Verification and Demonstration Initiative

Contact Information

- Christoph Kessel, OMAFRA
- Dr. Paul Voroney, University of Guelph

Project Goals

The objective of this project is to develop a better understanding of legacy phosphorus (P) in the sediment of tributaries adjacent to different land management regimes within a watershed.

Project Description

This project will:

1. Identify environmental conditions that cause tributary sediments to act as sources or sinks of dissolved P to lakes;
2. Develop methods to characterize and map P in tributary sediments throughout the watershed;
3. Predict if stream sediments will be sources of dissolve P under changing environmental conditions.;
4. Determine the likelihood of tributary sediment P buffering capacity to delay response between reductions of external P loadings through effective BMPs, and observed changes in tributary and lake water quality.

Results Summary / Expected Outcomes

This project is in preliminary stages.

1.9 Ontario Ministry of Agriculture, Food and Rural Affairs

1.9.3 Digestate and Lystek application management to maximize 4-R strategies

Project Goals

The objective of this project is to determine if using 4R nutrient stewardship practices will impact the use efficiency and fate of nitrogen (N) and phosphorus (P) from applied municipal organic amendments and to determine how soil organic matter and soil health changes when using municipal organic amendments combined with cover crops.

Project Description

This project will:

1. Understand the potential for digestate and processed biosolids to provide soil health, environmental and economic benefits;
2. Understand how digestate and biosolids can be used economically and environmentally during, pre and post cropping season;
3. Verify that N-inhibitors improve N use efficiency of organic amendments in field crops;
4. Understand and verify the combined benefits of using digestate and processed biosolids combined with cover crops on increased soil health; and
5. Demonstrate the benefits of using organic amendments, their best management practices(BMPs) and technologies to increase adoption during the growing season.

Results Summary / Expected Outcomes

This project is in preliminary stages.

Location

Wellington County

Partners

OSCIA

Funders

OMAFRA BMP Verification and Demonstration Initiative

Contact Information

- Andrew Graham, OSCIA
- Christine Brown, OMAFRA

1.9 Ontario Ministry of Agriculture, Food and Rural Affairs

1.9.4 Evaluation of phosphorus release rate from anaerobic digestate for crop land application in Ontario

Location

Laboratory and Greenhouse study with digestate from anerobic digestors in the Lake Erie Basin and southeast shores of Lake Huron.

Partners

University of Guelph

Funders

OMAFRA BMP Verification and Demonstration Initiative

Contact Information

- Deanna Nemeth, OMAFRA
- Dr. Paul Voroney, University of Guelph

Project Goals

The objective of this project is to determine the availability of phosphorus (P) in anaerobic digestate (AD) to agricultural crops so that AD can be managed as a nutrient source for economic and environmental benefit.

Project Description

This project will:

1. Characterize AD so land application options based on P can be developed for agriculture producers and their advisors to meet regulatory and cropping system requirements;
2. Verify and demonstrate BMPs for the application of AD on Ontario's agriculture land;
3. Develop guidelines for the land application of AD as a source of plant available P to minimize potential environmental impact from its use to protect tile, surface and ground water quality; and
4. Communicate information to producers and users of AD, biogas planning and crop consultants, and the scientific community working in this area.

Results Summary / Expected Outcomes

This project is in preliminary stages.

1.9 Ontario Ministry of Agriculture, Food and Rural Affairs

1.9.5 Farmland phosphorus beneficial management practices on clay soils

Project Goals

The objective of this project is to better understand the proportion of nutrients moving with water over the soil surface or/and through the soil exiting tile drains as well as the impact of cover crops on that movement to aid in the development of best management practices and reduce the risk of nutrient contaminated water.

Project Description

This project will:

1. Evaluate cover crop's ability to: reduce agricultural soil losses within hydrological soil conditions and climates across Southern Ontario; reduce phosphorus (P) export (Soluble Reactive P and Total P) in tile drains and surface runoff; and reduce soil and P losses during growing and non-growing season runoff periods;
2. Compare conservation cropping practices with conventional cropping practices to determine their effects on tile and surface P losses; and
3. Quantify tile drainage water quality associated with placement, rate and timing of P application in a corn-soybean-small grain rotation.

Results Summary / Expected Outcomes

This project is in preliminary stages.

Location

Kent County, Chatham, St. Mary's, Ridgetown, Alfred.

Partners

LTVCA

Funders

OMAFRA BMP Verification and Demonstration Initiative

Contact Information

- Jake Munroe, OMAFRA
- Colin Little, LTVCA

1.9 Ontario Ministry of Agriculture, Food and Rural Affairs

1.9.6 Great Lakes Agricultural Stewardship Initiative Priority Subwatershed Project

Location

Lake Erie, Lake St. Clair and the southeast shores of Lake Huron

Partners

- ABCA
- ERCA
- LTVCA
- OSCIA
- UTRCA

Funders

AAFC and OMAFRA through Growing Forward 2

Contact Information

- OSCIA, glasi@ontariosoilcrop.org
- OMAFRA, ag.info.omafra@ontario.ca 1-877-424-1300

Project Goals

The GLASI Priority Subwatershed Project will evaluate the effectiveness of a focused stewardship approach, delivered within a defined priority subwatershed area, at achieving measurable improvements in soil health and water quality. By implementing several highly targeted BMPs in a defined subwatershed, reductions in edge-of-field losses of soil and nutrients, with a particular emphasis on phosphorus, may be measured. These cumulative reductions may contribute to overall improvements in water quality.

Project Description

Through GLASI's Priority Subwatershed Project (PSP), governments are partnering with the Ontario Soil and Crop Improvement Association and four conservation authorities — Ausable Bayfield, Essex Region, Lower Thames Valley and Upper Thames River — to pilot and evaluate the effectiveness of targeted stewardship approaches. This includes installing monitoring equipment to collect edge-of-field and water quality monitoring data in defined subwatersheds and collecting site-specific data on best management practices adoption, land management data and economic information.

Results Summary / Expected Outcomes

The PSP is collecting this valuable information about soil health and water quality improvement to inform modelling approaches. This information will be used to evaluate measurable changes and examine the costs to reduce phosphorus loss from the agricultural landscape using a targeted stewardship approach. In 2018, results of the PSP will be available to inform ongoing stewardship program development and support continuous improvement in targeting approaches to achieve phosphorus reduction goals.

For More Information

OMAFRA's Environmental Stewardship Programming Overview webpage.

1.9 Ontario Ministry of Agriculture, Food and Rural Affairs

1.9.7 Imagery and the non-growing season: What does it tell us about soil management?

Project Goals

The objective of this project is to explore the use of imagery technology to determine the fate of cover/residue over the non-growing season (NGS) in Essex, Elgin and Wellington Counties.

Project Description

This project will:

1. Evaluate the potential use/applicability of satellite imagery for determining soil management conditions during the NGS in three different areas of southern Ontario;
2. Compare results from multiple satellite imagery platforms with multiple ground observations methods in each of the areas; and
3. Determine the feasibility and accuracy of algorithms and methods developed to interpret imagery in the NGS

Results Summary / Expected Outcomes

This project is in preliminary stages.

Location

Essex, Elgin and Wellington Counties.

Partners

AAFC

Funders

OMAFRA BMP Verification and Demonstration Initiative

Contact Information

- Peter Dorris, OMAFRA
- Dr. Pamela Joosse, AAFC

1.9 Ontario Ministry of Agriculture, Food and Rural Affairs

1.9.8 Improving phosphorus management and soil health in field tomatoes

Location

Essex County, Chatham-Kent.

Partners

University of Guelph

Funders

OMAFRA BMP Verification and Demonstration Initiative

Contact Information

- Christoph Kessel, OMAFRA
- Dr. John Zandstra, University of Guelph

Project Goals

The objective of this project is to improve soil health and phosphorus (P) management in soils growing tomatoes in Southwestern Ontario.

Project Description

This project will:

1. Benchmark of current P practices (rates, source, timing and application) and soil health through producer surveys and field sampling;
2. Evaluate the current Ontario P fertilizer guidelines at cooperator locations; and
3. Identify sites with greater than 26 ppm soil test P that will be used for grower demonstration of yield and crop health response to zero P application

Results Summary / Expected Outcomes

This project is in preliminary stages.

1.9 Ontario Ministry of Agriculture, Food and Rural Affairs
1.9.9 Monitoring constructed wetlands for phosphorus mitigation

Project Goals

Assess the ability of constructed wetlands to mitigate agricultural phosphorus loading.

Project Description

The performance of new and existing constructed wetlands on various farm properties will be studied for their ability to mitigate phosphorus surface loading from nearby farm fields. An inventory of constructed wetlands on farm properties in the Conservation Authority watershed will also be determined as well as the minimum water quality/flow monitoring sampling requirements needed at a constructed phosphorus treatment wetland to guide future management actions of such wetlands by farmer landowners.

Results Summary / Expected Outcomes

1. Undertake and support studies that investigate the functions and ecosystem services of wetlands including hydrology, water quality and quantity, phosphorus reduction capabilities, carbon sequestration, and fish and wildlife habitat;
2. Develop and make available new and/or updated evaluations of wetlands within the Great Lakes basin, with a focus on coastal wetlands and other wetlands that influence the Great Lakes;
3. Support demonstration projects to increase adoption of management practices in selected agricultural landscapes that increase nutrient use efficiency and reduce the risk of phosphorus losses

Location

Lower Thames Valley Watershed

Partners

LTVCA

Funders

OMAFRA (COA)

Contact Information

LTVCA

1.9 Ontario Ministry of Agriculture, Food and Rural Affairs

1.9.10 Tile flow: A best management practice systems approach

Location

Ilderton and Londesborough.

Partners

University of Waterloo

Funders

OMAFRA BMP Verification and Demonstration Initiative

Contact Information

- Richard Brunke, OMAFRA
- Dr. Merrin Macrae, University of Waterloo

Project Goals

The objective of this project is to test the suitability and effectiveness of a commercial filter system as a best management practice (BMP) to reduce dissolved reactive phosphorus (DRP) and particulate phosphorus (PP) in ON production systems.

Project Description

This project will:

1. Test a commercial filter system as a suitable BMP to reduce DRP and particulate phosphorus (PP) in the surface water runoff from farms that already employ bundled BMPs for the reduction of P loss;
2. Compare the effectiveness of the filter system in reducing DRP and PP between 2 commercial farm fields that have established tile and surface water quality monitoring systems; and
3. Quantify DRP and PP leaving through tile drains and overland flow on 2 commercial grain and oil seed farm fields in southwestern Ontario

1.9 Ontario Ministry of Agriculture, Food and Rural Affairs

1.9.11 Demonstrate the use of turbidity monitoring for total phosphorus in agricultural watersheds during run-off/storm events and their use to trigger mitigation activities

Project Goals

- To test real-time, low cost turbidity sensors to be used as a surrogate for total phosphorous (TP), to better understand the correlation between turbidity and TP in the field.
- To develop a bench top drainage model demonstrating how continuous, real time turbidity data can be used to automatically respond to turbidity readings by controlling drainage systems to ultimately reduce TP entering waterways. This is anticipated to be especially valuable during storm events when much of the TP leaves fields.

Project Description

- Real-time turbidity monitoring is ongoing using a custom-built, low cost turbidity sensor to investigate the correlation between turbidity and TP. Water quality data (turbidity, total Phosphorous, temperature etc.) is being collected from two sites in collaboration with the Lower Thames Valley Conservation Authority and the Grand River Conservation Authority. The low end of the measurement range of this turbidity sensor is approximately 20 NTU. The project is focused on identifying events with high turbidity and TP.
- The data is being analyzed to verify if the turbidity sensor can identify periods of higher TP. If this method of identifying peaks in TP proves to be effective, it will reduce the need to install large, costly TP monitoring systems in applications that simply need to know when these peak storm events are causing high turbidity or TP. This could act as a trigger to automatically activate management or monitoring activities at a particular turbidity or TP threshold.
- This sensor could also provide a more timely indicator of TP concentration and a deeper understanding of water quality in tile drainage systems, enabling the sensor to be used as a trigger to automatically activate remediation methods such as diversion to settling ponds, in-situ retention or filtration during periods of high TP concentration.
- The use of this real-time data will be demonstrated in a desk-top model that will allow a model drainage system to respond automatically to the changing conditions in the field.
- One installation and sampling site is located in an agricultural drain in the Jeannette's Creek subwatershed which is within the Lake Erie basin.
- The data being collected from the turbidity sensor will be stored by OMAFRA.
- This phase of the project began in 2017 and will be completed in 2018.

Location

Located in Tilbury East in Kent (the Jeannette's Creek subwatershed) which outlets to the Thames River.

Partners

- LTVCA
- GRCA

Funders

OMAFRA

Transferability

- If the sensor performs well in field conditions it could be used in a variety of settings where low cost, real time turbidity or TP data is needed.
- This sensor is also currently being used to support washwater recycling in field vegetable processing plants, which leads to cost savings for the vegetable processors as well as reduced environmental impact from the washing facilities.

Contact Information

- Water Management Engineer or Technical Systems Integration Engineer
  OMAFRA
  519-846-3390

Next Steps

- The desktop model is still under development, but it will be used as an outreach tool for farmers and drainage professionals to showcase the benefits of turbidity monitoring to implement management practices such as controlled drainage.
- The performance of the turbidity sensor will be analyzed and if effective for long term field installation, more turbidity sensors can be built.

Lessons Learned

Sensor performance in continuous field conditions differs from use over the short term (less than 12 hr continuous use).

Results Summary / Expected Outcomes

- Two turbidity sensors have been installed and preliminary data is starting to come in.
- A water quality dataset is being compiled for the site that compiles both the new turbidity sensor data as well as data from the conservation authorities including TP, turbidity, temperature.
- A benchtop model is being built to represent the control measures implemented alongside the automated monitoring system. This model will demonstrate the ability to continuously monitor parameters such as water turbidity, flow rate, water table height etc. and autonomously adjust the configuration of the model drainage system in response.

Photo Credit: Janice Levangie, OMAFRA

1.10 Ryerson University

1.10.1 Agri-Model: Integrating land management surveys and regional watershed modelling

Project Goals

- Survey farmers in Nissouri Creek and Big Creek
- Compare results with earlier surveys from the 1970's
- Collect detailed soil survey to quantify levels of soil test P
- Develop regional watershed model to understand how changes on land affect changes to streams

Project Description

A number of studies are currently trying to link efforts to improve agricultural production with improvements to water quality. In the absence of direct input from agricultural producers, scientists and policy makers must make assumptions about land management when conducting regional scale assessments. To fill this gap in our knowledge, the University of Windsor and Ryerson University have begun a study on agricultural land management in the MWNS sentinel watersheds. In 2017 and 2018, agricultural producers will be invited to participate to ensure their land stewardship is accurately portrayed. Those who choose to participate will be asked detailed questions about their crop rotations, tillage practices, fertilizer use, manure management, drainage, and soil or water conservation measures. Current practices will be compared to historical observations from the 1970s. Comparing land use information with water quality from a range of sites will reveal how differences in agriculture and the physical environment relate to water quality. All survey information will be kept strictly confidential; only aggregate information will be released. Understanding the implications of land management for Great Lakes water quality requires a regional scale mathematical model.

Several watershed-modelling projects are currently being developed across Southern Ontario. Existing watershed modelling projects typically develop predictions at the mouths of larger rivers. However, a focus on the main outlet can overlook the significant differences in land management and physiography throughout Southern Ontario. Sentinel headwaters, such as those in the MWNS, provide an opportunity to incorporate detailed information into a regional model. In 2016, the University of Windsor began a 3-year project incorporating headwater sentinel watershed information to evaluate the relationship between agricultural land management, physiography, and watershed nutrient loading from agricultural watersheds throughout Southern Ontario. The deep historical data record at the sentinel watersheds provides an opportunity to understand in greater spatial detail how land management and water quality have evolved since the 1970's.

AGRI MODEL

Location

- Nissouri Creek - Embro
- Big Creek - Comber

Partners

- Headlands Agri-Environmental
- MOECC
- University of Waterloo

Funders

MOECC

Transferability

Model will be developed to generalize conclusions to all of Southern Ontario

Contact Information

- Christopher Wellen,
  Ryerson University,
  Christopher.wellen@ryerson.ca

Next Steps

- Survey Big Creek
- Develop regional models

Lessons Learned

Significant field to field variability

For More Information

- Ryerson Land &Waters Resources Group
- Agri-model

Results Summary / Expected Outcomes

- Nissouri Creek already surveyed
- Significant changes in land management since the 1970's have major implications for watershed functioning
- Our detailed survey will allow us to assess the effects of already existing conservation measures

Mel Luymes surveying a farmers (photo credit: Christopher Wellen)

1.11 St. Clair Region Conservation Authority
1.11.1 St. Clair River Area of Concern Program

Project Goals

The goal of the AOC program is to re-designate all Beneficial Use Impairments (BUIs) to "not impaired". Once all remedial actions are completed or addressed, the AOC can be removed from the list of AOCs in the Great Lakes Basin; this process is commonly referred to as "delisting"

Project Description

In 1991 12 environmental challenges were identified as needing to be addressed within the St. Clair River AOC. These 12 challenges are referred to as Beneficial Use Impairments (BUIs). They include:

- Restrictions on Fish and Wildlife Consumption
- Tainting of Fish and Wildlife Flavour
- Degraded Fish and Wildlife Populations
- Fish Tumours or Other Deformities
- Bird or Animal Deformities or Reproductive Problems
- Degradation of Benthos
- Restrictions on Dredging Activities
- Restrictions on Drinking Water Consumption or Taste and Odour Problems
- Beach Closings
- Degradation of Aesthetics
- Added Cost to Agriculture or Industry
- Loss of Fish and Wildlife Habitat

In 1995, 38 remedial actions were recommended to restore the "impaired" beneficial uses in the St. Clair River and undertake further research on those that require it.

Project partners have made significant progress towards improving conditions in the river and continue to undertake work which will move the St. Clair River towards delisting. Shoreline enhancements and habitat restoration and creation have increased the biological connectivity between the aquatic and terrestrial environments. Recent legislation and upgrades to both municipal and industrial facilities have decreased the volume and frequency of spills into the river. Improvements have been observed in the aesthetics of the river. The proposed remediation of mercury contaminated sediment will greatly contribute to the improvements of a number of "Impaired" BUIs.

Location

Boundaries of the St. Clair River AOC encompass portions of:

- City of Sarnia
- Lambton County
- St. Clair Township
- Municipality of Chatham-Kent
- Aamjiwnaang First Nation
- Walpole Island First Nation

Partners

- Aamjiwnaang First Nation
- City of Sarnia
- DUC
- Friends of the St. Clair River
- Lambton County
- Lambton Public Health
- MNRF
- Municipality of Chatham-Kent
- OMAFRA
- Rural Lambton Stewardship Network
- Sarnia-Lambton Environmental Association
- SCRCA
- St. Clair Township
- Walpole Island First Nation

Funders

- ECCC
- MOECC

Contact Information

- Kelly Johnson (St. Clair River Remedial Action Plan Coordinator),
  SCRCA
  519-245-3710 ext. 255

Next Steps

Currently three BUIs, “Bird or Animal Deformities or Reproductive Problems”, “Restrictions on Dredging Activities”, and “Beach Closings” are moving through the re-designation process. In 2018 the Canadian RAP (Remedial Action Plan) Implementation Committee (CRIC) will be exploring the possibility of re-designating additional BUIs “Fish Tumours or Other Deformities”, “Restrictions on Drinking Water Consumption or Taste and Odour Problems”, and “Loss of Fish and Wildlife Habitat”.

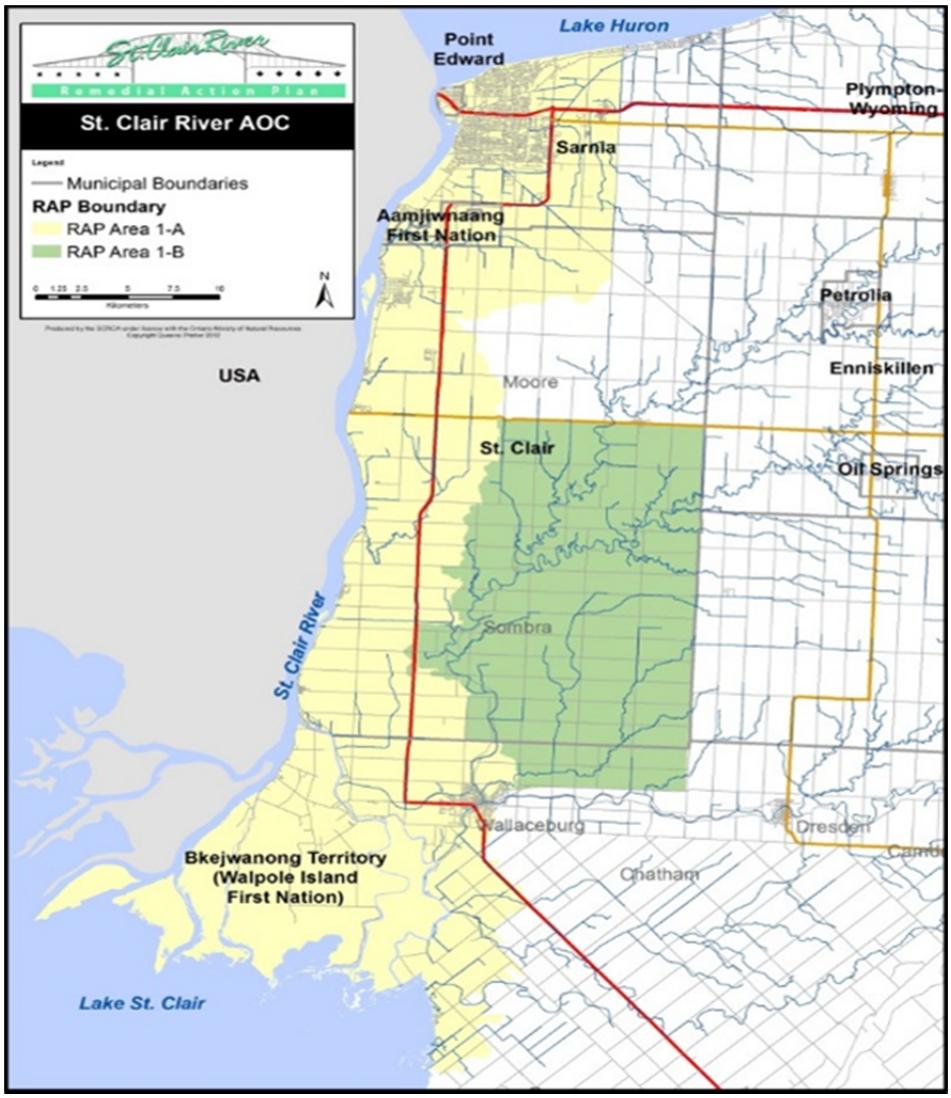
For More Information

Friends of the St. Clair River webpage.

Results Summary / Expected Outcomes

For over 20 years there has been significant changes to environmental protection legislation and a collective effort from government, First Nations, industry and other stakeholders to restore the AOC. Due to significant improvements in water quality resulting from implementation of regulations and improvements to industrial and municipal waste water processing and agricultural practices, as of February 2018 three BUIs have been re-designated to “Not Impaired”, four remain “Impaired”, three are in the process of being re-designated, and two “Require Further Assessment”.

Work continues in the AOC towards re-designating the remaining BUIs and ultimately delisting of the St. Clair River as an Area of Concern.



St. Clair River AOC (photo credit: SCRCA)

1.12 Thames River Phosphorus Reduction Collaborative
1.12.1 Thames River Phosphorus Reduction Collaborative

Project Goals

Identify pathways where agricultural waters flowing through field tiles and surface runoff into municipal drains contribute to P loading; consideration of technologies to absorb P and to remove soluble P from water.

Project Description

Coordination on municipal drain and field drainage systems and associated outreach. Projects under development for 2018-21 period.

Results Summary / Expected Outcomes

In 2017, literature review was completed, priority areas identified, and a press release on role of this PRC was circulated.

Next Steps

Applications for funding, such as ECCC programs.

For More Information

Thames River Phosphorus Reduction Collaborative website.

Location

Both Upper and Lower Thames watershed areas.

Partners

Cities Initiative with OFA, which is extended to:

- drainage community
- environmental groups
- conservation authorities
- First Nations
- AgriBusiness
- local federations of agriculture
- commodity organizations

Funders

Sector partners and government

Transferability

Knowledge is applicable throughout Canada for agriculture and small cities.

Contact Information

- Charles Lalonde,
  TRPRC.
  519-993-0877,
  Charles.lalonde73@gmail.com

1.13 University of Guelph
1.13.1 Digital soil mapping of Lake Erie basin

Location
Brant, Bruce, Chatham-Kent, Elgin, Essex, Haldimand, Haliburton, Hamilton, Huron, Lambton, Middlesex, Niagara, Oxford, Perth, Waterloo, Wellington.

Funders
OMAFRA-University of Guelph Partnership Research Program

Transferability
Through the development of detailed soil maps and an innovative strategy for soil sampling, new method for soil mapping and upscaling information, this project aims to provide detailed soil information to the farm managers, modelers, policy developers and decision makers who are working in the Lake Erie Basin.

Contact Information

- Asim Biswas,
  University of Guelph,
  biswas@uoguelph.ca

Project Goals
To develop a detailed high resolution soil map of Lake Erie basin (Canadian side).

Project Description
Soil varies considerably from location to location. There is an urgent need for accurate, up-to-date and spatially referenced soil information. This need has been expressed by the modelling community, land managers, policy developers and decision makers. The need coincides with an enormous leap in technologies that allow for improvements in accurately collecting and predicting soil properties through new techniques called digital soil mapping. While traditional soil maps typically show only general distribution accompanied by the soil survey report, digital soil maps are richer in context with greater spatial detail. This project aims to develop digital soil maps of the Lake Erie Basin and a smart phone app for the region. The decline in Great Lakes water quality has in part been pointed to the agricultural sources. However, the estimation through modelling water quality used sparse and historical soil data at large scales. This project aims to provide detailed soil information to the farm managers, modelers, policy developers and decision makers who are working in the Lake Erie Basin through the development of detailed soil maps and an innovative strategy for soil sampling, new method for soil mapping and upscaling information.

Results Summary / Expected Outcomes
This project is ongoing.

1.13 University of Guelph

1.13.2 Evaluation of alternative best management practices in critical contributing areas in agricultural landscapes of Ontario under changing climate

Project Goals

To improve SWATDRAIN model to simulate sediment, nitrogen, phosphorus, and pesticide loadings from agricultural landscapes.

Project Description

Many best management practices (BMPs) can be implemented on agricultural landscapes to manage water flows, sediment transport, and agrichemical pollution. However, given the specificity of each landscape, there are presently no credible methods of determining a priori which BMP would work best in a given situation and, more importantly, where it should be located. Climate change in Ontario is going to cause non-uniform spatial and temporal distribution of precipitation hence aggravating flooding, drought, and pollution problems. Our Research Team has developed a new landscape model, called SWATDRAIN, that builds on the existing strengths of the SWAT watershed model and adds significantly improved subsurface hydrology component to the model. In this project, we will further improve SWATDRAIN to simulate sediment, nitrogen, phosphorus, and pesticide loadings from agricultural landscapes.

Results Summary / Expected Outcomes

This project is ongoing.

Location

Provincial Scope.

Funders

OMAFRA New Directions Research Program

Transferability

The model will become an excellent tool to recommend the most appropriate and effective BMPs and, more importantly, their location on agricultural landscapes.

Contact Information

- Shiv Prasher,
  McGill University,
  shiv.prasher@mcgill.ca
- Ramesh Rudra,
  University of Guelph,
  rrudra@uoguelph.ca

1.13 University of Guelph

1.13.3 Extending WEBs/WBBE modelling and interface to examine cost effectiveness of agricultural BMP policies in a representative watershed of the Lake Erie basin

Location

Nissouri Creek Subwatershed within the Upper Thames River Watershed.

Funders

OMAFRA-University of Guelph Partnership Research Program

Transferability

Extending from the WEBs/WBBE program, this project proposes to further develop the integrated modelling and interface to evaluate cost effectiveness of various policy scenarios for agricultural BMPs in a representative watershed of the Lake Erie Basin.

Contact Information

- Wanhong Yang, University of Guelph wayang@uoguelph.ca

Project Goals

To further develop the integrated modelling and interface to evaluate cost effectiveness of various policy scenarios for agricultural BMPs in a representative watershed of the Lake Erie Basin.

Project Description

With growing concerns about near shore water quality issues of Lake Erie such as algae blooms, BMP implementation in contributing watersheds has become one of the important measures for mitigating these negative effects. Within this context, it is necessary to evaluate the cost effectiveness of agricultural BMP policies on improving water quality. In AAFC's Watershed Evaluation of BMPs (WEBs) program during 2005-2013 and OMAFRA's Watershed Based BMP Evaluation (WBBE) program during 2010-2013, farm economic, watershed hydrologic and integrated modelling has been developed to examine costs, benefits, and cost effectiveness of BMPs at field/farm and watershed scales. A GIS interface for the modelling has also been developed to conduct BMP assessment in an interactive manner. The integrated modelling and interface has been applied to the South Tobacco Creek watershed in Manitoba (WEBs watershed) and the Gully Creek watershed in Ontario (WBBE watershed) to examine cost effectiveness of several agricultural BMPs including conservation tillage, nutrient management, cover crop, water and sediment control basin, and forage conversion.

Results Summary / Expected Outcomes

This project is ongoing.

1.13 University of Guelph

1.13.4 Management of phosphorus loads on a field to watershed basis: An assessment of current practices as an integrated system

Project Goals

To develop and test a multi-barrier framework for phosphorus loss reduction on farms.

Project Description

Movement of phosphorus from agricultural lands to receiving waters is a function of the pathways by which runoff is generated. Current nutrient management practices set out under O.Reg 267/03 focus on specific activities and practices that provide for regulatory due diligence on the farm. The proposed research will undertake to assess the effectiveness of practices that minimize the losses of phosphorus from farm operations in a watershed (e.g. measures to reduce concentrated runoff, bank erosion, and interception of phosphorus by tile drainage). This approach provides for, not only an assessment of the efficacy of each practice, but also provides an assessment of the cumulative effect of the sequence of mitigating measures along the flow path. The tests of the efficacy are based on a meta analysis of the literature, expert development of the framework, expert review of the framework and practical utility by farm operators.

Results Summary / Expected Outcomes

This project is ongoing.

Location

Fairchild Creek in the Grand River Watershed (eastern basin of Lake Erie), Big Creek in Essex County (Western basin of Lake Erie) and Nissouri Creek in the upper Thames Watershed (tributary to Lake St Clair).

Funders

OMAFRA-University of Guelph Partnership Research Program

Transferability

The approach taken for this project has proven to be effective in the development of risk mitigation for agricultural threats under the Clean Water Act. A utility-focused evaluation of use of the framework will provide an assessment of the institutional requirements for implementation of the framework.

Contact Information

- John Fitzgibbons, University of Guelph, jfitzgib@uoguelph.ca

1.13 University of Guelph

1.13.5 SWAT modelling and assessment of agricultural BMPs in the Upper Medway watershed

Location

Located in Lucan-Biddulph Township in Middlesex County, the Upper Medway subwatershed is the headwaters for Medway Creek, which outlets to the Thames River in London.

Partners

- OSCIA
- OMAFRA
- UTRCA

Funders

OSCIA with funding from AAFC and OMAFRA through Growing Forward 2

Transferability

The methodology of SWAT modelling is transferable to other watersheds in the Great Lakes Basin.

Contact Information

- Wanhong Yang,
  University of Guelph
  (519) 824-4120 ext. 53090
  wayang@uoguelph.ca

Next Steps

Continue refining SWAT modelling results.

For More Information

GLASI Priority Subwatershed Project

Project Goals

The purpose of the project is to conduct watershed modelling to evaluate water quantity and quality effects of agricultural BMPs in the Upper Medway watershed, one of the six priority subwatersheds in the Great Lakes Agricultural Stewardship Initiative.

Project Description

This project sets up and calibrates the Soil and Water Assessment Tool (SWAT) to examine the water quantity and quality effects of various BMP implementation scenarios in the Upper Medway watershed. The datasets for SWAT modelling include climate, DEM, soil, landuse, land management (205-2017), hydrography, BMP information, monitoring locations and flow and water quality data. The SWAT modelling was applied to evaluate water quantity and quality effects of a suite of BMPs including conservation tillage, fertilizer incorporation, precision nutrient management, cover crop, Water and Sediment Control Basin (WASCoB) or berm, rock Chute, windbreak, grassed waterway, vegetative buffer strip, and tile drain.

Results Summary / Expected Outcomes

The SWAT modelling was applied to simulate water quantity and quality effects of various BMPs implemented in the Great Lakes Agricultural Stewardship Initiative (GLASI) from 2015 to 2018. In comparing to the baseline scenario with historical land management practices, the 20 GLASI WASCoBs/berms have the potential of reducing sediment, TN, and TP by 42 ton/yr, 4,087 kg/yr, and 110 kg/yr respectively corresponding to a relative sediment, TN, and TP reduction of 3.62%, 5.47%, and 4.48% at the watershed outlet. The 4 GLASI rock chutes have the potential of reducing sediment by 6.0 ton/yr or 0.52% of the total sediment load at the watershed outlet. The reduction of flow, TN, and TP are not obvious at the watershed outlet. The one GALSI windbreak has the potential of reducing sediment, TN, and TP by 13.0 ton/yr, 526.0 kg/yr, and 60.2 kg/yr respectively corresponding to relative sediment, TN, and TP reductions of 1.12%, 0.70%, and 2.45% at the watershed outlet. The GLASI land management BMPs including conservation tillage, fertilizer incorporation, precision nutrient management, and cover crop in 49 fields have the potential of reducing sediment, TN and TP loadings at the watershed outlet by 93.0 t/yr, 3,097.0 kg/yr, and 126.0 kg/yr, which represent 8.02%, 4.15%, and 5.13% reductions respectively. The modelling results demonstrated the effectiveness of GLASI BMPs in reducing sediment and nutrients at the watershed outlet.

Lessons Learned

Long-term land management data and watershed & edge-of-field monitoring of flow and water quality are essential for improving the performance of watershed modelling for evaluating the effectiveness of agricultural BMPs.

1.14 University of Michigan Water Centre

1.14.1 Watershed assessment of nutrient loads to the Detroit River

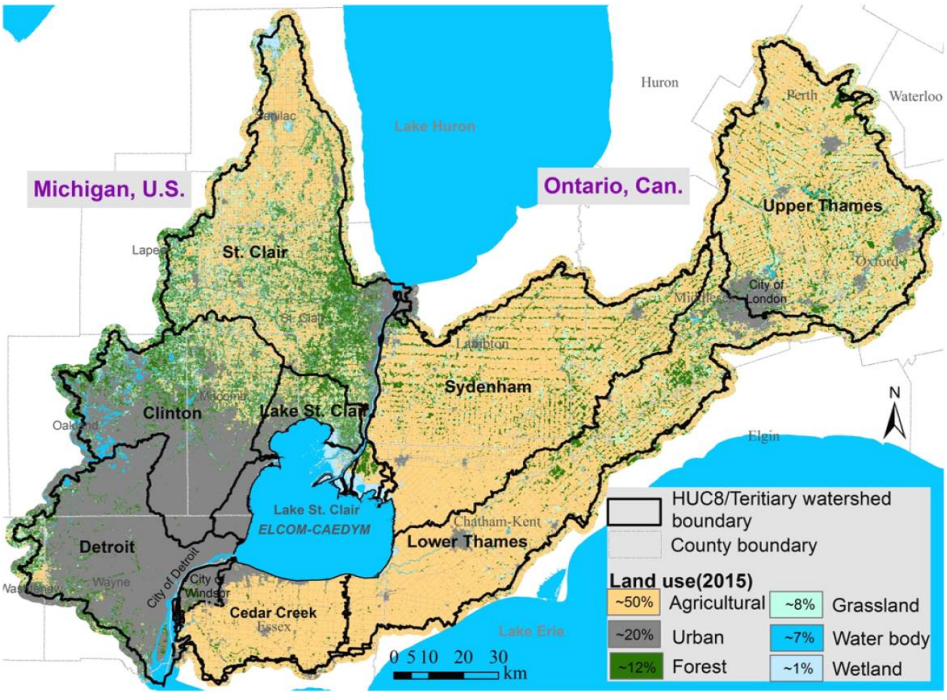
Project Goals

1. Engage the policy and management community;
2. Develop watershed and lake models to assess nutrient loads from different sources; and
3. Explore options for reducing P loads from the most important sources.

Project Description

This study will model the nutrient dynamics in Lake St. Clair, and the watersheds that drain into the St. Clair and Detroit rivers and Lake St. Clair. The planned modeling approach is designed to characterize nutrient loads to the Detroit River and then compare the efficacy of different management options, such as conservation practices for farms or urban stormwater strategies.

The research team is developing three unique models that can simulate the dynamics of this complex watershed that includes extensive urban and agricultural environments on both sides of the border as well as a large lake (Lake St. Clair) that receives and processes much of the loads upstream of the Detroit River. The three models being developed are: (1) An urban model to characterize loads from the greater Detroit area; (2) A regional watershed model for the entire study area using the Soil and Water Assessment Tool (SWAT); and (3) A Lake St. Clair model to explore nutrient transport and retention in the lake.



Project study area (photo credit: University of Michigan Water Centre)

Location

The project study area includes the US and Canadian land areas that drain to the St. Clair River, Lake St. Clair, and the Detroit River.

Partners

The research is being conducted by a team based at the University of Michigan. The project is being guided by input from a 30-person advisory group that includes representatives from federal, state, and provincial governments; non-profits; universities; and local organizations actively involved in watershed management, policy development or applied research.

Funders

Fred A. and Barbara M. Erb Family Foundation

Transferability

This modeling project is led by a team that has also developed watershed models for the Maumee, Raisin, and Huron rivers. The modeling methods are transferable. The team is currently evaluating the potential benefits of different nutrient reduction practices. Once completed there will be a chance to compare results with different modeling teams and across different Lake Erie watersheds.

Contact Information

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Next Steps

Currently the team is developing management scenarios to evaluate through watershed and urban models. The team will rely on the project advisory group to help craft take home messages, design information products, and share results with relevant organizations.

For More Information

https://graham.umich.edu/project/assessing-detroit-river-nutrient-loads-lake-erie

Results Summary / Expected Outcomes

This project will wrap up in December of 2018. Results will include information about where nutrients are coming from and comparisons of different nutrient reduction strategies.

Lessons Learned

Modeling of Lake St. Clair indicates that during the ice-free months, the lake is retaining modest portions of total phosphorus and dissolved phosphorus that enters the lake from upstream tributaries. Annual analyses are suggesting that this retention has changed since the 1990s. The contributions from different tributaries are retained to a different degree depending on the seasonality of loads and the hydrodynamics of Lake St. Clair.

1.15 University of Toronto
1.15.1 Wet Lands

Project Goals

The extensive systems of agricultural tile drains carrying phosphorus rich water in the Great Lakes Watershed exacerbate yearly HABs by circumventing and eliminating landscapes like floodplains and wetlands, which allow for the interaction of water with land. Wet Lands is a speculative design research project that aims to develop nature-based solutions and flexible policies for reducing nonpoint source phosphorus on individual farms through landscape interventions that take into consideration the physical and economic needs of individual property owners while addressing regional scale impacts.

Project Description

The project uses a unique method of parametric spatial scenario modelling developed by the authors to both quantify and visualize regional scale impacts of flexible policies and incentives for private landowners, a key hurdle in addressing nonpoint source pollution in rivers and waterbodies. Essex County (within the Lake Erie watershed) is used as a test case to develop a parametric spatial scenario model using GIS data and historical ecological research to assess four landscape and policy strategies at increasing scales: (1) design, identification, and implementation strategy for agricultural reservoirs; (2) the conversion of frost-sensitive crop fields into seasonal wetlands; (3) policy and design for drainage buffers scaled to the individual farm; and (4) a county-wide strategy for crop intensification and diversification.

Results Summary / Expected Outcomes

Early parametric models suggest a 10% adoption rate of the suggested strategies would allow for the capture and temporary storage of 46% of spring rains. The physical space where water and land interact becomes temporary or permanent habitat. A 10% adoption rate of the suggested strategies has the potential to increase permanent habitat in Essex county by 19% and temporary habitat from October to April by 68%. Given the mixed results in published studies of phosphorus reductions by wetlands, field tests of the proposed designs will be required to more accurately quantify the expected results such interventions could have on the scale of the Lake Erie basin

Lessons Learned

This methodology, which simultaneously addresses the design of nature-based solutions and the political and economic frameworks required in its formation over time. The highly visual and spatial nature of this exploration has been invaluable in sharing our and ideas with people across disciplines (scientists, engineers, and policy makers). Scenario modeling in particular does not attempt to show a finished or idealized condition—it offers possibilities, shapes discussions, and hopefully, leads to collaborative applied research. While the modeling was effective at spatially conveying a concept, further study and expertise is required to further assess the feasibility of the recommended policies as well as the scientific evidence of phosphorus reduction.

Location

Essex County, Ontario

Transferability

The ideas explored in this research are transferable to agricultural lands reclaimed from wetlands through subdrainage infrastructure that would benefit from increasing wetland area and inundated lands for both habitat and phosphorus reduction. This includes much of the central and western basins of the Lake Erie basin. There is broader transferability in using parametric spatial scenario modeling for exploring the impacts of various flexible policies to address regional scale issues.

Contact Information

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- Justine Holzman, University of Toronto, justine.holzman@daniels.utoronto.ca

Next Steps

Establishing partnerships and designing site specific field tests of the proposed design(s) is the next step. The authors are currently developing a proposal for the “Flooding Fields” strategy and hope, after scientific reviews of the work, to secure funding for a pilot project.

For More Information

http://paleosol.com/wet-lands

1.16 University of Waterloo

1.16.1 Developing new modules for the Cold Regions Hydrologic Model platform for the simulation of phosphorus transport at farm and watershed scales under different BMPs, soil types, climate conditions and tile drain settings

Location

Our study sites are farms near Londesboroug and Ilderton, in the municipality of Middlesex Centre contained in the Oxbow Creek sub watershed.

Partners

- Agricultural Water Futures
- OMAFRA
- University of Waterloo, Biogeochemistry Lab

Funders

- Global Water Futures
- University of Waterloo, Biogeochemistry Lab

Transferability

After we verify our modules and platform for our field sites under various climate scenarios, soil types and tile drainage conditions we can employ the platform for the prediction of nutrient transport in other sites.

Contact Information

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For More Information

- GWF website
- AWF in Canada website
- Biogeochemistry Lab, University of Waterloo webpage.
- Centre for Hydrology, University of Saskatchewan webpage.

Project Goals

To develop a module for CRHM capable of predicting phosphorus transport through tile and surface water outflows for different precipitation events (magnitude, intensity, form), various climate conditions (frozen, thawed, wet/dry), different soil types and under various BMPs.

Project Description

- Our project is a part of the Agricultural Water Futures (AWF), that is funded under Global Water Futures (GWF). AWF is led by Dr. Merrin Macrae, University of Waterloo, with collaborations with the universities of Saskatchewan and Wilfrid Laurier, as well as AAFC.
- One of the goals of the GWF suite of projects is to enhance the CRHM platform, as a numerical hydrologic model for the cold regions, and make it capable of simulating nutrient transport at farm and watershed scales. Our team in the Biogeochemistry Lab at the University of Waterloo, as a part of the modeling group within GWF and AWF, is working on developing the modules for simulation and prediction of phosphorus transport.
- In association with other projects since 2011, we have collected climate, water flow and water chemistry data at 15 minute intervals from for our farm sites in the Thames River watershed. This is being used to parameterize and validate the CRHM model. Process-based knowledge from studies conducted over the past 5 years at these sites is being used to inform the model development.

Results Summary / Expected Outcomes

- We will predict/simulate tile and surface flow and phosphorus concentrations in tile and surface water using the CRHM platform, and will then test the model under different types of precipitation events, seasons, BMPs, soil types and tile network settings.
- We will couple the CRHM model with future climate scenarios to better assess how runoff volumes and chemistry will vary in future.

Next Steps

- Develop modules for CRHM to be able to simulate:
  - Phosphorous transport at the watershed scale
  - Transport of other nutrients in farm and watershed scales

Lessons Learned

- There are a lot of important details within field sites regarding field measurements that are specific for each site. An understanding of in-field processes can assist with model development.
- Careful collection of field data is essential to model development and validation. The proper quality controlling/assurance within data sets is a lengthy process but is critical.

1.16 University of Waterloo
1.16.2 Dairy manure management to mitigate phosphorus loss

Project Goals

To determine if incorporation or tillage practice play a significant role at reducing phosphorus loss in tile drains.

Project Description

Water samples from tile drains are being sampled whenever flow occurs throughout the entire calendar year from three adjacent plots with different treatments. Two plots received shallow tillage, whereas the other received deeper tilling to simulate conventional tilling methods. All plots received the same rate of liquid dairy manure applied with a drag line. Following manure application, one of the plots that only received shallow tilling had the manure incorporated into the soil. The water samples are being tested for soluble reactive phosphorus and total phosphorus to determine which management practice reduces subsurface phosphorus runoff.

Results Summary / Expected Outcomes

This project is in the preliminary stages with initial data collection ongoing.

Next Steps

Quantification of annual P loads in tile drainage.

Location

Located in Perth South Township in Perth County, part of the subwatershed Glengowan of the Upper Thames River watershed.

Partners

- AAFC
- OMAFRA
- Wilfrid Laurier University

Funders

- Dairy Farmers of Canada
- Global Water Futures
- OMAFRA (BMPVD)

Transferability

The results of this project should be transferable to locations within Southern Ontario with similar soil characteristics as those found at the research site.

Contact Information

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1.16 University of Waterloo

1.16.3 The role of discourse in environmental governance: The case of nutrient runoffs in western Lake Erie basin

Location

The geographic context for this research are two watersheds in the Western basin of Lake Erie: The Thames Watershed in Ontario and the Maumee Watershed in Ohio.

Partners

This research is being conducted under the supervision of Dr. Rob de Loe at the School of Resources, Environment and Sustainability (SERS) in the Faculty of Environment at the University of Waterloo

Funders

University of Waterloo

Contact Information

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Project Goals

The purpose of study is to understand the different conceptualizations of nutrient runoff by stakeholders with regard to eutrophication/algal blooms in western Lake Erie. The study is based on the premise that, in order to be effective, policy interventions to address nutrient issues may need to consider the different discourses by stakeholders on the role and extent of different sources of nutrient runoff contributing to the problem.

Project Description

This project adopts an interpretive approach to social science research. Data is collected in the form of policy documents, reports, other publications as well as stakeholder interviews. This is an ongoing research and so far more than 50 individuals from government, CAs, NGOs, Municipalities and other groups have been interviewed.

Results Summary / Expected Outcomes

- Stakeholders have differing definitions of the nutrient issue as well as the relative importance and weight of various components that constitute the problem. This may affect effectiveness of policy interventions;
- Economic interests come into play in the form of specific discourses related to nutrient issues;
- Collaborative solutions proposed to dealing with nutrient issues may need to address equity and proportionality issues.

Next Steps

Detailed data analysis, write up of dissertation, publication of results in academic journals.

1.16 University of Waterloo

1.16.4 Linking fertilizer placement and subsurface flowpaths in no-till soils under different antecedent temperature and moisture conditions

Project Goals

- To quantify the mobilization of P under surface broadcast and subsurface placement application strategies, under different soil antecedent temperature conditions (frozen vs unfrozen) in silt loam and clay no-till soils
- To quantify the progression of the wetting front under different antecedent moisture conditions (wet vs dry) in silt loam and clay no-till soils
- To relate hydrologic flow pathways under different antecedent temperature and moisture conditions to P placement strategies to minimize P loss

Project Description

- Laboratory comparison of subsurface nutrient losses following surface and subsurface application of inorganic fertilizer, under multiple non-growing season events on frozen and unfrozen ground, in intact no-till clay and silt loam soil monoliths
- Field experiment investigating wetting front progression in wet and dry clay and silt loam soil using brilliant blue dye as a tracer, to relate fertilizer placement to flowpaths in no-till soils and understand risks to subsurface losses

Results Summary / Expected Outcomes

- Preliminary results show that subsurface placement of fertilizer can limit subsurface losses of P in both silt loam and clay soils, and should be considered as a BMP to aid in phosphorus reduction to waterways
- Further analysis will link fertilizer placement to preferential flow paths to determine risk of subsurface P transport among different soil textures and antecedent conditions
- Detailed results, including relative reductions in subsurface P loss, will be published upon project completion

Next Steps

- Continued analysis and preparation of research for publication
- Future studies may consider fertilizer placement trials at larger spatial and temporal scales, including year-round, field scale monitoring both surface and subsurface flow from fields with different nutrient placement strategies

Lessons Learned

- Fertilizer placement is an important consideration for phosphorus management, and should be considered in conjunction with the rate, source and timing of fertilizer application
- Subsurface fertilizer placement is a management practice that can be used alongside other site appropriate BMPs.

Location

Working farms near St. Mary's, ON in the Glengowan Corridor subwatershed and farm site near Kingsville, ON in the Wigle Creek subwatershed of Essex Region

Partners

- Landowners
- OMAFRA
- Ecohydrology Research Group, University of Waterloo

Funders

- OMAFRA (BMPVD program)
- NSERC

Transferability

Results are not limited to the Thames River Watershed, but can be transferable across southern Ontario to sites with similar soil types and management practices to those investigated in this project.

Contact Information

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1.16 University of Waterloo

1.16.5 Freeze thaw cycles affecting supply and transport of phosphorus in agricultural soils

Location

This study is in St. Marys, Ontario, Perth County, in the Glengowan Corridor sub-watershed and outlets to the North Thames River.

Partners

- Landowners
- University of Waterloo

Funders

- NSERC
- Agricultural Water Futures (under Global Water Futures)

Transferability

This will be comparable to similar soil types, and climate regions.

Contact Information

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Project Goals

To determine how freeze thaw cycles impact soil processes and subsequently phosphorus release during the non-growing season. This project will help determine the soil mechanisms that contribute to high phosphorus release in the spring, and will comment on possible best management practices in the non-growing season.

Project Description

- Agricultural soils are monitored to understand phosphorus speciation changes under varying temperatures and moisture conditions.
- Soils are monitored under snow and without snow cover to determine the impacts of a changing climate on nutrient release.
- This one-season study will be completed in early April 2018.

Results Summary / Expected Outcomes

Expected outcomes are mixed as microbial communities may be reduced in frozen soils and therefore reduce organic phosphorus digestion and therefore reduce mineral P release. However, the mechanical soil degradation from freezing soil, and P release from lysing frozen cells in plants and microbial organisms may increase P release.

Next Steps

This project is in the early stages of field work and lab analyses. The field study will continue until early April.

Lessons Learned

There are many soil processes contributing to phosphorus release in the non-growing season, which contribute to our understanding and ability to mitigate nutrient release in our waterways

Building the snow fence (photo credit: Janina Plach)

Taking samples (photo credit: Janina Plach)

1.16 University of Waterloo

1.16.6 The use of geotextiles as a filter for phosphorus in overland flow from agricultural croplands in southern Ontario

Project Goals

- Evaluate geotextile filter ability to reduce P loads from surface runoff
- Understand how the filter works, for how long, under what conditions
- Understand how BMP addition to already well managed fields impacts P losses

Project Description

Multiple rings of Filtrexx geotextile filter material were placed around a hickenbottom at the edge of a well-managed agricultural field. Automated (ISCO) water samplers were situated in fields to collect water samples from runoff above and below the filter material during surface runoff events. Water samples were analyzed for dissolved and particulate forms of P as well as suspended sediments and ion concentrations in the Biogeochemistry Lab at the University of Waterloo. Data outlining estimated P reductions is being compiled be published in a master's thesis and journal articles.

Results Summary / Expected Outcomes

It has been found that filter material can reduce the amounts of dissolved and particulate forms of P in surface runoff, but these reductions are not consistent. The filter has the ability to remove some larger grain sediments from the runoff (i.e. reduce suspended sediment concentrations), but these particles are not the ones most often containing P. Lab experiments on the filter are expected to provide insight into the material's capacity and main mechanism for P retention. It is expected that after the study period is completed that a full analysis of the material will be completed to try and determine its longevity and what can be done with it afterwards.

Next Steps

The material's performance will continue to be monitored until the spring of 2018. The filter material will be evaluated in the lab to determine how much P was removed from surface runoff and remained in the filter, allowing for recommendations to be made specific to the Ilderton site. Filter performance under different flow and seasonal conditions will also be investigated to provide answers on whether or not season and/or event type impact the filter efficacy. Ideally, other studies using the material will be conducted using different configurations of material set up, different locations, and different field management practises.

Lessons Learned

It has been found that new technologies in agricultural systems (like geotextiles) may not ready to be implemented at wide scales. The filter was found to be an effective tool, but more research to discover most effective use is needed. Preliminary results suggest that there may be a point at which landowners have reduced their P losses to an extent that edge-of-field treatment systems can do little more; this may be an opportunity to focus future studies on sites where stacked BMPs are not being used for P removal.

Location

One site is located outside of Ilderton in Middlesex Centre, contained in the Oxbow Creek sub watershed. Another site is located in Londesborough.

Partners

- Landowners
- OMAFRA
- University of Waterloo

Funders

OMAFRA (BMPVD Program)

Transferability

This work is somewhat transferrable across parts of southwestern Ontario. Particularly, the efficacy of filter materials in P retention at the edge of field, and the understanding that at some point, more and more BMP's for P reduction may not always produce further reductions is transferable. Another research site in the South Maitland subwatershed near Londesborough will also provide information on how the filter performs on a different field and under different conditions.

Contact Information

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1.16 University of Waterloo

1.16.7 Landscape sensitivity to phosphorus losses from agricultural soils in the Lake Erie watershed

Location

As part of an international study, regional agricultural fields were located in central and southwestern Ontario, including two field sites in the Thames River watershed (St. Mary's and Ilderton).

Partners

- USDA – The Agricultural Research Service, National Soil Erosion Research Laboratory
- USDA – The Agricultural Research Service, Soil Drainage Research Unit

Funders

- AAFC (Growing Forward 2)
- Grain Farmers Association of Ontario
- Land Improvement Contractors of Ontario

Transferability

Location of the study sites are representative of the major landscape types found in the Lake Erie watershed. Results are expected to be comparable and applicable to other fields located in the watershed.

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Project Goals

Phosphorus loadings in river tributaries vary considerably around the Lake Erie basin. This project is designed to evaluate the potential for surface and subsurface agricultural soils to retain or release phosphorus to runoff differently across the Lake Erie watershed. Results will help understanding of the potential effectiveness of different Best Management Practices (BMPs) to minimize soil phosphorus losses across regions with different soil types (fine-textured clays, loams) and soil chemistry.

Central Ontario field site – St. Mary's (photo credit: Janina Plach)

Project Description

Targeting BMPs to specific soil types and regions may be necessary to achieve the reductions in Lake Erie phosphorus loadings due to potential inherent differences in soil phosphorus retention properties across the watershed.

- Soil samples (surface and subsurface) were collected from agricultural fields across the Lake Erie watershed in Ontario, Indiana and Ohio.
- Soils were analyzed at the University of Waterloo for a variety of soil properties to determine how "tightly" phosphorus was bound to the soil. Analysis included total phosphorus concentrations (legacy phosphorus), phosphorus sorption capacity (how close to saturation were the soils) and plant available phosphorus concentrations.
- The soil chemistry data will be published in an peer reviewed journal and the dataset will be used for future modeling to help predict the risk of phosphorus runoff in differing soil textures, geographical regions, and under changing soil conditions and BMPs.
- The three year project began in 2016. Data from the project will be available in 2019.

Results Summary / Expected Outcomes

- Regional differences in physical and chemical soil properties show different patterns in phosphorus retention across the Lake Erie watershed.
- Fields in central Ontario had calcareous soils, with soil phosphorus bound more tightly with calcium than soils from southwestern Ontario, Indiana and Ohio.
- Subsurface soils in southwestern Ontario, Indiana and Ohio had a higher clay content and a greater potential for subsurface preferential flow-pathways. This may increase the risk of phosphorus runoff to tile drains in these regions compared to fields located in central Ontario.

Tile drain runoff – Essex County (photo credit: Janina Plach)

Subsurface soil – Essex County (photo credit: Janian Plach)

Next Steps

Soil data from this project will be included in runoff models to help delineate impacts of soil chemistry on water quality, as well as to assess the potential impacts of BMPs on soil phosphorus losses in different soil types and landscapes of the Lake Erie watershed.

Lessons Learned

- Diverse soil physical and chemical properties in the landscape may partially explain the regional differences in phosphorus loadings to Lake Erie.
- Management of phosphorus losses across the Lake Erie watershed may need to consider regional differences in water transport pathways and soil chemical properties.

For More Information

- The project details page on the GFO website.
- Current projects on Merrin Macrae's research website at the University of Waterloo.

1.16 University of Waterloo

1.16.8 Phosphorus speciation, bioavailability and loadings from the Thames River to Lake St. Clair

Location

The whole Thames River with a particular focus on the large reservoirs in the Upper Thames (i.e. Fanshawe, Pittock and Wildwood)

Partners

- MOECC
- ECCC
- UTRCA
- LTVCA
- Ryerson University

Funders

MOECC – COA

Transferability

Results from this study are expected to be applicable to other watersheds in Southern Ontario.

Contact Information

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Next Steps

Continued data collection until 2020.

Project Goals

Improve the conceptual as well as quantitative understanding of how nutrient loadings from the landscape translate to nutrient loadings to receiving water bodies after retention, remobilisation and transformation processes occur in the Thames River channel and its tributaries, as well as provide an improved understanding of the potential in-stream interventions which could decrease sediment and nutrient loading in the basin.

Project Description

A nested sampling approach is being employed whereby water quality samples are collected at multiple stations between the headwaters and the river mouth between 2016 and 2020. Sampling locations have been chosen, close to Water Survey Canada gauging stations to allow calculation of instantaneous loads and estimation of seasonal and annual loads. Locations have also been chosen to try and isolate urban, suburban, and rural inputs as well as upstream and downstream of areas where considerable biogeochemical processing is expected to occur e.g. dammed reservoirs and floodplains.

All data from this project is being stored at the University of Waterloo, some data is additionally stored with Environment and Climate Change Canada.

Results Summary / Expected Outcomes

- Determination of the rates of chemical and biological transformations between different phosphorus forms within different sections of the Thames River.
- Estimation of phosphorus loading at different times of year from nested sections of the Thames River Watershed.
- Estimation of the urban non-point source phosphorus loading from the city of London during different times of year.
- Determination of a monthly mass balance model for phosphorus within the Fanshawe Reservoir.
- Estimation of the total legacy phosphorus accumulation within sediments in Fanshawe Reservoir and potentially within Wildwood and Pittock reservoirs.

Lessons Learned

- Rivers do not act simply as conduits transferring phosphorus loading from the landscape to the lake.
- Phosphorus speciation, bioavailability and loading changes during transport from headwaters to the river mouth.
- Significant phosphorus removal occurs within reservoirs due to sedimentation and burial processes.
- Transformation and attenuation processes occurring within the river channel are poorly understood and quantified in current watershed P loading models.

1.16 University of Waterloo

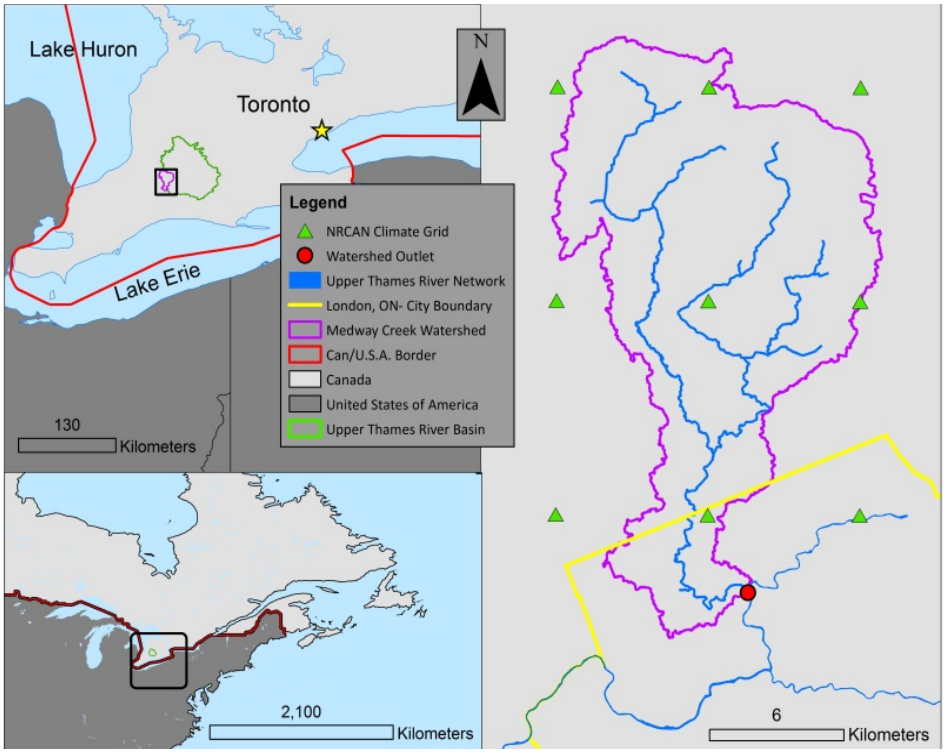
1.16.9 Soil water assessment tool modelling with climate change scenarios to determine the impact on nutrient and sediment losses and controlled tile drain feasibility assessment

Project Goals

As the climate changes it will intensify the current hydrologic cycle. This project focuses on the seasonality of these changes and how they affect runoff volumes and pathways, and the associated nutrient and sediment export in the Medway Creek watershed (MCW). A second component of the study compares field scale data collected in the Thames River watershed with field-scale model output, and investigates the potential for controlled drainage to modify P loss in runoff.

Results Summary / Expected Outcomes

- As a result of climate change in MCW, we can expect to see more extreme precipitation and large temperature increases in winter and spring. This results in greater subsurface hydrological activity in the non-growing season and increased TP and nitrate losses.
- Although the increase in precipitation is smaller in summer, there is still potential for increased high flow conditions causing increased TP export, possibly due to changes in timing between large precipitation events increasing surface runoff.
- Controlled tile drain assessment is still in progress.



Location of the MCW in Canada. With the distribution of the climate station grid (green) and area inside London city limits (yellow) (photo credit: University of Waterloo)

Location

- Medway Creek sub-watershed (200 Km2) – Climate Change Scenarios
- Nissouri Creek sub-watershed (30 Km2) – Controlled Tile Drain Assessment
- Field Sites: Londesborough and Ilderton working farms

Partners

- UTRCA
- Institut de recherche et de développement en agroenvironnement
- Ouranos, Climate scenarios and services group
- University of Waterloo

Funders

- OMAFRA
- Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec
- Quebec-Ontario Cooperation for Agri-Food Research

Transferability

As these watersheds have characteristics similar to many others in the Lake Erie basin, results are transferable.

Contact Information

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Next Steps

Assess how the climate change scenarios will influence controlled tile scenarios

For More Information

- Biogeochemistry Research Group webpage.

Lessons Learned

- Nutrient losses will only worsen with time unless new or targeted BMPs are implemented within the Medway Creek watershed.
- The 40 percent TP spring load reduction target (from 2008 levels) needs to be reassessed as the climate changes and larger goals might be needed due to the increases in TP export.

1.17 University of Western Ontario & Canadian Rivers Institute

1.17.1 Identifying effects of nutrient enrichment on stream productivity through artificial stream experiments

Project Goals

1. Develop knowledge regarding how the amount and timing of nutrient loads to streams impact primary production in stream ecosystems
2. Determine the rate of nutrient uptake by instream primary producers and how nutrient availability and delivery impact these rates of uptake.

Project Description

Project goals will be achieved by conducting a series of nutrient addition experiments at the Thames River Experimental Stream Sciences (TRESS) Centre. Experiments will manipulate the timing and amount of bioavailable phosphorus being delivered to the artificial stream systems and resident primary producer communities. Project endpoints will include periphyton biomass, periphyton growth rate, periphyton community composition and periphyton uptake of P.

Results Summary / Expected Outcomes

Anticipated results include nutrient thresholds associated with periphyton growth and biomass for both pulse and press nutrient loads. As well as estimates of P uptake/retention by resident periphyton communities. These results will help inform estimates of assimilative capacity of streams in the Lake Erie Basin.

Next Steps

This project is ongoing with the next series of experiments to explore how ambient P concentrations impact nutrient uptake during pulse events.

Location

The TRESS centre is located at the Adelaide Pollution Control Plant in London, Ontario.

Partners

- City of London
- UTRCA

Funders

- City of London
- NSERC

Transferability

Results should be generally applicable to streams in the Lake Erie Basin and to stream ecosystems in general.

Contact Information

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1.18 University of Windsor

1.18.1 Combination of a red sand bed and chitosan biofilter for reducing phosphate in manure-generated wastewater

Location

Sebringville, ON in Perth East Watershed.

Partners

- UTRCA
- University of Windsor

Funders

- OMAFRA
- UTRCA

Transferability

This technology is transferable, with modifications, as a P reduction method to many point sources of phosphate.

Contact Information

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For More Information

Chitosan Bio-filter at Luckhart's Truckwash, Sebringville, Ontario Final Report: June-Nov 2015 Data.

Project Goals

The objective was to reduce phosphate in wastewater emanating from manure before it entered the watercourses.

Project Description

The project was set up at a truck wash. At this facility the wastewater, consisting of manure and cleaning fluids, is held in a primary treatment pond. The wastewater is then pumped into two smaller, shallower ponds (North and South) for further biotreatment in an artificial marsh. The water from the pond then collects in another pond. The red sand bed then receives the water from the last pond. The filtered water from the red sand bed is harvested via a sump pump buried 2 feet into the red sand bed. The water is then pumped into the biofilter which contains the iron chitosan and an agitator. The water was sampled for soluble P and total suspended solids at the outflow of the pond, outflow of the red sand bed and the outflow from the chitosan biofilter. The P levels were monitored at this site from June to Nov 2017. The data is contained within the attached report.

Results Summary / Expected Outcomes

The data clearly showed that a large red sand filter can lower PS levels in the 100 µg/mL range by ~100-fold. Furthermore, a combination of red sand and a 1 kg chitosan biofilter can significantly lowered the PS from manure to near PWQO levels (0.03µg/mL) and that under these conditions the iron-chitosan bio-filter was functional for over 2 months.

In the fall monitoring period, Nov, 2015, we observed that the PS levels entering the red sand increased by ~10-fold possibly due to concentration of the PS in the red sand bed during the low precipitation period Aug- Oct. The chitosan was able to lower these levels by 10-fold.

As these data indicate, combination of red sand and an iron-chitosan-flake biofilter are very effective in attenuating PS and TSS emanating from manure generated at a livestock transporter washing operation.

Next Steps

Future aims are to test the longevity of the red sand bed and use larger capacity biofilters with alternative fitration matrices such as derivatized phosphate binding sawdust.

Lessons Learned

Sampling is difficult in the dry parts of the summer. In addition, it is essential to coordinate with the landowner to ensure that the primary treatment ponds contain enough wastewater to drive the system.

1.18 University of Windsor

1.18.2 Microbial influences on nutrient flux from agricultural conduits feeding the Great Lakes

Project Goals

- Quantify how microorganisms (bacteria, archaea) are influencing nutrient flux (Nitrogen, Phosphorus, Carbon) between the sediment-water interface in agricultural conduits that feed the Great Lakes.
- Test the ability of novel molecular tools (metatranscriptomics) to assess and predict the impact of microbial gene expression on nutrient retention and release.
- •Assess how nutrient loads, land use patterns, and suspended sediment transport mediated by high-flow events relate to microbial activity in selected experimental plots.
- Obtain data that will be useful in incorporating microbial processes into models that compute and predict internal nutrient loading to shallow, eutrophic settings.

Project Description

- Fertilizer and manure application in agricultural practice can serve as non-point sources of nutrients (N, P, C, Fe) to the environment through runoff and sequestration in artificial (ditches) and natural (streams) conduit sediments.
- Microorganisms, including bacteria and archaea, are major drivers of nitrification/denitrification and phosphorus solubilization within sediments, and these processes can lead to increased bioavailability of N and P promoting downstream eutrophication.
- Using shotgun RNA sequencing techniques, this project seeks to quantify how microbial genes influence nutrient retention and mobilization from agricultural-sourced drains and tributaries.
- Several locations within agricultural Essex County, Ontario, will be used as study systems to develop and test hypotheses related to N and P retention and release as facilitated by sediment-bound microorganisms. Sites include a farm located upstream from a Provincial Water Quality Monitoring Network (PWQMN) station at Big Creek (Lakeshore), and a well-resolved experimental plot in use by AAFC.

Assessing the amount of snow/ice on Big Creek. Winter 2017, near Comber, Lakeshore (photo credit: Chris Weisener)

Location

- Municipality of Lakeshore
- St. Clair River – Lake St. Clair – Detroit River Watershed

Partners

- AAFC
- City of Windsor
- ECCC
- ERCA
- MOECC
- Ontario Greenhouse Vegetable Growers

Funders

NSERC

Transferability

To our knowledge, this is the first study to assess in situ microbial gene expression as a potential internal nutrient loading influence on the tributaries of Lake St. Clair and the western basin of Lake Erie. It is anticipated that this data will be transferable to other watersheds in Essex and Kent County and can be used to develop and test future hypotheses related to the biogeochemical processes that exert control over N and P behaviour in agricultural conduits.

Contact Information

- Dr. Christopher Weisener (Associate Professor)
  University of Windsor
  519 253-3000 Ext 3753

Next Steps

- Working with partners from MOECC and AAFC to design a temporal and spatial sampling strategy in the Big Creek area in the municipality of Lakeshore.
- Deploy passive sediment samplers.

Lessons Learned

To capture the effects of stochastic pulse events (snow melt/storms) on conduit chemistry and suspended sediment load, it may be necessary to deploy passive sediment samplers on a seasonal basis.

Results Summary / Expected Outcomes

It is hypothesized that correlations exist between measurable nutrient flux at the sediment-water interface and microbial gene expression patterns across transects that run from agricultural plots to tributaries that drain into the Great Lakes.

PhD Candidate Nick Falk retrieving a passive sediment sampler. Winter 2017, Big Creek, Lakeshore (photo credit: Chris Weisener)

1.19 Upper Thames River Conservation Authority
1.19.1 Controlled drainage

Project Goals

- To evaluate the effectiveness of controlled drainage at reducing nutrient (P) losses.
- To explore the benefits and limitations of the Best Management Practice (BMP) in a Southwestern Ontario landscape.
- Reducing nutrient loads from tile drainage on a field-scale may be one way to reduce phosphorus losses from rural non-point sources.

Study area (photo credit: UTRCA)

Project Description

Reducing nutrient loads from tile drainage on a field-scale may be one way to reduce phosphorus losses from rural non-point sources. This research project aims to understand the potential impact of controlled drainage on nutrient export in different regions of Ontario.

- Controlled drainage, or drainage water management, uses a water control structure to restrict tile flow during certain time periods when drainage is not needed.
- Gates in the control structure can be closed during the non-growing season to limit excess drainage and nutrient loss. Gates are opened prior to planting a crop to ensure suitable conditions.
- Gates can be closed again during the growing season to store water and nutrients in the field for crops to access. If necessary, gates are opened again prior to harvest to allow drainage for equipment traffic.
- Controlled drainage conserves water by increasing retention time in the soil profile.
- At both sites, a controlled drainage plot is compared to a free-drain plot on working farms
- Sites are monitored for flow and water chemistry of the tiles.

Results Summary / Expected Outcomes

- The project is in its second and fourth year of study, at the Middlesex and Essex sites respectively.
- Monitoring results to be analyzed and available in the summer of 2018.

Location

- Site #1: Middlesex County, Medway Creek Watershed (a tributary of the Thames River)
- Site #2: Essex County, draining into the Western Lake Erie Basin

Partners

- AAFC
- ERCA
- Landowners
- OMAFRA
- University of Manitoba
- University of Waterloo (Merrin Macrae and Michael Funk)
- UTRCA

Funders

- AAFC
- MOECC

Transferability

- This BMP is easily adapted to any agricultural field with tile drainage and minimal topography.
- As a potential tool for management of nutrient losses and climate change mitigation, controlled drainage is well-suited for Ontario.

Contact Information

- Michael Funk (Agricultural Soil & Water Quality Technician), UTRCA,
  519-451-2800 ext. 305,
  funkm@thamesriver.on.ca

Next Steps

- After the effectiveness of the practice is better understood, organizations can determine the widespread applicability of the BMP in reducing nutrient pollution into Lake Erie.
- Implementation and promotion of the BMP to follow.

Lessons Learned

- Controlled drainage requires adaptive management by the landowner, depending on climate and soil type.
- Scientific research papers will be published as a deliverable to this project
- Excellent demonstration sites used for educational field tours.

For More Information

- OMAFRA Publication AF150 - Best Management Practices for Phosphorus
- Agricultural BMP's page from UTRCA website
- Controlled Drainage: Use of Controlled Drainage is Spreading in Ontario
- Controlled Drainage: Measuring the Economic and Environmental Benefits

Photos and Youtube Videos

- UTRCA Flickr album – "Controlled Drain Project" May 2014
- UTRCA YouTube video – "Agriculture Drain Solution" May 30, 2014

UTRCA's Brad Glasman (Manager of Conservation Services) installing a controlled drain with a landowner (photo credit: UTRCA)

1.19 Upper Thames River Conservation Authority
1.19.2 Phosphorus retention along a restored stream channel

Project Goals

To determine the effect of channel naturalization on phosphorus and sediment transport.

a. Understand the ability of a restored stream channel to retain phosphorus
b. Compare phosphorus concentrations within sediment and vegetation
c. Characterize the transport of sediment along the stream reach

Project Description

Experiment One:

- The capacity for restored section to retain phosphorus tested by measuring the following parameters:
  - Physicochemical water quality parameters
  - Phosphorus content in sediment and vegetation
  - Vegetation and sediment biomass
  - Soil texture

Experiment Two:

- Phosphorus concentrations artificially increased in the restored and control stream reach
  - New control selected upstream to test unrestored conditions
- Potassium phosphate solution slowly added to the water over two hour timeframe using a constructed drip system
- Water samples collected at set intervals from 5 transects to assess the timing of phosphorus transport and the location of phosphorus uptake.
- Sediment samples collected pre and post spike to compare phosphorus concentration.

Results Summary / Expected Outcomes

Experiment One:

- Natural channel design displays the potential to function as designed for sediment transport
  - Greater silt fraction behind rock barriers
  - Greater sand and gravel fraction in-stream
- In-stream sediment had a greater potential to release phosphorus to the overlying water column, whereas total phosphorus content greater in sediment behind rock deflectors
- Canary Reed Grass had the greatest potential to release phosphorus due to high phosphorus content and biomass
  - The release of phosphorus from these species requires bankfull flow events

Experiment Two:

- Overall results were inconclusive and no trends emerged in the data
- Difference in physical soil properties and chemical properties of water column behind the rock deflectors may indicate different phosphorus cycling processes occur, however this requires further study to conclude.

Location

Section of the Medway Creek in the Medway Creek sub watershed.

Partners

- Dr. Adam Yates, Western University
- Dr. Merrin Macrae and Biogeochemistry Lab, University of Waterloo
- Henry Jun, MOECC
- Landowner co-operator
- UTRCA

Funders

MOECC from the Great Lakes Protection Initiative

Transferability

- The meandering pattern used to restore this stream can be mimicked across rural drains to flush sediment from stream reach, improve stream bank stability and reduce the transport of fine textured particles
- Potential to couple in-stream restoration with in-field or edge of field best management practices
- Results can aid in understanding the potential for the retention or mobilization of P from both vegetation and sediment

Contact Information

- Tatianna Lozier (Agricultural Soil & Water Quality Technician)
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Next Steps

- Study generated baseline dataset of the current distribution of P along a restored section of the stream
- Further research needed to understand the seasonality of phosphorus mobilization and retention in order to fully understand the ability of the low flow channel to act as a sink for phosphorus
- Future research should evaluate the physical and chemical properties within the rock deflectors to understand whether they are contributing to a phosphorus sink
- Consider should be given to alternative techniques to understand in-stream processes and monitor alternative physio-chemical properties as indicators for soil health

Lessons Learned

Experiment One:

- The low flow channel was designed to meet engineering specifications. However, field observations indicate the channel should be narrowed by an additional 30% to enhance physical function and encourage greater nutrient assimilation through the system.
- Challenge to collect meaningful in-stream water quality data under drought conditions. It may be beneficial to explore alternative techniques to understand processes under low flow conditions.
- The initial results of this study show the potential for low flow channel construction to increase phosphorus assimilation within drainage networks of the Great Lakes basin.

Experiment Two:

- An inconclusive data set may be related to several factors
- Incomplete mixing between the spike solution and stream limited the detection of the spike solution in the first 50m downstream
    - This limited the ability to calculate a retention time for the remaining transects
- Difficulty collecting representative soil samples
    - Variably in the sediment composition among soil core samples may have limited the ability to accurately reflect phosphorus uptake
    - An increased number of replicate soil samples may reduce variability in the data
- Narrow window of time available for experiment, due to requirement for characteristic flow and weather conditions.
- Based on the inconclusive results relating to phosphorus retention from both experiments, it is recommended that other stream health indicators be explored as options to evaluate the impact of stream restoration
    - Biological indicators
    - Alternative physical and chemical properties

1.19 Upper Thames River Conservation Authority

1.19.3 Resaturating riparian buffer strips to reduce nutrient losses in tile drainage

Project Goals

- Monitor the effectiveness of this edge of field BMP
- Enhance the function of riparian buffer strip
- Reduce peak flow volume in tile
- Reduce nitrate and dissolved phosphorus from tile drainage
  - Sorption to soil
  - Plant uptake
  - Microbial transformation

Project Description

Implementation of this project is scheduled for Spring 2018.

- Main tile intercepted at the edge of the field and the buffer using a control box.
- Water redirected into lateral pipe that runs underneath the buffer and parallel to the adjacent watercourse.
- Gates in control structure set to regulate the amount of water into the buffer strip.
- Creates elevated water table within the buffer.
  - Brings tile water to the most biologically active area of the soil.
  - Creates hydraulic gradient to move the water from the buffer to the adjacent watercourse

Results Summary / Expected Outcomes

- Data collection is background and sampling will begin Spring 2018
- Nutrient removal efficiency to be determine by monitoring the following parameters:
  - Continuous level and flow from tile drainage
  - Continuous water table level
  - Nutrient concentrations before and within the buffer strip
  - Soil samples will be collected prior to installation as well as periodically over the monitoring period to assess nutrient saturation of the buffer soil.

Next Steps

- Watershed is being modelled to determine impact of BMPs on water quality, as well as to assess future impacts of expanded work.
- Continued monitoring of water quality, flow and land use practices.

Location

- Middlesex County
- Oxbow Creek subwatershed

Partners

- UTRCA
- University of Western Ontario

Funders

- OSCIA
- OMAFRA

Transferability

Research from Midwest United States finding this BMP is a highly cost effective practice to effectively removes nitrate from tile drainage

Contact Information

- Tatianna Lozier (Agricultural Soil & Water Quality Technician), 519-451-2800 ext. 233 loziert@thamesriver.on.ca

1.19 Upper Thames River Conservation Authority
1.19.4 Tertiary wetland for treatment of agricultural runoff

Location
Perth, Trout Creek

Partners
- Upper Thames River Conservation Authority
- Farmer co-operators

Funders
OMAFRA (COA)

Transferability
Wetland construction and enhancement is a promoted BMP in many watersheds.

Contact Information
- Tatianna Lozier (Agricultural Soil & Water Quality Technician), 519-451-2800 ext. 233 loziert@thamesriver.on.ca

Next Steps
- Establish vegetation within shallow areas of wetland to enhance sediment filtration and nutrient uptake
- Install monitoring wells around wetland to quantify groundwater contributions
- Potential to monitor outputs between cells to determine where within the wetland sediment or nutrient reduction is occurring
- Long-term monitoring past the post construction phase of the wetland.

Project Goals
Re-direct and slow a proportion of agricultural runoff through a constructed wetland to remove nutrients and sediment
- Determine the nutrient removal efficiency of the wetland
- Evaluate the practicality of a wetland to compliment a suite of BMPs.

Project Description
- A 3 cell tertiary wetland captures and treats runoff from 100ac of agricultural land
  - Both tile and surface runoff drained through municipal drain
- Designed to capture 100% of flow during low flow periods and the first 6 inches during high flow periods.
- Bi-weekly and event samples collected from the inlet and outlet of the wetland
- Sample analyzed for total phosphorus and soluble reactive phosphorus
- Inlet and outlet tile instrumented with calibrated V-notch weir and data logger to record water level

Results Summary / Expected Outcomes
- Challenge to monitor wetlands due to the complexity of potential flow paths
  - Defined inlet and outlet helps to limit sampling locations
- Results to date are preliminary and will be analysed Spring 2018

Tatianna Lozier (Agricultural Soil & Water Quality Technician) looks on over wetland construction at Wildwood Conservation Area (photo credit: UTRCA)

Photos and YouTube Videos
- Constructed Wetland at Wildwood Conservation Area Flickr album
- Rural Wetland Construction video
- Constructed Wetland in Perth County video

1.19 Upper Thames River Conservation Authority
1.19.5 Treatment of dairy farm runoff with slag filter

Project Goals

Slow, control and treat runoff from bunker silos and barnyard, and determine the phosphorus removal efficacy of a slag filter.

Project Description

- Multi stage field scale filter system was designed to capture and treat runoff from dairy farm
  - Runoff from bunker silos and barnyard area flows into settling area, which outlets into a slag filter through a standpipe. The water upwells through the slag filter to flow through a final filter strip
- Slag filter is the main phosphorus removal mechanism
  - Trench filled with blast furnace slag
- Sample collection began Spring 2017
  - Samples are collected below the slag filter (pre-treatment) and above the slag filter (post treatment) to determine the removal rate of phosphorus

Results Summary / Expected Outcomes

- Filter system alone not effectively reducing phosphorus
  - Slag media is the primary removal mechanism for phosphorus
  - Slag material is calcium based and therefore precipitation as calcium-phosphates is the primary removal mechanism for phosphorus in solution
- Flow dynamics through the filter were tested by measuring the difference in pH and calcium between the bottom and top of the filter
  - Greater pH, lower Ca and P after the water upwells through the slag filter indicates that calcium and phosphorus are precipitating out of solution
- Average total phosphorus reduction of 97% observed over sample time period
- Large proportion of phosphorus entering the filter in dissolved form
  - Settling area and filter sock on standpipe aid to reduce sediment entering the slag filter

Location

Oxford County, North Woodstock.

Partners

- AAFC
- Landowner cooperator
- University of Waterloo
- County of Oxford, CWP
- TRCWR
- UTRCA

Funders

- MOECC, Showcasing Water Innovation Project
- OMAFRA (COA)
- CWP

Transferability

- Dairy farms are continually increasing in size so potential for harmful leachate in runoff will increase proportionately
- Filter system could provide an option to treat runoff
  - Area of land required will depend on the volume of water from silos and barnyard area
- Slag media has the potential to treat both point and non-point sources of phosphorus and can be utilized in a variety of applications

Contact Information

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Next Steps

- Precipitation reactions have formed a hardpan layer on the filter, which should be broken up to ensure the system will not being short circuited through preferential flow paths
- Sampling should continue to verify continued removal efficiency of the slag material
  - Consideration should be given to monitoring additional parameters such as calcium and pH to validate phosphorus removal
- Instrumenting the slag filter with a multi-level piezometer could indicate phosphorus removal with depth through the filter
- Utilize lifespan estimation software (ie. Phrog) for slag media and evaluate changes in removal efficacy overtime

Lessons Learned

- Difficult to retrofit project for monitoring objectives
  - Considerations for future monitoring potential should be anticipated prior to construction
- Winter sampling a challenge
  - During cold temperatures, surface water across the system freezes. This limits functionality of the filter and sampling potential

Wensink Diagram (photo credit: UTRCA)

For More Information

- Ontario's First Farm-scale Phosphorus Filter

1.19 Upper Thames River Conservation Authority
1.19.6 Upper Medway Priority Subwatershed Project

Project Goals

The Priority Subwatershed Project (PSP) is designed to evaluate the effectiveness of a focused stewardship approach at achieving measurable improvements in soil health and water quality. It will help to determine the effectiveness of BMPs at reducing phosphorus loading into a watercourse.

Project Description

Through BMPs, this project will attempt to reduce phosphorus losses from rural non-point sources using cost-effective practices that benefit both the environment and the farm operation.

- Landowners within the target watershed were approached with cost-share funding as an incentive to implement BMPs in an intensive effort to reduce phosphorus losses into the Upper Medway Creek.
- The BMPs offered included conservation tillage, cover crops, in-field erosion control structures, buffer strips, and phosphorus management.
- Water quality is monitored using event-based sampling to determine if phosphorus loading in the Upper Medway Creek subwatershed is reduced.
- Land management and water quality data is used by researchers at the University of Guelph to model the potential impacts of BMPs.
- The three year project began in late 2015. Results from the project will be available in 2018.
- The Upper Medway project is running simultaneously with five other subwatershed projects in the Lake Erie basin.

Upper Medway landowner and UTRCA Agricultural Soil & Water Quality Technician, Mike Funk (photo credit: UTRCA)

Location

Composed of roughly 4,000 acres of predominantly agricultural land, the Upper Medway subwatershed is located in Lucan-Biddulph Township in Middlesex County.

Partners

- AAFC
- ABCA
- ERCA
- Hensall District Co-op
- LTVCA
- OMAFRA
- OSCIA
- University of Guelph, Wanhong Yang
- University of Waterloo, Merrin Macrae
- Upper Medway Landowners

Funders

AAFC and OMAFRA through Growing Forward 2.

Transferability

With locations across the Lake Erie basin, the Priority Subwatershed Project has representative watersheds across different landscapes. Results are expected to be comprehensive and applicable to other watersheds.

Contact Information

- Michael Funk (Agricultural Soil & Water Quality Technician)
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Next Steps

- Continued monitoring of water quality, flow and land use practices.
- Watershed is being modelled to determine the impact of BMPs on water quality, as well as to assess future impacts of expanded work.

Lessons Learned

- Phosphorus reduction is a complex task that takes time to measure in a large-scale agricultural setting.
- Relationships and trust are needed to promote collaboration with landowners.
- Practices that reduce phosphorus losses can also be an economic benefit to landowners.

For More Information

- OMAFRA Publication *AF150 - Best Management Practices for Phosphorus*
- Agricultural BMP's page from UTRCA website

Results Summary / Expected Outcomes

- 18 landowners have implemented a total of 32 projects. Even more landowners have been involved through outreach efforts.
- The most popular BMPs among landowners were conservation tillage, cover crops, and phosphorus management (optimizing nutrient placement and timing).
- A water quality dataset is being built for the subwatershed and stored using WISKI software on the UTRCA network. Continuous flow monitoring at the subwatershed outlet, event-sampling for water quality, and event-based grab sampling for tributaries within the subwatershed is also occurring.
- Edge-of-field cover crop monitoring plots are being used to develop proof of practice. The plots have been monitored since January 2014.
- Land management data (crops, tillage, soil cover and fertilizer management) is being collected from landowners and stored on the UTRCA network.
- A soil chemistry database has been built for the subwatershed and stored on the UTRCA network. Hensall District Co-op helped to sample the subwatershed for soil chemistry parameters, including nutrient levels.
- Relationships have been built through one-on-one conversations and outreach activities, including a series of tailgate meetings to transfer knowledge and science to help landowners with management decisions.

Pictures & Youtube Videos

- Innovative Erosion Control
- Underwear Soil Test!
- Soil & Water Conservation
- Landowner Workshop
- Priority Watershed – Medway Creek
- Conservation Work on the O'Shea Farm
- Soil Your Undies Challenge
- New Way to Keep Soil on Farmland

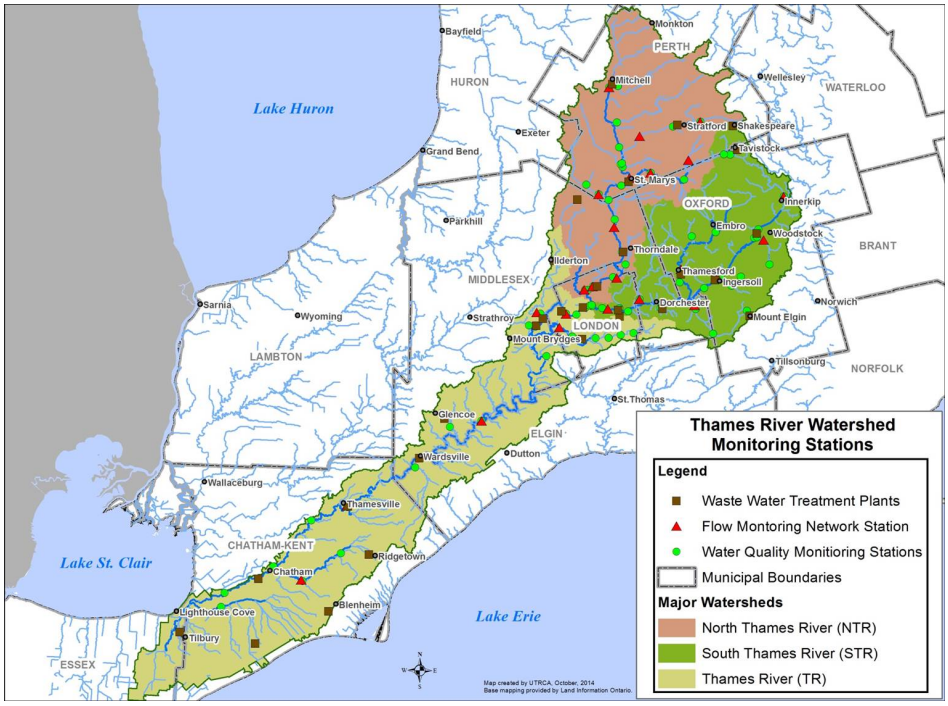
Cost shared BMPs on an Upper Medway landowner's farm (photo credit: UTRCA)

1.19 Upper Thames River Conservation Authority

1.19.7 Water quality assessment in the Thames River watershed – phosphorus loadings

Project Goals

In 2015 an assessment of available water quality and flow data for the Thames River was completed to determine loadings of phosphorus and sediment at Thames River and tributary locations across the watershed. The goal was to provide information, based on water quality data, to assist in understanding the source areas and timing of delivery of nutrient and sediment contributions to the Thames, for the purpose of informing ideas on implementation.



Thames River monitoring stations (photo credit: UTRCA)

Project Description

- This study assessed long-term monitoring data for the entire Thames River system. Freshwater Research (G. Nurnberg Ph.D. and B. LaZerte Ph.D.) conducted the water quality assessment providing data analysis, and scientific assessment. A large temporal (24 years of data within 1986-2012) and spatial (83 stations) sampling of water quality combined with daily flows from 26 flow gauges made it possible to describe and assess the variation of nutrients and sediments throughout the Thames River watershed. The study assessed available data sources including:
- 83 water quality monitoring stations. This includes Provincial Water Quality Monitoring Network, City of London river data, Environment Canada tributary loading data, subwatershed studies data (e.g. Nissouri Creek), and data collected during runoff conditions specifically for this study.
- 26 stream gauge stations for continuous flow data (Water Survey Canada, and UTRCA data)
- 30 wastewater treatment plants (discharge monitoring data)

Location

Thames River Watershed, Thames River and tributaries

Partners

- City of London
- ECCC
- Freshwater Research
- LTVCA
- OMAFRA
- MOECC
- UTRCA
- Western University

Funders

MOECC: Showcasing Water Innovation program

Transferability

Information obtained through this study was used to inform recommendations in the Thames River Shared Waters Approach to Water Quantity and Quality (2018), where one key goal is the reduction of phosphorus loadings in the Thames.

Contact Information

- Karen Maaskant (Water Quality Specialist)
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Next Steps

This study was an initial assessment of available water quality and quantity data with the goal of furthering the understanding of nutrient loadings, specifically for the Thames watershed, to help to inform priorities for implementation. Ideally future studies will build on this initial assessment to expand the understanding of loadings and further inform best actions to meet the phosphorus reduction goals for the Thames.

For More Information

Water Quality Assessment in the Thames River Watershed – Phosphorus and Sediment Sources, G. Nurnberg and B. LaZerte Freshwater Research, 2015.

- The time period of 1986 - 2012 was analysed to assess relatively recent conditions and still have enough data available to conduct a detailed analysis. Previous studies found that total phosphorus concentrations were significantly higher prior to this time period, in the 1970's
- The assessment of data focused on the three main sections of the Thames. A number of tributaries within these main river sections were also evaluated based on data availability
  - North Thames River from headwaters in Mitchell and Stratford to the forks in London
  - South Thames River from Tavistock to the forks in London
  - Thames River drainage area from the forks in London to the outlet of the Thames at Lake St. Clair
- Analyses Methods: The study assessed both loads and flow weighted concentrations. Three different models were used to calculate flow-weighted average concentration and loads depending on data availability. Both EGRET (model based on U.S. Geological Survey program of Weighted Regressions on Time, Discharge and Season) and GAM (General Additive Model based on an optimally weighted regression with smoothing) include a relationship between flow and concentration.

Highest loads occur during high flows in the winter and spring - North Thames River February 2018 (photo credit: UTRCA)

Results Summary / Expected Outcomes

- The study shows that the total load of phosphorus and sediment in the river that eventually reaches Lake St. Clair is highly dependent on water flows. Annual loads vary, influenced by annual flows. Loads follow the seasonal pattern of flows so that the highest loads occur during wet periods in the winter and spring. Approximately 75% of loadings occur during wet weather and snowmelt events (EC data).
- Phosphorus loadings are contributed from across the Thames River watershed, with:
  - 60% of the average annual total phosphorus load contributed upstream of the forks in London in the Upper Thames River watershed (North Thames branch and South Thames branch)
  - 40% of the load is added to the river from the Forks in London to the outlet at Lake St. Clair.

- Sediment loads are contributed from across the Thames River watershed, with:
    - 35% of the load contributed upstream of the forks in London in the Upper Thames River watershed (North Thames branch and South Thames branch),
    - 65% of the average annual sediment load contributed from the Forks in London to the outlet at Lake St. Clair.
- Results suggest that all tributaries across the watershed contribute to the phosphorus load in the Thames. Loads are cumulative, increasing from the headwaters towards the Forks in London, where the North Thames and South Thames Rivers combine, and further increase towards the mouth. Data was deemed adequate to determine load estimates for some locations including: about half of the 28 watersheds in the Upper Thames and main branches; and main Thames River sites and McGregor Creek in the Lower Thames. This data gives a general understanding of phosphorus loading from tributaries/watersheds in the Thames, many of which have similar land use.
- The study estimated the annual export of nutrient and sediment loads from the Thames River into Lake St. Clair at 342 tonnes/year TP, 187 t/yr SRP, and 113,000 t/yr total suspended sediment.
- Non-point sources (runoff from rural and urban areas) dominate total phosphorus loads, contributing approximately 85% of the load in the Thames. The 30 wastewater treatment plants in the Thames River watershed contribute approximately 15% of the total phosphorus load.
- The numerous small and larger dams and reservoirs along the Thames River and its tributaries can affect the timing of phosphorus and sediment load delivery through the watershed. During times of high load delivery (major flow events) much of the load can move through the small and large reservoirs; however, some of the phosphorus load will be temporarily retained in bottom sediment and later released into the water.

Section of the Thames River	Area km^2	TP Average Annual Load %	TSS Load %	TP Load tonne/km^2	TSS Load tonne/km^2
South Thames River Tavistock to Forks in London	1346	28%	16%	0.06	13.46
North Thames River Mitchell, Stratford to Forks in London	1427	32%	18%	0.07	14.25
Thames River Forks in London to Lake St. Clair	3089	40%	65%	0.04	23.97