



Knowledge Gaps Update: Nature-based Solutions to Manage Runoff

Background

In the late 1990's, harmful algal blooms (HABs) re-emerged as a complex problem for lakes of all sizes in the Great Lakes region. Voluntary measures to curb "nonpoint" nutrient losses from agriculture fields have accelerated, yet few concrete improvements have been made to the duration and intensity of HABs in the Great Lakes and smaller, inland lakes and rivers. Great Lakes surface water receives much of what happens on the land, with pollutants transported across watersheds. This fact sheet is focused on the scientific support needed to inform promising watershed management solutions. A companion fact sheet (Knowledge gaps: in-lake conditions) addresses scientific questions that require answers to better understand what is happening within our lakes.

What is known and unknown

With a large and diverse watershed including cities, agriculture, and industry, the Great Lakes are affected by many pollutants that enter waterways through runoff. More research is needed to stay ahead of changes within this ecosystem that provides drinking water to nearly 40 million people in the United States and Canada and forms the backbone of a \$9 trillion economy.

KNOWN

Around the Great Lakes basin, in both rural and urban areas, efforts to "slow the flow" are gaining momentum as the multiple benefits of stormwater storage become clear. Whether efforts are restoring wetland acres by breaking tiles on farmland or intentionally creating agricultural runoff treatment systems (ARTS) at a field's edge, these nature-based solutions have the potential to trap and store nutrients while attenuating flood risk and providing habitat for wildlife.

Urban stormwater solutions help to alleviate pressures on combined sewer systems.

Conservation ditches and natural channel design aid in the reduction of nutrients and sediments from being sent into waterways or downstream to the Great Lakes.

NOT KNOWN

More research is needed to better understand how efficient these nature-based solutions are in the capture and retention of nutrients over the long term. Important information about their management and longevity is also essential to prevent them from switching from beneficial "sinks" for phosphorus and nitrogen, into problematic "sources" of nutrients in a watershed.

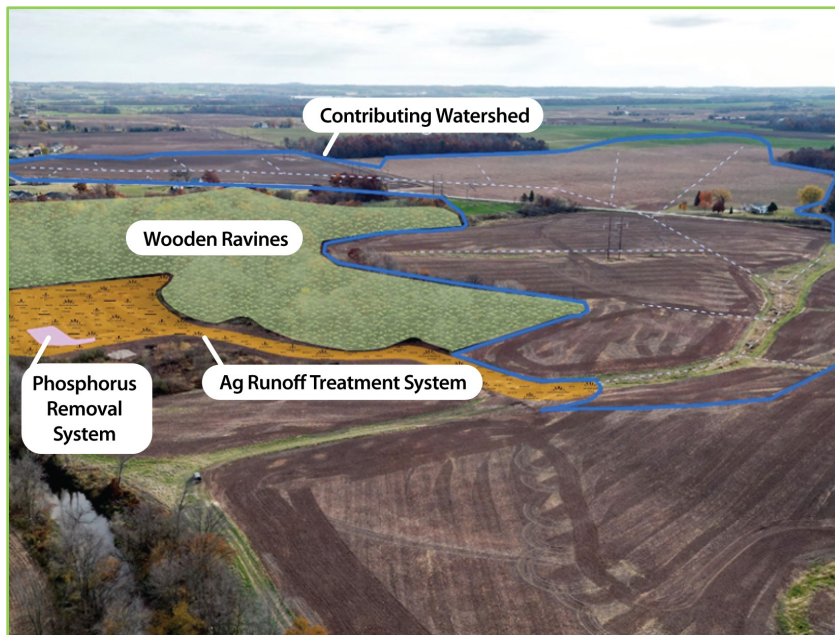
It is unknown which site-specific solutions for retaining stormwater could have the largest benefit for downstream waterbodies, in both rural and urban spaces. While remote sensing can help track landscape-level changes and identify water storage opportunities in the landscape, more research is needed.

It is unknown how legacy phosphorus (phosphorus that has accumulated in the soil, particularly from agricultural fertilization) affects the development of best management practices. To most optimally reduce nutrient loads waterways, more information is needed.

What is needed

- Fund research on nature-based solution effectiveness and legacy phosphorus
- Establish a program to improve remote sensing capabilities for stormwater storage planning

Current research highlights



Agriculture Runoff Treatment Systems (ARTS) was a term coined in 2017 in the Lower Fox River Basin of Wisconsin to represent an edge of field treatment train approach using Natural Resource Conservation Service standards as green infrastructure to mitigate the impacts of stormwater runoff from agricultural cropland. The primary goals of ARTS are to temporarily store runoff, reduce peak flows, and retain sediment and nutrients. In addition to treating edge of field runoff, the storing of water and returning peak flows to a pre-settlement condition has multiple benefits including the ability to append the outlet with a Phosphorus

Removal System (PRS) to remove dissolved phosphorus and the added downstream benefits of reducing stream-bank erosion and flooding.

This oblique image demonstrates an ARTS which Outagamie County Land Conservation District in Wisconsin installed on the landscape using Great Lakes Sediment and Nutrient Reduction Program funds, made available through the Great Lakes Restoration Initiative. The blue outlined area represents a cropland watershed of approximately 100 acres, with subsurface drain tile denoted by the dashed white lines. This watershed is intercepted by the ARTS footprint shown in orange and all runoff flows through a PRS, prior to discharging to Plum Creek and ultimately the Lower Fox River and the Bay of Green Bay. Annually this project is modeled to reduce 70 tons of sediment, 213 pounds of particulate phosphorus, and 184 pounds of nitrogen. This structural practice has permanent life expectancy with maintenance of trapped sediment being dredged every 10-15 years. Check out this ARTS introductory video our partners at The Nature Conservancy and Fox-Wolf Watershed Alliance helped us produce: <https://bit.ly/ARTSvideo>

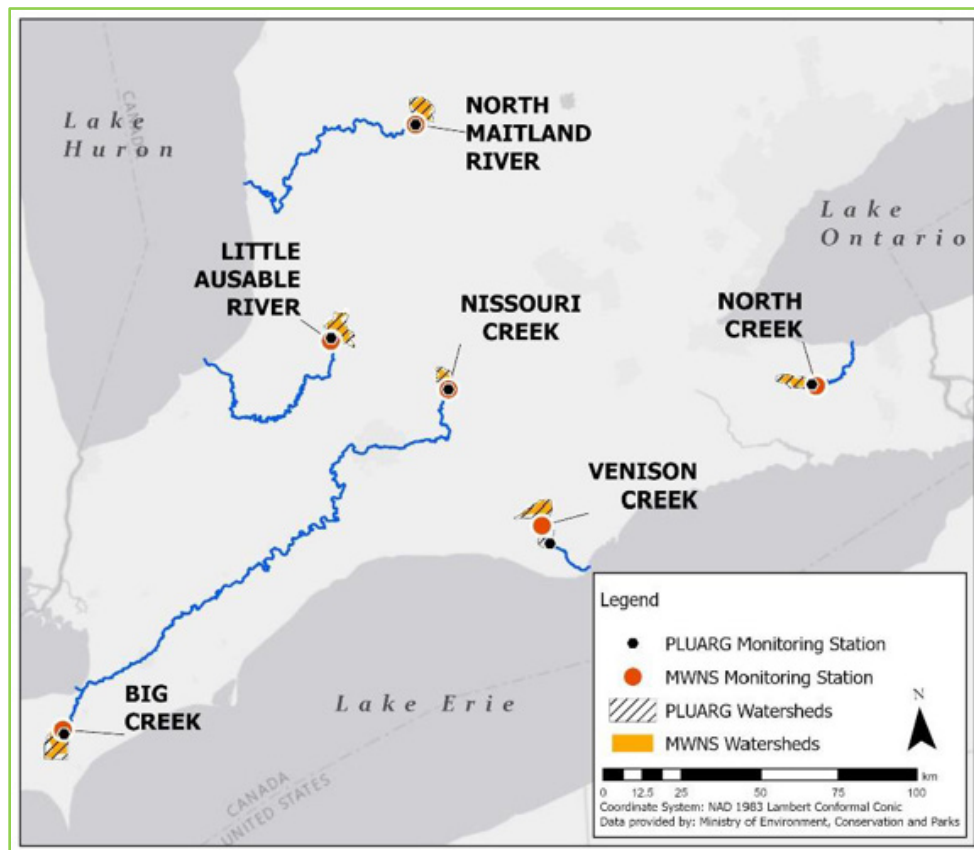
A recent study examined changes in the volumes and concentrations of nutrients and water volumes between the **1974 – 1978 Pollution from Land Use Activities Reference Group (PLUARG)** study and the **2016 – 2018 Ontario Ministry of Environment, Conservation and Parks (MECP) Multi-Watershed Nutrient Study (MWNS)** in the same watersheds. Both studies explored non-point nutrient sources in water from agricultural lands draining into the lower Great Lakes and are described in the Lake Erie Domestic Action Plan (2013) in response to recurring potentially harmful algal blooms and symptoms of eutrophication.

This study observed a shift in the seasonal timing of loading for important nutrients impacting algal growth, including phosphorus. During PLUARG years, the largest proportion of phosphorus loading occurred during the spring season but occurred during the winter and/or fall seasons during MWNS years. Relative to the 1970s:

- The amount of water moving over the watershed as runoff increased significantly in half of the watersheds.
- The amount of total and dissolved phosphorus leaving the watershed increased at nearly all study sites, by 50 – 125%.
- Total nitrogen and nitrate volumes exported from watersheds also increased at most sites.

This study highlights the importance of winter season monitoring for generating accurate loading estimates of nutrients entering the lower Great Lakes.

This piece is a summary of Then and Now: Revisiting nutrient export in agricultural watersheds within southern Ontario's lower Great Lakes basin (Nelligan et al. 2021, <https://doi.org/10.1016/j.jglr.2021.08.010>)



Study watersheds and monitoring locations of the 1970s (PLUARG) and the 2010s (MWNS) agricultural stream nutrient loading studies for the lower Great Lakes in Ontario, Canada.