A Certification Program for 4R Nutrient Stewardship

By Tom Bruulsema

The implementation of principles of 4R Nutrient Stewardship using a collaborative approach is helping to guide producers to adopt practices that benefit both their profitability and the health of Lake Erie.

Issue

Water quality and P loading have been connected issues for Lake Erie for decades. Lake Erie provides drinking water for millions of people, produces more than half the fish in the Great Lakes, and attracts many tourists. Algal blooms caused by nutrient loading threaten drinking water quality, beach quality, and coastal recreation. In addition, the nutrient loadings and algal blooms connect to a bottom water hypoxia issue in the Central Basin of the lake (IJC, 2014).

Programs established in the 1970s and 1980s have successfully reduced total P loadings per year from over 25,000 t in 1969 to 11,000 by the early 1980s (**Figure 1**). The majority of these loading reductions were achieved through controls on point sources such as sewage treatment plants. Increased use of conservation tillage on cropland is among the practices considered to have contributed to load reductions from nonpoint sources observed by 1995 (Richards et al., 2002).

Starting in the early 2000s, however, the western basin of Lake Erie began showing a resurgence of algal blooms similar to those that were frequent in the late 1960s to the early 1970s. In 2011, an algal bloom of unprecedented scale was documented by satellite monitoring. It became apparent that the increasing trend in bloom severity and extent paralleled an observed increase in loadings and concentrations of dissolved phosphate in the tributaries that drain a large area of productive cropland in northwestern Ohio and parts of Indiana and Michigan (**Figure 2**). Reasons for the increased phosphate in the tributaries are not fully understood, but it is recognized that several causes are probable. One major cause is changes in weather patterns, with increased frequency of intense rain in late fall and early winter, and increased river flows.

Nonpoint sources are estimated to contribute 71% of the dissolved and 89% of the total annual P load in the western Lake Erie watershed (Maccoux et al., 2016). Agriculture is considered a large source since it occupies over three quarters of the land area. Crop yields and P removed with harvested products have increased, but P application rates have not increased substantially during this period. As a result, the cropland P balance is changing from a small surplus to a small deficit (Jarvie et al., 2017). Aggregated soil sampling data indicates that the levels of P in the watershed's soils have not increased and instead the frequency of soils deficient in P has increased. In fact, Ohio soils are lower in available P than the soils of other states and provinces in the vicinity (Bruulsema, 2016). Practices such as tile drainage, broadcast application

Abbreviations and notes: P = phosphorus.

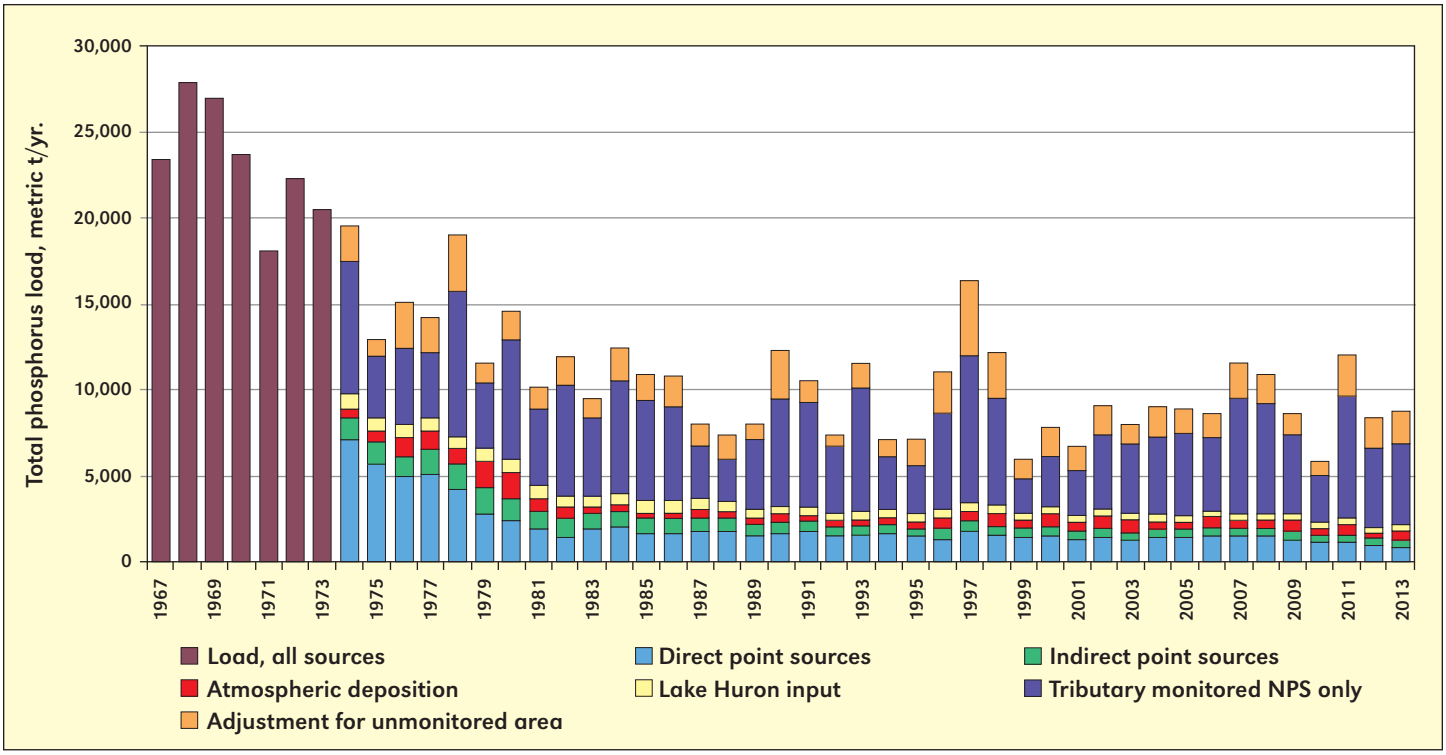


Figure 1. Total phosphorus loads to Lake Erie by source type (1967-2013). No source type attribution data are available prior to 1974. Source: Maccoux et al. (2016).

Figure 2. Much of the western Lake Erie watershed drains into the western basin of Lake Erie, which experienced increasing algal blooms from the mid-1990s to 2015. Source: http://4rcertified.org/about/

of fertilizer, and conservation tillage are identified as possible contributors to the trend in increased losses, but there are few consistent datasets on the frequency of these practices across the watershed over the time period.

Actions

By 2010, Ohio researchers from Heidelberg University had been reporting increases in loads and concentration of phosphate in the Sandusky and Maumee rivers, two of the major tributaries monitored in their water quality sampling program. The Andersons, a large agricultural retail business headquartered in Maumee, Ohio, began discussions with these scientists to better understand the issues. Recognizing that a large part of their business was located in the watershed, they became engaged, even to the extent of financially supporting the program monitoring the river P loads. Around the same time, the North American fertilizer industry was developing the concept of 4R Nutrient Stewardship—the application of the right source of nutrients at the right rate, right time, and right place. Working with the Nature Conservancy, The Andersons invited other local agricultural retailers, fertilizer industry associations, government agencies and environmental organizations to come together, with the aim of developing a specific implementation of 4R Nutrient Stewardship to change and document nutrient application practices toward reducing P losses. Following multiple engagement sessions, the stakeholders developed and agreed to support a voluntary program which became known as the Western Lake Erie Basin 4R Nutrient Stewardship Certification Program.

The program is directed at agri-retailers, and provides guidelines with criteria regarding the training of their staff, record keeping, on-farm recommendations and provided application services. Each participating retail location is audited to ensure consistency with the 41 criteria in the program. Regarding nutrient recommendations and applications, criteria include all plant nutrients, but are focused on practices relevant to reducing P losses. The criteria relate to source, rate, time, and place of nutrient application.

Source - they encourage utilization of all nutrient sources available to the producer, including manure, and appropriately considering the amounts of P available in these sources.

Rates - are based on soil testing and crop yield potential, and are not to exceed the recognized recommendations of the land grant university, unless the producer has documented results from on-farm adaptive research justifying a difference.

Timing - they assure that nutrients (including fertilizers, manures, and other sources) are not applied on soils that are frozen or snow-covered, and that surface broadcast applications are not made when large rainfall events are in the weather forecast.

Placement - they encourage injecting or banding P sources below the soil surface, and using variable rate applications accounting for within-field variability in soil P availability and expected removal of P by the crop.

It was recognized that while most of the practices listed above have been shown to reduce P losses while maintaining the opportunity to continue increasing crop yields, the knowledge base was insufficient to quantify the total reduction of P loss expected at the watershed scale, nor the amount contributed by each practice. Thus, the industry simultaneously agreed to support, through a 4R Nutrient Stewardship Research Fund, a project aimed at assessing the changes in practices and the resulting impacts on water quality.

Early Results

Since the program has only been in place for two years, it is too early to see direct impacts on water quality in Lake Erie. The approach, however, has demonstrated actual and potential benefits to the participating stakeholders.

The 4R certification program was launched in March 2014, though educational outreach to retailers had been underway since 2012. In its first two years, 30 retailers were certified. Through their producer customers, the reach of the certified retailers extends to over two million acres of cropland, including almost 40% of the agricultural land in the watershed (Vollmer-Sanders et al., 2016). Weather events in 2013 and 2015 featured unusually large amounts of rain in June and July, resulting in increased P loads and concentrations in the tributaries, and large algal bloom events. Against the backdrop of large weather effects, it is not possible to say as yet whether practice changes have been or will be effective in achieving the 40% load reduction agreed to by the collaborating federal, state, and provincial governments of the entire Lake Erie watershed (Government of Canada, 2016). Edge-of-field research on farm fields, however, is beginning to document efficacy of rate, time, and place practices in reducing losses. The research, initiated in 2014 and funded to continue through 2019, has documented the importance of losses through subsurface tile drains, and the connection to surface-placed P inputs by macropore flow through the soils.

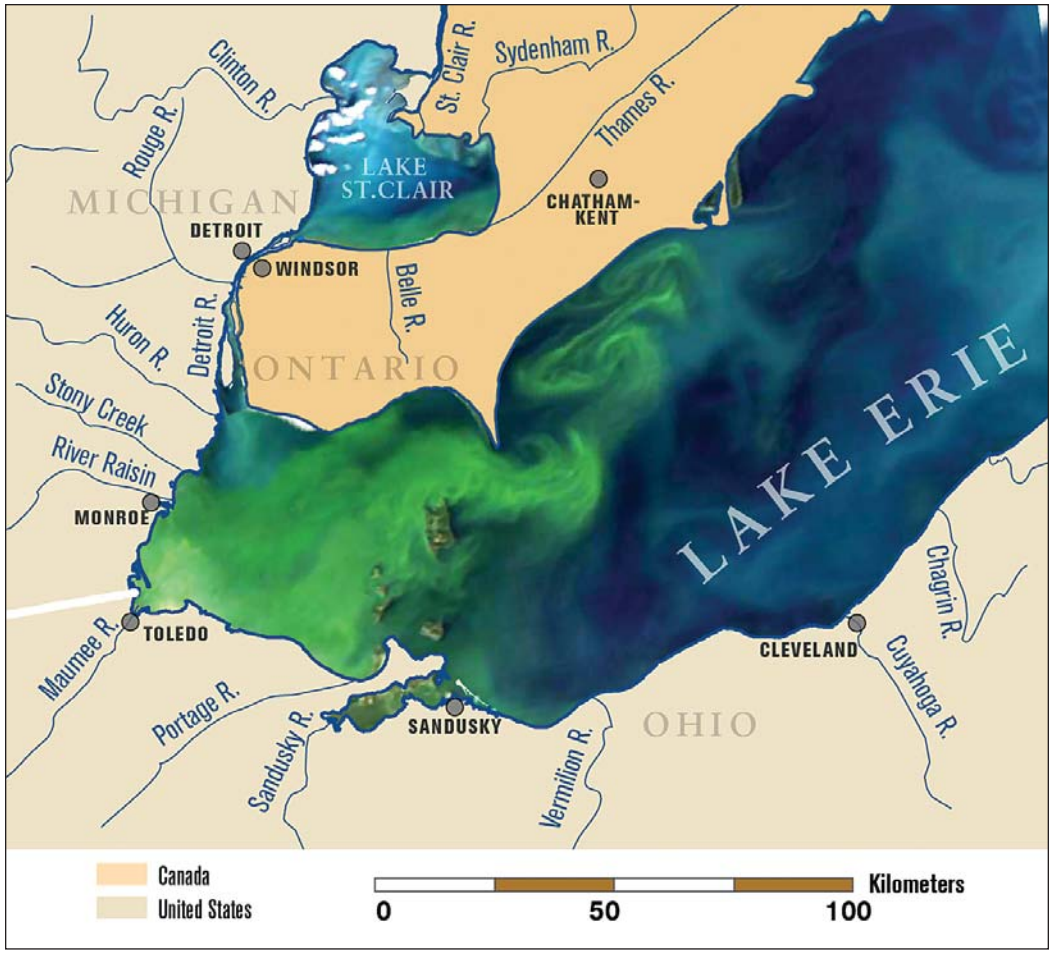
Agri-retailers are experimentally introducing equipment that places the commonly used granular forms of P fertilizer in the soil while retaining residue cover on the soil—combining

the benefits of conservation tillage in limiting losses of particulate P while using placement that limits loss of the dissolved form. This equipment can also apply at variable rates within the field, matching the P supply to crop need (Reese, 2014).

Conclusions

The value of the program was demonstrated during a widely publicized "do not drink" advisory issued for the City of Toledo's water supply in August of 2014. While the program was not yet at a stage to have impacted P losses or algal blooms, the many stakeholders involved were able to provide consistent messages about the efforts being made to address the issue. Subsequent public pressure for action resulted in the state of Ohio passing two legislative bills that made some aspects of the voluntary 4R program mandatory for all producers. Collaboration in developing the guidelines nevertheless provided benefits for all involved. Government agencies were able to get better buy-in to the regulations since they had been developed with stakeholder input. Retailers were well positioned and informed, enabling them to support their producer customers with assurance of regulatory compliance.

One remaining issue of uncertainty surrounds conservation tillage and its impact on P loading within the watershed. Incorporation or sub-surface injection of applied P is known to reduce loss risks for dissolved P, but the associated increase in soil disturbance may increase losses of particulate P through erosion. Additionally, owing to the large influence of weather on annual loads of P in the tributaries, many years may be required to detect the effect of this and other programs being implemented to reduce P loading from nonpoint sources.



Lake Erie algal bloom on September 3, 2011 (overlaid on a map of the lake and its tributaries) about six weeks after its initiation in the lake's western basin. On this date, it covered the entire western basin and began to expand into the central basin where it will continue to grow until October. Source: Michalak et al. (2013).

Acknowledgements

Appreciation is expressed to reviewers Chris Henney, Lara Moody, and Carrie Vollmer-Sanders. BC

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