Executive Summary

The Western Lake Erie Basin (WLEB) is important economically and ecologically. Over the past half century there has been increased focus on the interactions between land-uses and water quality in the region, as has occurred across the Nation. Roughly 73 percent of the land in WLEB is managed as cultivated cropland. Since the relationship between nutrients and Lake Erie were brought to public awareness nearly 50 years ago, WLEB agricultural producers, following the advice of scientists and policy makers, have consistently sought to adopt responsible agricultural practices that reduce the impacts of agriculture on the Great Lakes system, maintain yield stability, and support farming sustainability. This report covers some of the recent history of agricultural conservation and its impacts on water quality in WLEB. This report represents the second time that the Conservation Effects Assessment Project (CEAP) has completed a voluntary farmer survey in WLEB; the first survey was conducted in 2003-06, with the second conducted in 2012. Having two survey periods allows analysis of change over time in agricultural conservation adoption and estimation of the impacts of these changes on water and soil quality.

This is the second of two CEAP reports covering the 2012 Special Study in WLEB; the first report analyzed edge-of-field loss dynamics, while this report focuses on instream channel dynamics and their role in determining the relationships between edge-of-field conservation gains and gains made towards reducing sediment and nutrient load deliveries to Lake Erie and reducing deposition of nutrients and sediment in the ditches, channels, streams, and rivers of WLEB. While reductions in edge-of-field losses and lake delivery loads may have immediate impacts on water quality across WLEB, reductions in deposition rates may have significant impacts on future conservation outcomes. Nutrients and sediment deposited in the WLEB hydrological system from current and past land-uses may serve as legacy sources of nutrients and sediment well into the future, impacting delivery loads even as edge-of-field conservation efforts continue to reduce edge-of-field losses.

Conservation Gains in Western Lake Erie Basin (WLEB)

Between the 2003-06 and 2012 surveys, farmers continued to adopt conservation practices in WLEB. The impacts of these conservation practices are most obvious when the 2003-06 or 2012 Conservation Conditions are compared with what losses, loads, and deposition rates could be like if no agricultural conservation practices were ever adopted in WLEB.

Relative to if no conservation practices were in place:

- the 2003-06 Conservation Condition:
    - decreases sediment losses from cultivated croplands by 61 percent;
    - decreases sediment load delivery to Lake Erie by 29 percent; and
    - decreases sediment deposition in ditches, channels, streams, and rivers in WLEB by 65 percent.

    - decreases nitrogen losses from cultivated croplands by 22 percent;
    - decreases nitrogen load delivery to Lake Erie by 16 percent; and
    - decreases nitrogen deposition in ditches, channels, streams, and rivers in WLEB by 26 percent.

    - decreases phosphorus losses from cultivated croplands by 53 percent;
    - decreases phosphorus load delivery to Lake Erie by 39 percent; and
    - decreases phosphorus deposition in ditches, channels, streams, and rivers in WLEB by 60 percent.

- the 2012 Conservation Condition:
    - decreases sediment losses from cultivated croplands by 80 percent;
    - decreases sediment load delivery to Lake Erie by 40 percent; and
    - decreases sediment deposition in ditches, channels, streams, and rivers in WLEB by 84 percent.

    - decreases nitrogen losses from cultivated croplands by 26 percent;
    - decreases nitrogen load delivery to Lake Erie by 17 percent; and
    - decreases nitrogen deposition in ditches, channels, streams, and rivers in WLEB by 37 percent.

    - decreases phosphorus losses from cultivated croplands by 61 percent;
    - decreases phosphorus load delivery to Lake Erie by 41 percent; and
    - decreases phosphorus deposition in ditches, channels, streams, and rivers in WLEB by 72 percent.

Comparison Between 2003-06 and 2012 Conservation Conditions

A primary benefit of conducting the 2012 National Resources Inventory (NRI) CEAP-Cropland Farmer Survey is that it allows comparison of conservation benefits achieved at two points in time, in 2003-06 and 2012. Current APEX and SWAT modeling capacities allow estimation of changes in edge-of-field nutrient and sediment losses and load deliveries to Lake Erie, as well as estimation of changes in instream dynamics. Simulated instream or channel dynamics provide estimates of the amount of sediment and nutrients being deposited and or remobilized annually under simulated conditions. Sediment and nutrients deposited in the WLEB hydrological system from past, current, or future land-uses may serve as sediment and nutrient sources, impacting delivery loads and masking edge-of-field conservation gains.

As shown above, relative to if no practices were in place, the 2003-06 Conservation Condition provides significant benefits to reducing sediment and nutrient losses from the edge of cultivated cropland fields, reducing the amount of sediment and nutrients delivered to Lake Erie and reducing the amount of sediment and nutrients deposited in ditches, channels, streams, and rivers. The 2012 Conservation Condition provides additional benefits to those provided in the 2003-06 Conservation Condition. The outcomes noted below call attention to the significant roles that deposition and resuspension play in instream dynamics in WLEB ditches, channels, streams, and rivers.

Relative to the 2003-06 Conservation Condition, the 2012 Conservation Condition:

- decreases sediment losses from cultivated croplands by 47 percent;
- decreases sediment load delivery to Lake Erie by 14 percent; and
- decreases sediment deposition in ditches, channels, streams, and rivers in WLEB by 55 percent.

- decreases nitrogen losses from cultivated croplands by 6 percent;
- decreases nitrogen load delivery to Lake Erie by 1 percent; and
- decreases nitrogen deposition in ditches, channels, streams, and rivers in WLEB by 16 percent.

- decreases phosphorus losses from cultivated croplands by 17 percent;
- decreases phosphorus load delivery to Lake Erie by 3 percent; and
- decreases phosphorus deposition in ditches, channels, streams, and rivers in WLEB by 30 percent.

Hypothetical Conservation Scenario Simulations

Single-approach and Multiple-approach Conservation Scenarios were simulated and compared to the 2003-06 and 2012 Conservation Conditions. Single-approach Conservation Scenarios simulated include the adoption of structural practices, the adoption of appropriate nutrient management for all crops in all rotations, and the adoption of cover crops. Multiple-approach Conservation Scenarios simulated include the following combinations of Single-approach Conservation Scenarios: structural erosion control plus nutrient management; structural erosion control plus nutrient management plus cover crops; and structural erosion control plus nutrient management plus drainage water management. In the simulation of each hypothetical Conservation Scenario, all acres that could receive treatment under the rulesets of that Conservation Scenario were treated with the practices applied within that Scenario. Although farmers and policy makers would likely consider costs and benefits when making a decision to adopt a conservation practice or program, in these analyses we did not consider the potential impacts of conservation practices on crop yields or magnitude of conservation benefits.

This is the first CEAP-Cropland report that estimates impacts of conservation practices on legacy load dynamics in addition to edge-of-field losses and delivery loads to Lake Erie. Results demonstrate that adoption of a comprehensive conservation approach addressing all aspects of the Avoid, Control, Trap (ACT) conservation system should be undertaken on all cultivated cropland acres in WLEB in order to achieve maximum benefits from conservation practice adoption. There is no “Best Management Practice” that fits every conservation goal and every acre’s vulnerabilities. Instead, comprehensive conservation plans that pair complementary practices will provide the best management. Such plans are tailored to meet articulated conservation concerns in the context of farmer goals, soil needs, local weather, and other characteristics unique to each farmed acre. The most recent WLEB-CEAP report (2016) suggested that expansion of Variable Rate Technologies and soil testing may be important factors in achieving continued conservation gains in the region.

Relative to the 2012 Conservation Condition the most effective hypothetical Conservation Scenarios simulated here:

- for reducing edge-of-field sediment losses are:
  - Structural Erosion Control plus Nutrient Management plus Cover Crops (89 percent annual sediment loss reduction).
- for reducing sediment delivery loads to Lake Erie are:
  - Structural Erosion Control plus Nutrient Management plus Cover Crops (26 percent annual sediment load delivery reduction).

- for reducing sediment load deposition in ditches, channels, streams, and rivers in WLEB are:
    - Structural Erosion Control, Structural Erosion Control plus Nutrient Management, Structural Erosion Control plus Nutrient Management plus Drainage Water Management, and Structural Erosion Control plus Nutrient Management plus Cover Crops (100 percent annual reduction in sediment deposition; these four Scenarios lead to resuspension of previously deposited sediment).
- for reducing edge-of-field nitrogen losses are:
    - Structural Erosion Control plus Nutrient Management plus Cover Crops (54 percent annual nitrogen loss reduction).
- for reducing nitrogen delivery loads to Lake Erie are:
    - Structural Erosion Control plus Nutrient Management plus Cover Crops (42 percent annual nitrogen load delivery reduction).
- for reducing nitrogen load deposition in ditches, channels, streams, and rivers in WLEB are:
    - Structural Erosion Control plus Nutrient Management plus Cover Crops (59 percent annual reduction in nitrogen deposition) and Structural Erosion Control plus Nutrient Management, Structural Erosion Control plus Nutrient Management plus Drainage Water Management (42 percent annual reduction in nitrogen deposition).
- for reducing edge-of-field phosphorus losses are:
    - Structural Erosion Control plus Nutrient Management plus Cover Crops (50 percent annual phosphorus loss reduction).
- for reducing phosphorus delivery loads to Lake Erie are:
    - Structural Erosion Control plus Nutrient Management plus Cover Crops (23 percent annual phosphorus load delivery reduction).
- for reducing phosphorus load deposition in ditches, channels, streams, and rivers in WLEB are:
    - Structural Erosion Control plus Nutrient Management plus Cover Crops (80 percent annual reduction in phosphorus deposition).

Conservation Investments in WLEB

Conservation practice investments in WLEB are substantial; in 2012, adoption of conservation practices in WLEB cost around $277 million annually, with funding from federal and state sources, non-profit organizations, farmers' pockets, and more. Annualized costs associated with the hypothetical Conservation Scenarios simulations were estimated to include the following annual investments plus the annual investment ($277 million) associated with maintaining the 2012 Conservation Condition:

- Structural Erosion Control: $48.4 million for increased treatment on 68 percent of WLEB cultivated cropland acres.
- Nutrient Management: $111.7 million for increased treatment on 88 percent of WLEB cultivated cropland acres.
- Cover Crops: $284.1 million for increased treatment on 99 percent of WLEB cultivated cropland acres.
- Erosion Control plus Nutrient Management: $154.6 million for increased treatment on 96 percent of WLEB cultivated cropland acres.
- Erosion Control plus Nutrient Management plus Cover Crops: $439.5 million for increased treatment on 100 percent of WLEB cultivated cropland acres.

Take-Away

This research demonstrates that farmers have been willing to listen to and respond to recommendations made by scientists and policymakers in order to help address environmental concerns around Lake Erie. Voluntary conservation continues to make strides in the region, decreasing edge-of-field nutrient and sediment losses, thus reducing the amount of nutrients and sediment being deposited in WLEB waterways and the amount of nutrients and sediment being delivered to Lake Erie. As of 2012 the regional investment in agricultural conservation totaled roughly $277 million, with an average of 2.4 practices per cultivated cropland acre and an average per-acre treatment cost of $57 (USDA-NRCS 2016). Comprehensive conservation planning will continue to be essential to achieving the most effective and economical gains. There are opportunities for increased conservation gains in the region, especially through planning for emerging conservation concerns. Similarly, it is important to determine the conservation goals on which it is most desirable to focus, taking into consideration both spatial and temporal goals and realities. Edge-of-field goals are most quickly met with on-field practices, but complementary instream and in-lake conservation practices may be necessary if a faster response is desired in delivery load and lake concentration reduction. The only way to develop effective conservation success is to assess conservation needs and goals and adopt strategies and comprehensive conservation plans specific to the goals, while considering temporal and spatial constraints that may delay achievement of those goals even when appropriate conservation practices have been adopted.