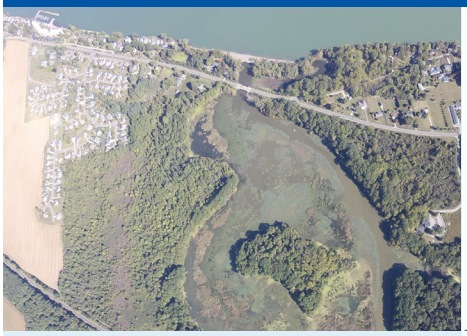

Quantifying Nutrient Retention by Lake Erie Coastal Wetlands

Project Location

Ohio

Project Duration

November 2017 to December 2019

Project Lead

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Project Type

Collaborative research – Generating science that informs decisions

Products

- A monitoring protocol and model user guide and cloud-based model interface that calculates the total phosphorus retention capacity of a wetland
- Working Wetlands infographic that illustrates how wetlands can benefit Lake Erie water quality
- Working Wetlands Story Map that explores how wetlands can be managed for different ecosystem services

Project Partners

- City of Sandusky
- Erie Soil and Water Conservation District
- Ohio Department of Natural Resources, Ohio Coastal Management Program
- Ohio State University
- The Nature Conservancy Ohio
- University of Toledo
- U.S. Geological Survey, Great Lakes Science Center

Project Webpage

nerrssciencecollaborative.org/project/Arend17

Overview

Excessive amounts of phosphorus entering Lake Erie have been causing harmful algal blooms in the lake and low oxygen conditions in lake bottom waters. Coastal managers identified wetland restoration as an important management tool to reduce nutrient loading to Lake Erie and Sandusky Bay, Ohio. As phosphorus flows through a wetland, it can be absorbed by plants and deposited on the soil surface, and some of that phosphorus is buried and stored long term in the sediment and peat of a wetland. However, the capacity of different coastal wetlands to retain nutrients and improve water quality over the long run is hard to quantify and predict.

This project capitalized on the unique long-term water quality monitoring record at Old Woman Creek Reserve to quantify the long-term capacity for a riverine, coastal wetland to retain phosphorus. The team developed a new analytical approach, and technical tools enable others to calculate the retention capacity of their own flow through wetlands. Project findings are helping to demonstrate the value of H2Ohio, a new wetland restoration initiative in Ohio.

Project Approach

To help guide the project, the team convened a collaborative learning group made up of individuals from federal, state, and county agencies, conservation organizations, universities, and private waterfowl hunt clubs. The group met quarterly to discuss wetland management priorities and strategies, tour wetland sites, provide feedback on initial results, and help develop communications products.

To estimate how much phosphorus was captured and stored in the wetland, the project team developed a Bayesian change-point model that compares the total phosphorus load flowing into the wetland to the concentration of phosphorus leaving it to estimate the threshold beyond which the wetland is overloaded. Researchers at Old Woman Creek Reserve regularly monitor water quality parameters entering their wetland complex and exiting into Lake Erie, which provided an ideal data set for this model. To compensate for limited wetland data, the team then applied a Bayesian hierarchical statistical modeling approach to pool data from multiple wetlands and improve the predictive accuracy.

The hierarchical model included short-term nutrient data collected from a diked coastal wetland and two riverside wetland complexes in Ohio, which also allowed the team to explore differences among wetland types in long-term phosphorus retention. To assist wetland managers and conservationists in applying the model to their own wetlands, the team created a monitoring protocol and model user guide, as well as a suite of innovative communication products to promote project findings.

Results

The model successfully estimated long-term phosphorus retention for flow-through wetlands that have distinct water inflow and outflow locations, such as riverine wetlands and some constructed wetlands. The approach can be used with greater confidence when data are available that span a range of phosphorus loading conditions. Phosphorus assimilation in embayment coastal wetlands cannot be predicted well with this model. In embayment wetlands, water enters and exits in the same location and water exchange is driven by highly variable wind events, as opposed to tributary flow.

The four wetlands studied had an upper limit for their capacity to assimilate and retain phosphorus over the long run. Analyses found that the study wetlands could retain between 0.008 and 1.88 tons of phosphorus per year, and above its threshold a wetland became overloaded and phosphorus would flow out of the wetland at a higher concentration. The wide range of retention thresholds is due to differences among wetlands in size, hydrology, and likely other factors, such as age of the constructed wetlands. The team was unable to calculate retention on a per-area basis because in Old Woman Creek, the surface area to which water was exposed varied depending on water depth, weather patterns, and the condition of the wetland's opening to Lake Erie. However, small wetlands that receive high phosphorus loading often appear to be functioning above their retention capacity threshold. Sediment accretion is the primary mechanism for long-term phosphorus storage, which means wetlands must be able to accumulate sediment to retain phosphorus, and sediment may need to be removed periodically if the wetland becomes saturated over time.

Benefits

- This project's topic, timing, and partnerships have enabled project findings to be readily accessible and usable for those leading a new water quality initiative in Ohio—H2Ohio —which is funding the restoration and enhancement of over 35 wetlands within the state.
- Project communication tools are helping to demonstrate the services provided by wetlands, have been incorporated into H2Ohio's website, and will be used in teacher training workshops at the reserve.
- Coastal wetland managers now have access to a newly developed model and monitoring guidelines that can be used to better determine how, where, and what types of coastal wetlands are most effective for nutrient assimilation.
- This project has jumpstarted a new community of practice. Most of the collaborative learning group members hope to continue collaborating on management priorities that were identified through the project. Seventy percent of the group members indicate they would use the newly developed communication tools, and 40 percent planned to use project monitoring and modeling tools.

- Project results are helping to inform the ongoing monitoring program at Old Woman Creek. Specifically, the project demonstrated the need for high-frequency water quality sampling to monitor and detect changes in nutrient and sediment retention.

What's Next

Members of the project team are continuing to work on critical next steps for this research, including developing estimates of retention on a per-area basis for wetlands with suitable data. Additionally, the team is exploring ways to adjust the model for other nutrients and has begun calculating assimilation capacity for nitrate. Building on the success of the collaborative learning group, Old Woman Creek hopes to sustain a community of practice for wetland managers and explore the following key priorities identified by the group:

- Investigating water quality effects on vegetation and developing management guidance.
- Developing guidance on how different plant species take up phosphorus.
- Pursuing monitoring projects to better characterize sediment dynamics.

About the Science Collaborative

The National Estuarine Research Reserve System's Science Collaborative supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is managed by the University of Michigan's Water Center through a cooperative agreement with the National Oceanic and Atmospheric Administration (NOAA). Funding for the research reserves and this program comes from NOAA. Learn more at nerrssciencecollaborative.org or coast.noaa.gov/nerrs.