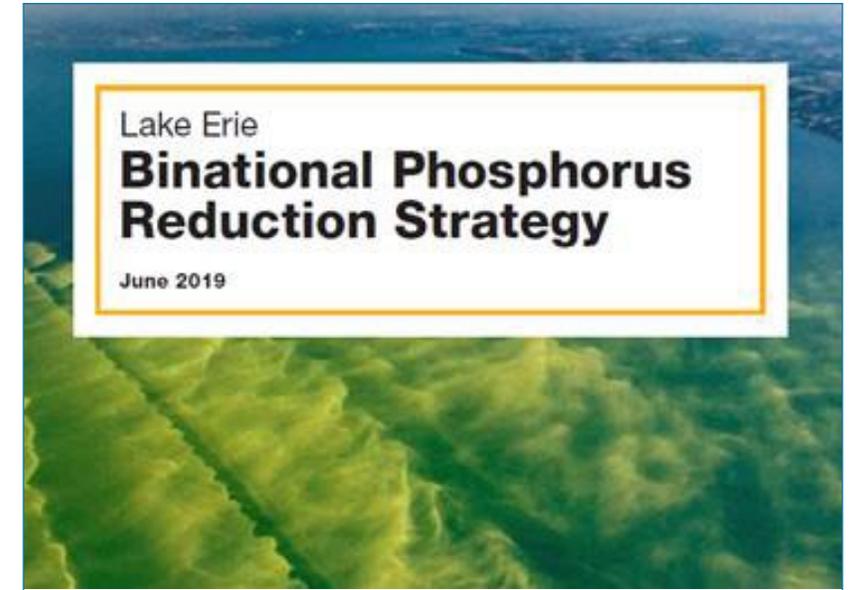
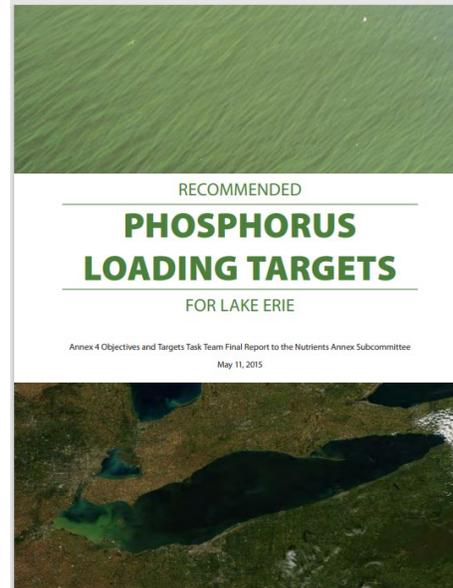


Indicators of Progress in Lake Erie

Ohio Domestic Action Plan
Webinar

July 2, 2025

Santina Wortman
U.S. Environmental Protection
Agency
Great Lakes National Program



Outline

EPA's role



```
graph TD; A[EPA's role] --> B[Phosphorus Trends]; B --> C[Conditions in the Lake]; C --> D[Key takeaways]
```

Phosphorus Trends

Conditions in the Lake

Key takeaways



Great Lakes National Program Office (GLNPO)

EPA's GLNPO leads coordination and partnerships with states, other federal agencies, and Canada on nutrient management programs to prevent HABs through two major Clean Water Act programs:

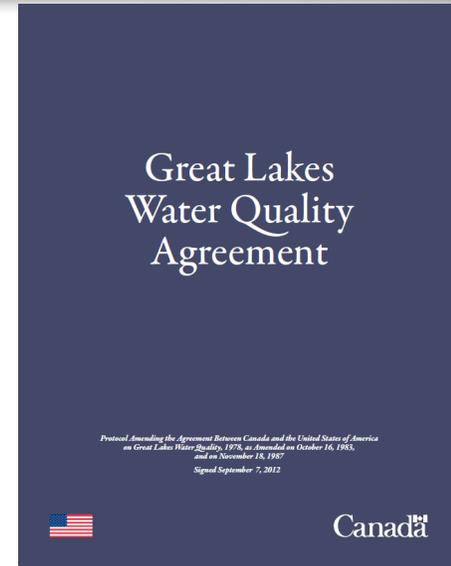
U.S.-Canada Great Lakes Water Quality Agreement (GLWQA)

- Co-chaired by EPA and Canada Water Agency.
- Sets phosphorus limits; identifies and prioritizes actions that need to be implemented

Great Lakes Restoration Initiative (GLRI)

- Administered by EPA, in partnership with 16 other federal agencies.
 - Dedicated funds for HABs prevention & phosphorus reduction efforts
- Approximately \$20 million* annually for:
 - On the ground projects (conservation practices, wetlands)
 - Farmer-led outreach and demonstration farms;
 - Real-time HABs monitoring and tracking;
 - Water quality monitoring and assessments.

*Federal GLRI investments by EPA, NRCS, USACE, USGS and NOAA.



Federal Agency Roles in the DAP

- State-of-the-art HABs forecasts and tracking during the bloom season
- On the ground demonstration projects
- Collaboration with States
 - Leveraging programs & authorities
 - Evaluating and testing what's working
 - Communicating key messages

USDA NRCS Video:

<https://www.youtube.com/watch?v=-LB8qg97pfw>

[Western Lake Erie Basin Partnership | Ohio Sea Grant](#)



**US Army Corps
of Engineers®**



Multiple Action Plans. One Binational Strategy.

Indiana

Indiana's Great Lakes Water Quality Agreement (GLWQA)



DOMESTIC ACTION PLAN (DAP)
for the
WESTERN LAKE ERIE BASIN (WLEB)

December 2023

Pennsylvania

Commonwealth of Pennsylvania



Final
Pennsylvania Lake Erie Phosphorus Reduction
Domestic Action Plan

September 2017

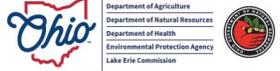
Compacts and Commissions Office
Pennsylvania Department of Environmental Protection
P.O. Box 8465
Harrisburg, PA 17105-8465
717-772-4785
www.dep.pa.gov

Ohio

Promoting Clean and Safe Water in Lake Erie:
Ohio's Domestic Action Plan 2023 to Address Nutrients



In accordance with
the Great Lakes Water Quality Agreement
January 2024



Canada-Ontario

Canada-Ontario Lake Erie Action Plan:
2024 Evaluation and Update Report



Canada Ontario

Michigan

Michigan's
Lake Erie Domestic Action Plan

UPDATE

Taking Action On Lake Erie

May 2025



Michigan.gov/LakeErieDAP | 800-662-9278

U.S. (including New York)

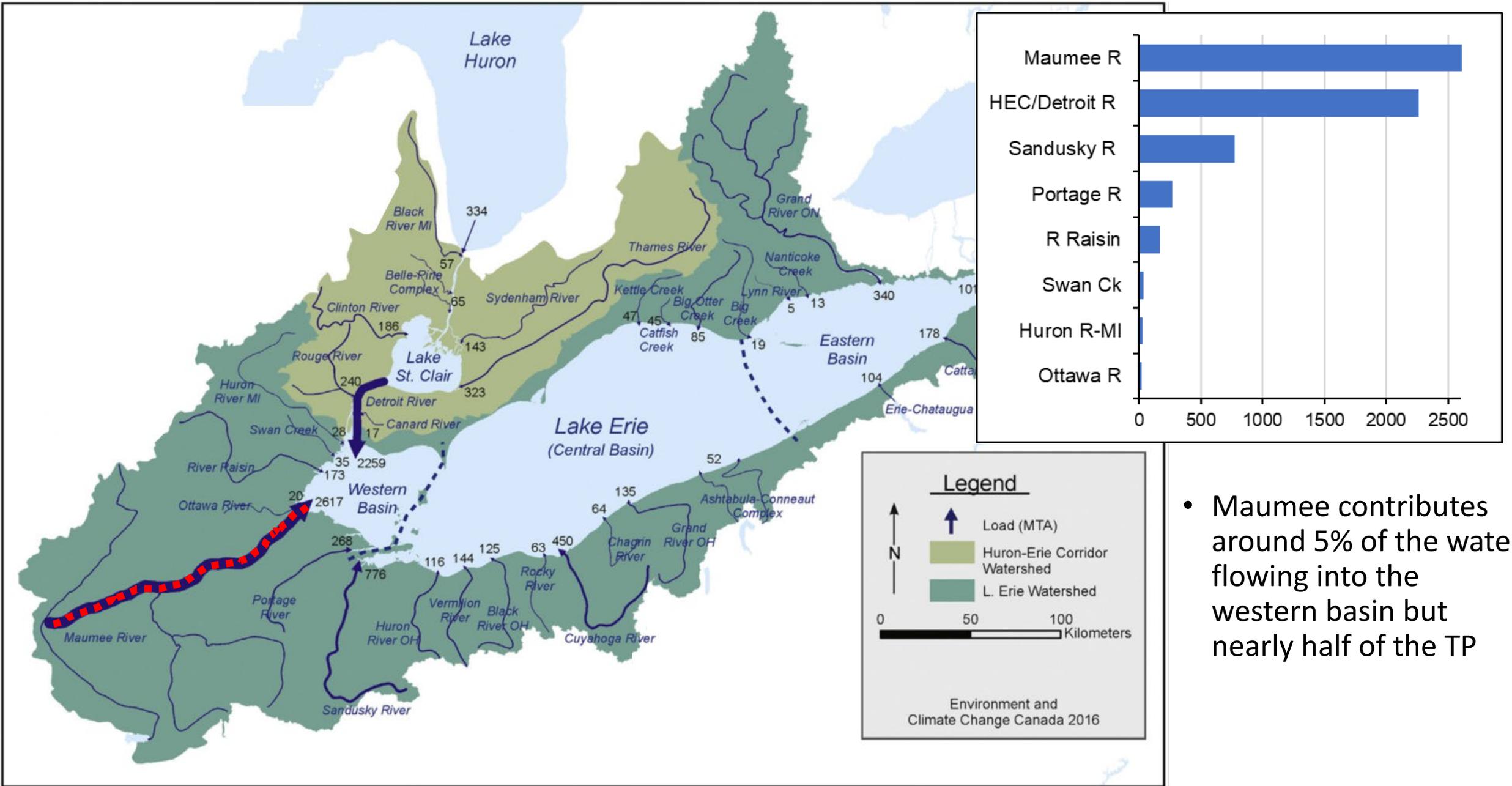
U.S. ACTION
PLAN FOR LAKE
ERIE



2018-2023 Commitments and strategy for phosphorus reduction

This document outlines federal and state efforts to achieve the binational phosphorus load reduction targets adopted in 2016 under the Great Lakes Water Quality Agreement.

Lake Erie
**Binational Phosphorus
Reduction Strategy**
June 2019



- Maumee contributes around 5% of the water flowing into the western basin but nearly half of the TP

Mean total phosphorus loadings (MTA) to Lake Erie (2003–2013)

Maccoux et al. 2016, JGLR

Recommended Phosphorus Loading Targets for Lake Erie

Annex 4 Objectives and Targets Task Team Final Report to the Nutrients Annex Subcommittee (2015)

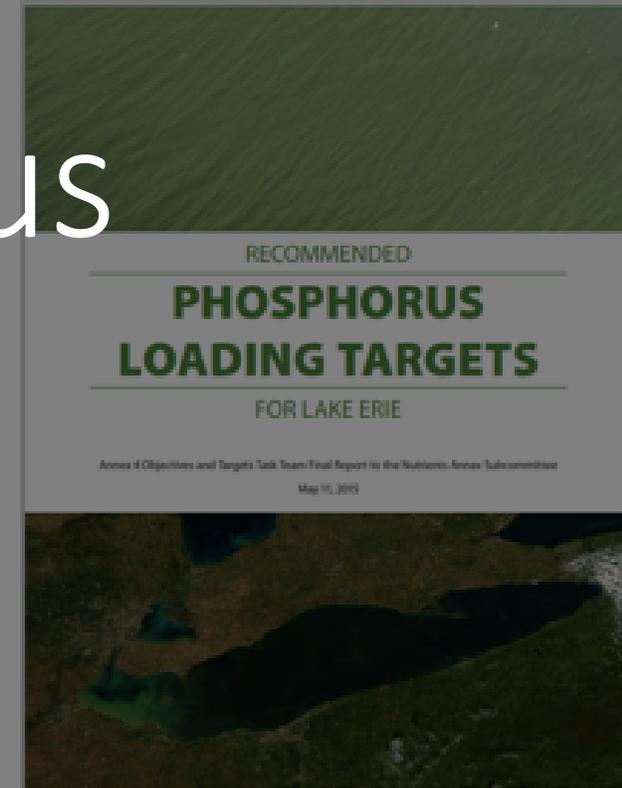
HABs

Hypoxia

Load Targets recommended to achieve desired thresholds for eutrophication response indicators in Lake Erie.

| | Spring (Mar-July) | Annual |
|--|---------------------|-----------|
| Algae – Bloom biomass less than or equal to 2004 or 2012 9 years out of ten, and/or reduce risk to boaters | 860 MT [†] | |
| Phosphorus load from the Detroit River and Thames River | 186 MT [†] | |
| Phosphorus load from the Detroit River | 40% reduction* | |
| Phosphorus load from the Detroit River | 40% reduction* | |
| August –Sept Average Hypolimnetic Oxygen of 2 mg/L or more in the Western and Central Basins, (excluding atmospheric load) | | 6000 MT** |
| Phosphorus load from the Detroit River – insufficient information to establish target | | |

Status of Phosphorus Loads and Targets



[†] based on inter-annual flow variability for the March-July period.

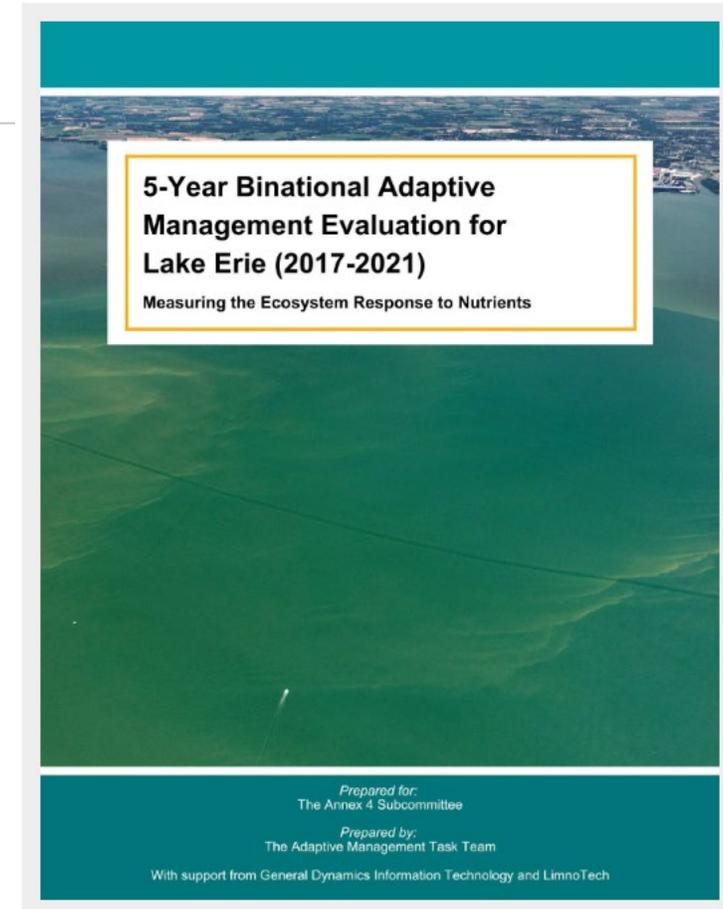
^{**} based on 2008 loads

Reduction of annual loads to the Western and Central Basins, including the Detroit River and atmospheric

5-Year Binational Adaptive Management Evaluation for Lake Erie (2017-2021)

PHOSPHORUS LOADS

- Phosphorus loads to the lake continue to be highly correlated to tributary discharge.
- Beyond annual variability, no clear change over the 2017-2021 period.
- Conditions vary by watershed. In some years, some tributaries met the target for either TP or dissolved P. But on the whole, phosphorus reductions have not yet been consistent or extensive enough to meet targets.



U.S.-Canada Annual Target

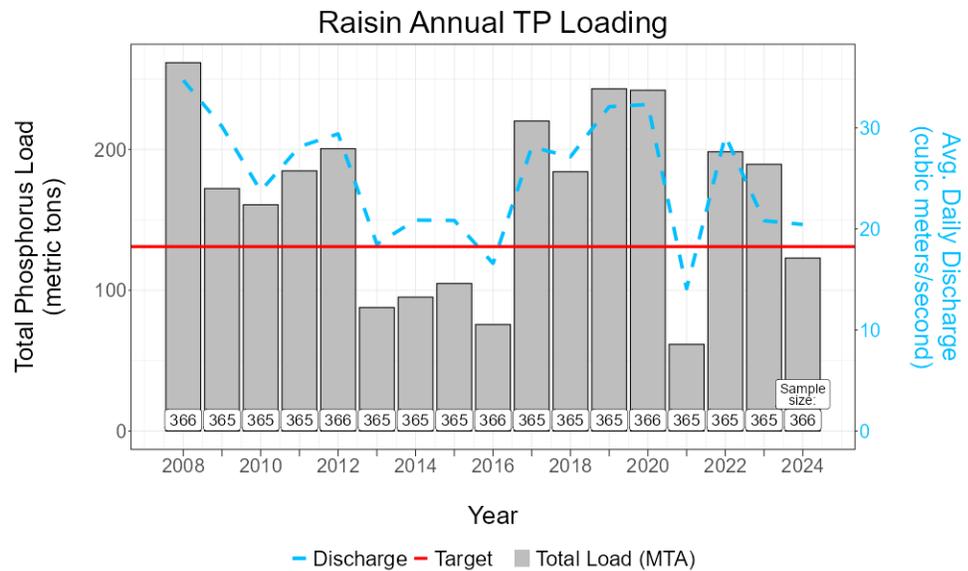
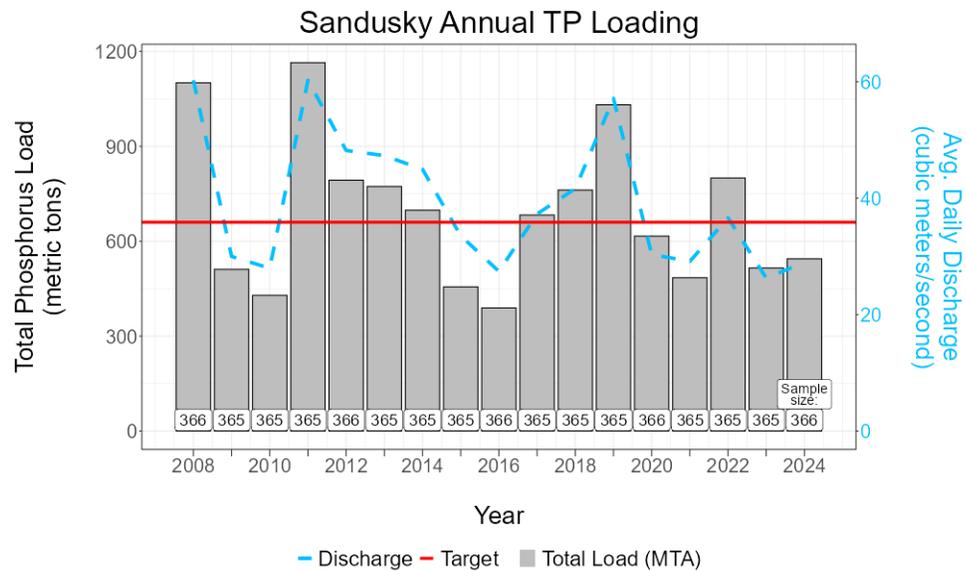
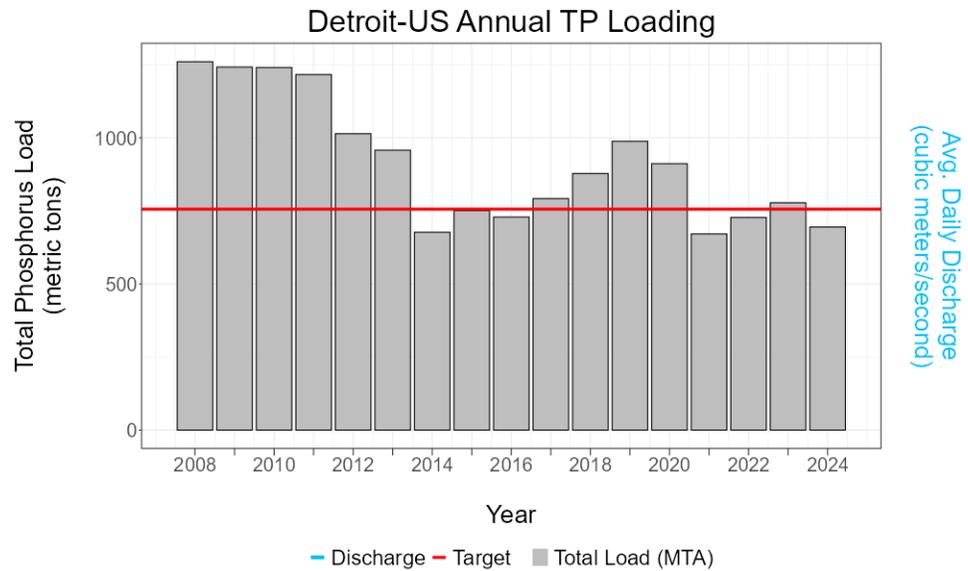
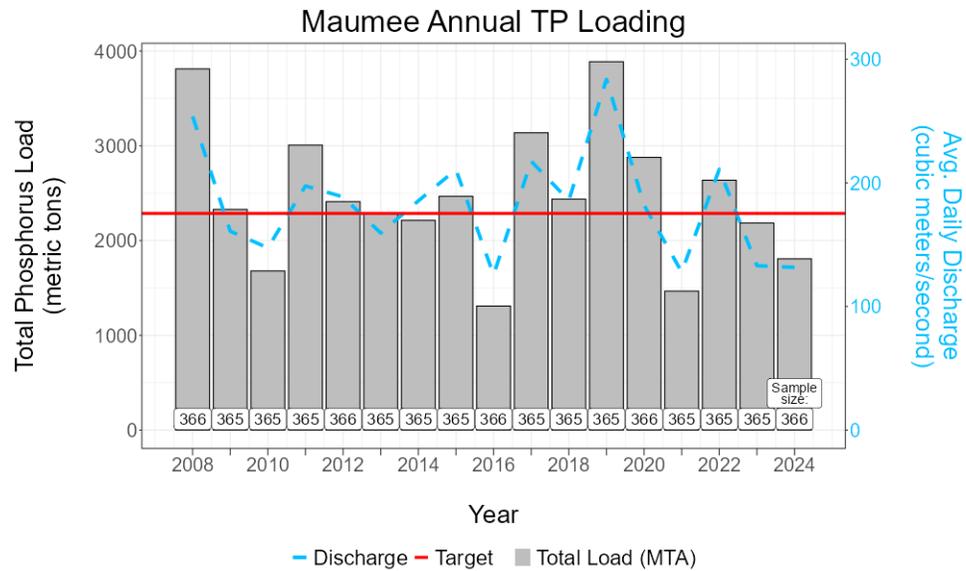
Phosphorus Loads to the Central Basin



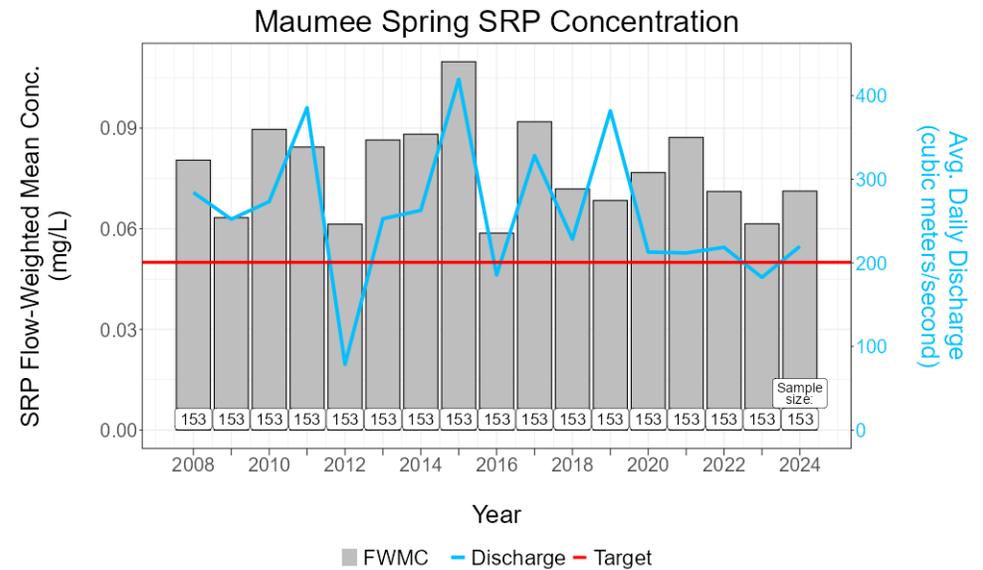
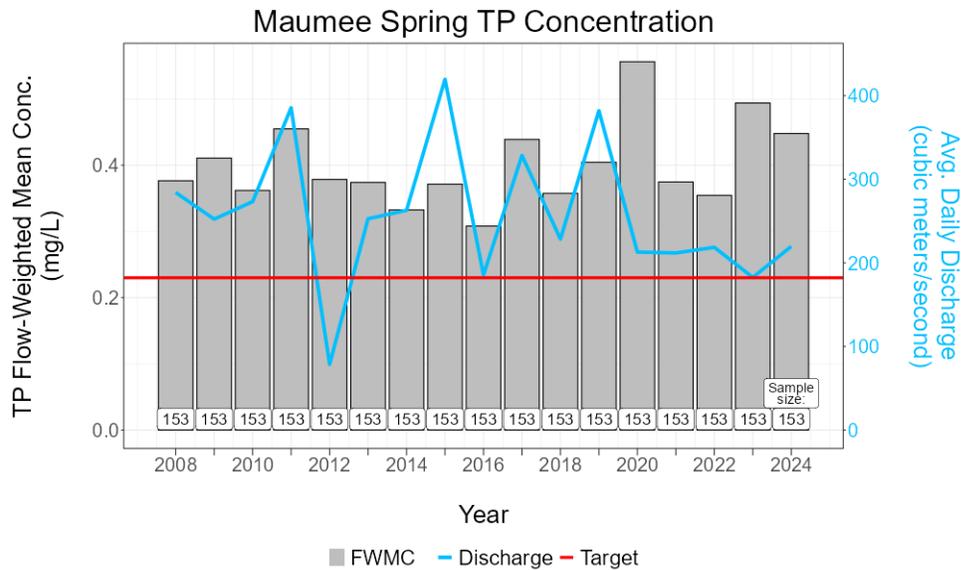
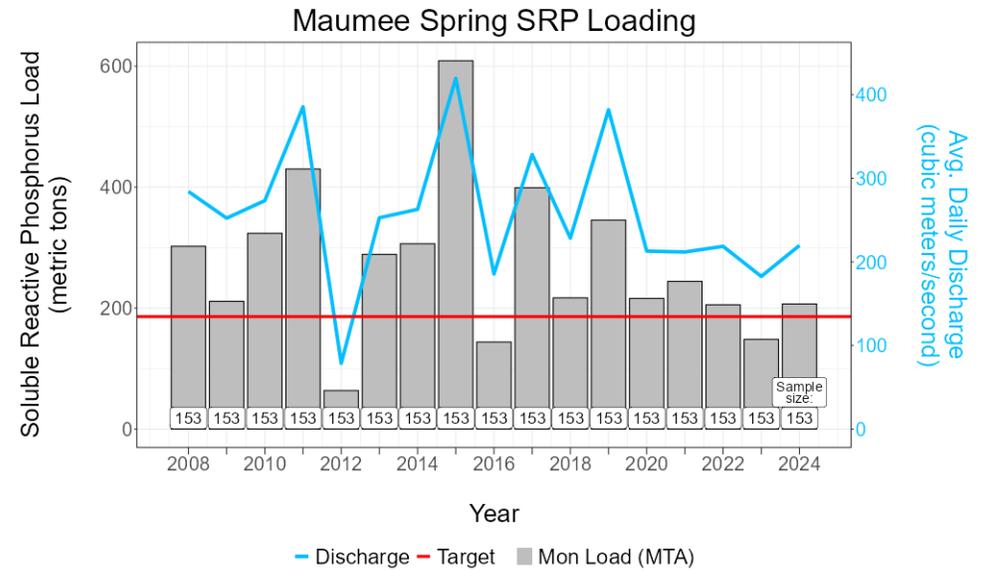
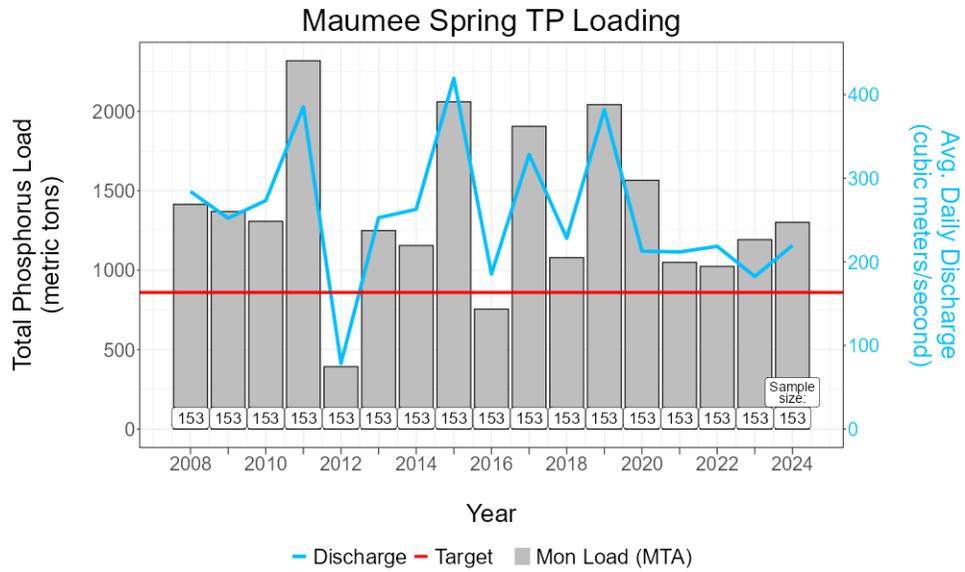
| Water Year | TP Load (MTA) |
|------------|---------------|
| 2008 | 9559 |
| 2009 | 7525 |
| 2010 | 5207 |
| 2011 | 9930 |
| 2012 | 7133 |
| 2013 | 7599 |
| 2014 | 7205 |
| 2015 | 6285 |
| 2016 | 4873 |
| 2017 | 8367 |
| 2018 | 8882 |
| 2019 | 11607 |
| 2020 | 8587 |
| 2021 | 6287 |
| 2022 | 8117 |
| 2023 | 7655 |
| 2024 | 6851 |

— Discharge from Major Tributaries
 ■ Unmonitored Non-Point Sources
 ■ Atmospheric Deposition
 ■ Direct Point Sources
— Target Load
 ■ Monitored Non-Point Sources
 ■ Indirect Point Sources
 ■ Input from Lake Huron

US Priority Tributaries: Annual TP Loads



Maumee River SPRING (March-July)



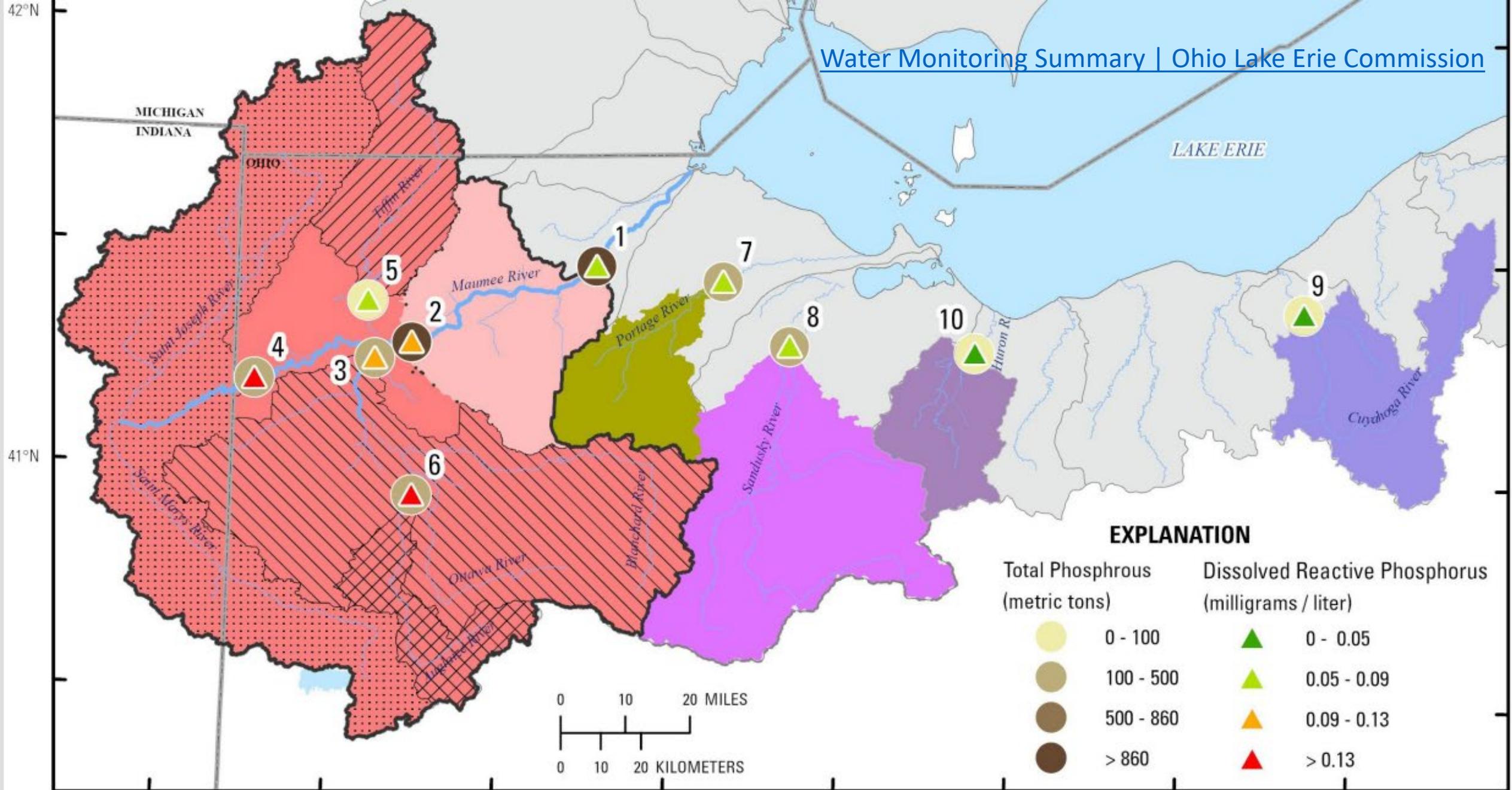


Figure 4: Phosphorus monitoring in the Lake Erie watershed. Data from March 1, 2024 - July 31, 2024.

OLEC Water Monitoring Factsheet 2024

A publication of the Ohio Lake Erie Commission with the assistance of the following partners:



[Water Monitoring Summary | Ohio Lake Erie Commission](#)

- Annual summary for multiple nutrients (TP, SRP, TN)
- Data collected from 10 tributary sites
- Loads, concentrations, discharge



Why is water monitoring done, and by whom?

Federal, state, and educational institutions conduct water monitoring for a variety of reasons.

The U. S. Geological Survey (USGS), along with its federal, state, and local partners, investigates the occurrence, quantity, quality, distribution, and movement of water and shares data with the public and other agencies involved with managing our water resources.

Ohio EPA conducts water monitoring...

Ohio DNR is interested in protecting recreation, fish, and wildlife water uses by installing nutrient reducing wetlands.

Educational institutions such as Heidelberg University's National Center for Water Quality Research do water monitoring to answer research questions.

What do we measure?

Many components are measured. This summary focuses on total phosphorus, dissolved reactive phosphorus, & nitrogen as nitrite (NO₂)+nitrate (NO₃).

Why this summary?

This summary provides an overview of nutrient loads and concentrations that cause harmful algal blooms in Lake Erie. Summarizing the results of these water monitoring efforts provides critical information to agencies and the public.

We are tracking annual changes and comparisons to water quality goals established by Annex 4 of the 2012 Great Lakes Water Quality Agreement and the 2015 Western Basin of Lake Erie Collaborative Agreement. The

Where is the water monitored?

Ohio EPA, Ohio DNR, USGS, and Heidelberg University have established many sampling stations in the Lake Erie watershed. These stations are located at USGS streamflow gages. This allows loads to be calculated from sample data.

Figure 1 shows a subset of over 30 monitoring stations used to assess the nutrient contributions upstream of the lake influenced sections of the riv-

What is Flow-Weighted Mean Concentration (FWMC)?

The FWMC is the total load for the time period divided by the total discharge volume for the time period. FWMC standardizes the measure of phosphorus delivery from a tributary so that year-to-year and trib-to-trib performance can be compared despite different flows.

Water Monitoring Summary

March 1, 2024 - July 31, 2024

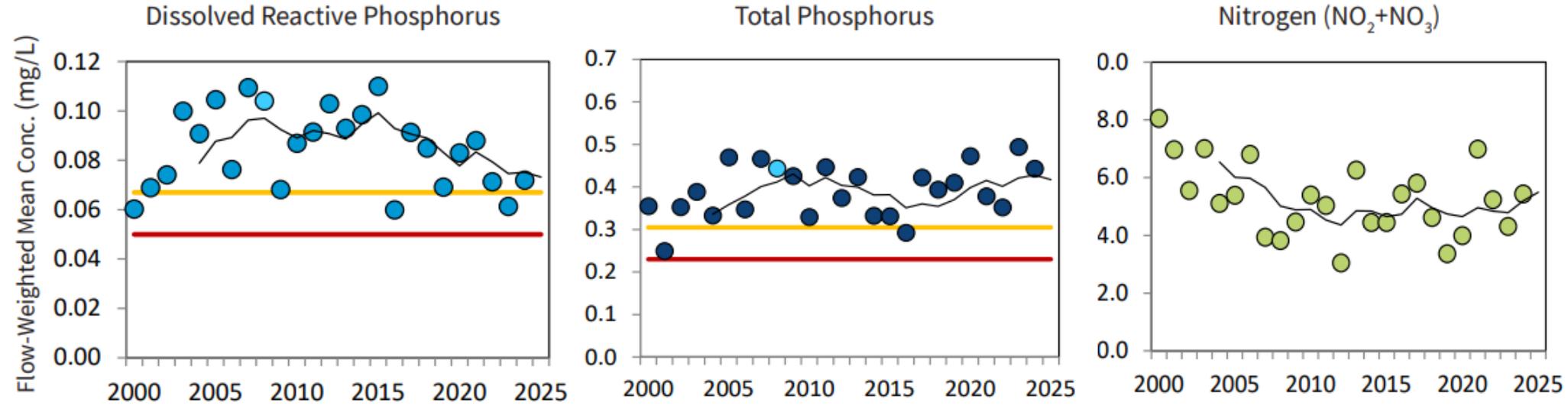


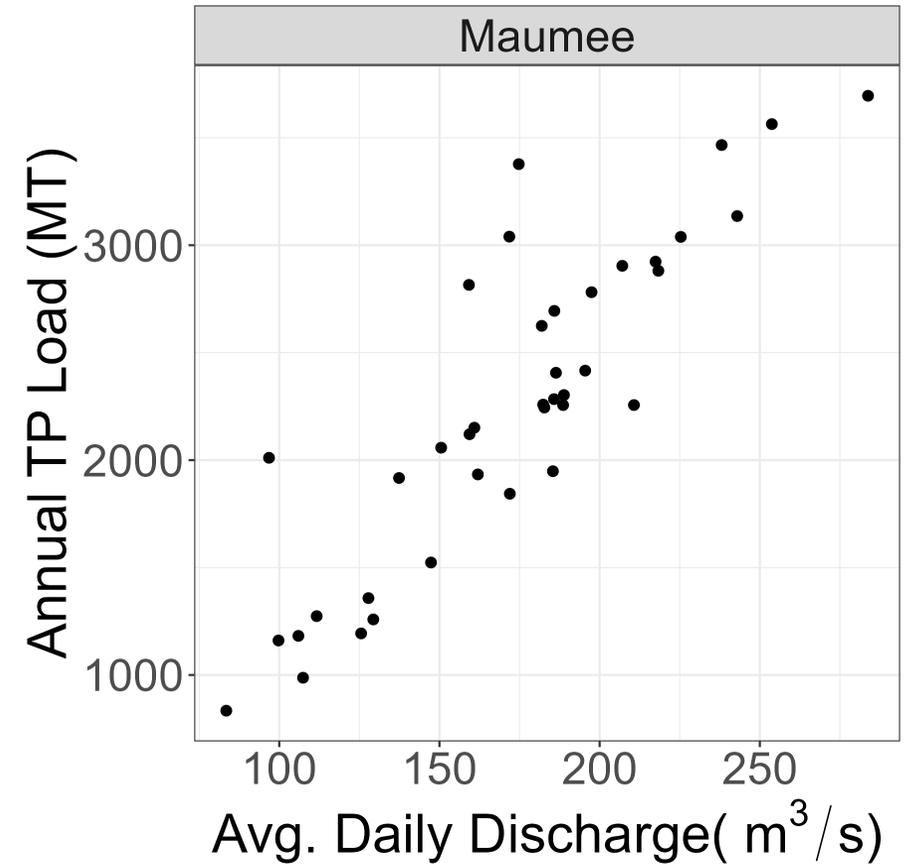
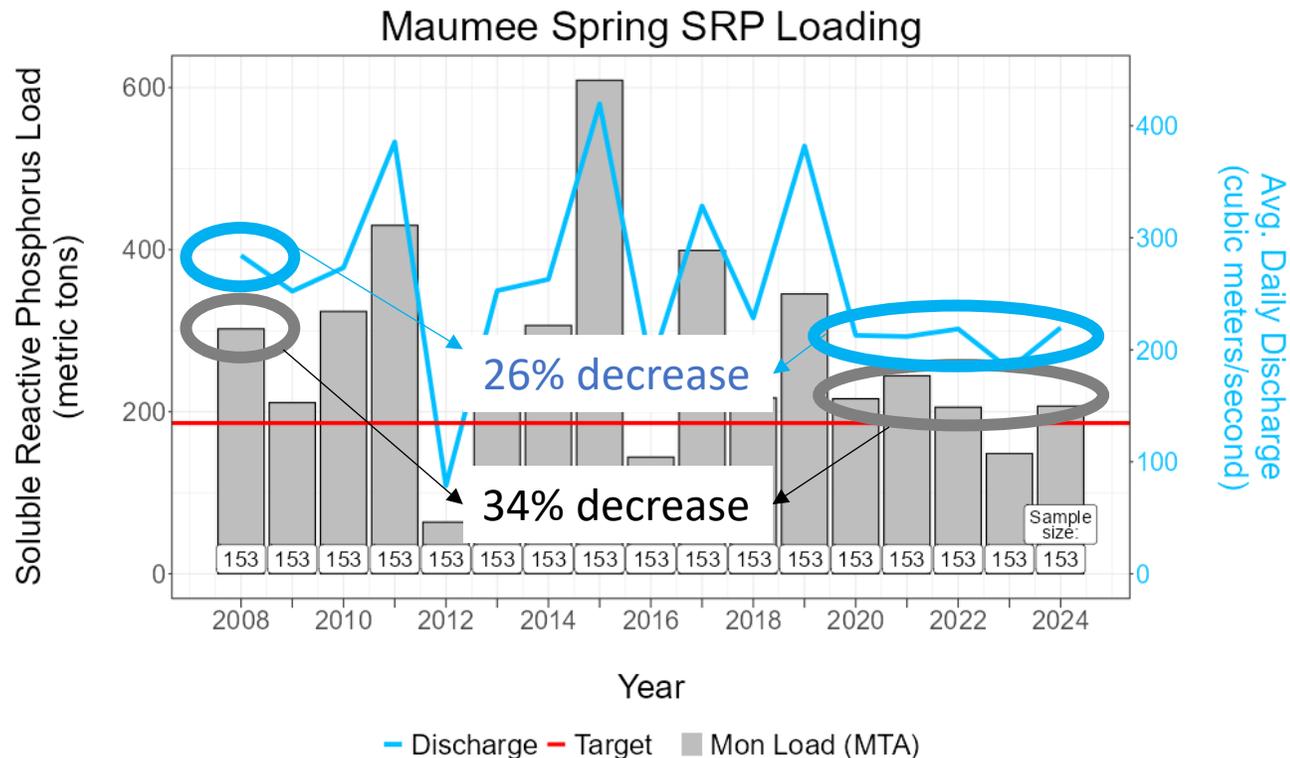
Figure 3: Loading season nutrient flow-weighted mean concentrations for the Maumee River near Waterville by water year. The five-year running average (black line) smooths out annual variation and shows trends. The brighter blue dot highlights 2008. The red line is the Annex 4 target flow-weighted mean concentrations. The yellow line is the Western Lake Erie Basin Collaborative 20% reduction target.

How does 2024 compare to previous years?

The top left chart of Figure 3 shows the dissolved reactive phosphorus flow-weighted mean concentration at 0.072 mg/L in 2024. Although dissolved reactive phosphorus levels are not yet reaching the target, they have been lower since 2015. Total phosphorus flow weighted mean concentrations have been around 0.4 mg/L since 2000. In 2024, total phosphorus was 0.44 mg/L. Nitrogen flow weighted mean concentrations have decreased since 2000 but have been about the same since around 2005.

Let's dig deeper...

- Load is highly dependent on discharge, which is highly variable from year-to-year



Flow-Normalized Loads



Ecological Indicators

Volume 125, June 2021, 107601



Lake Erie tributary nutrient trend evaluation: Normalizing concentrations and loads to reduce flow variability

Freya E. Rowland ^{a, b}, Craig A. Stow ^c, Laura T. Johnson ^d, Robert M. Hirsch ^e

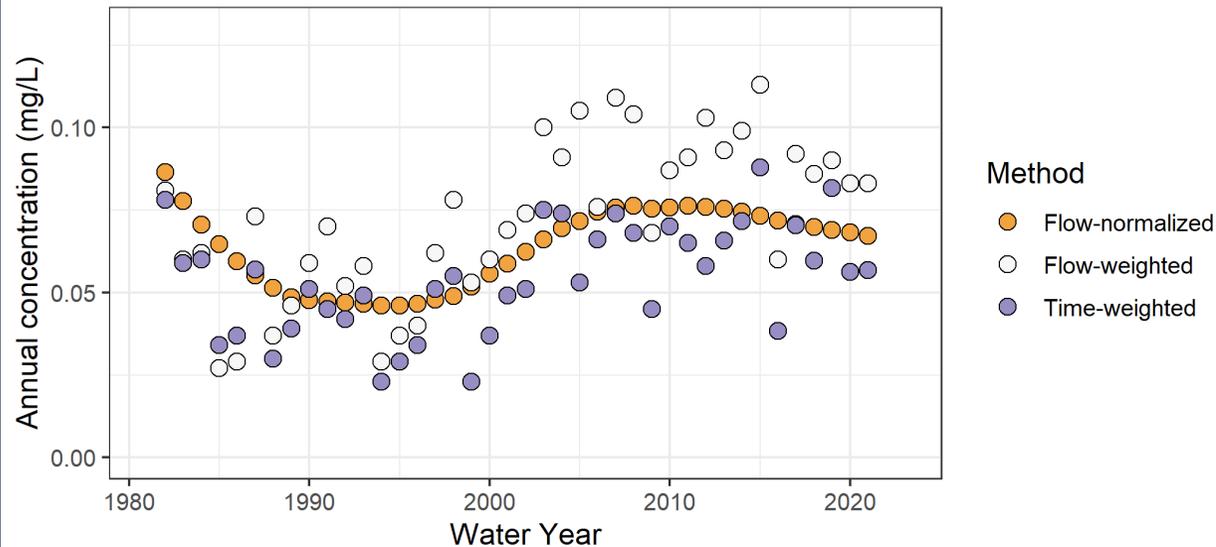
The WRTDS flow-normalization method provides a statistical estimate of how loads are changing absent year-to-year changes in discharge, potentially providing insights into watershed changes.

Removes variability in loads due to variation in discharge

Calculated using Weighted Regression on Time, Discharge, and Season approach (USGS, EGRET R package)

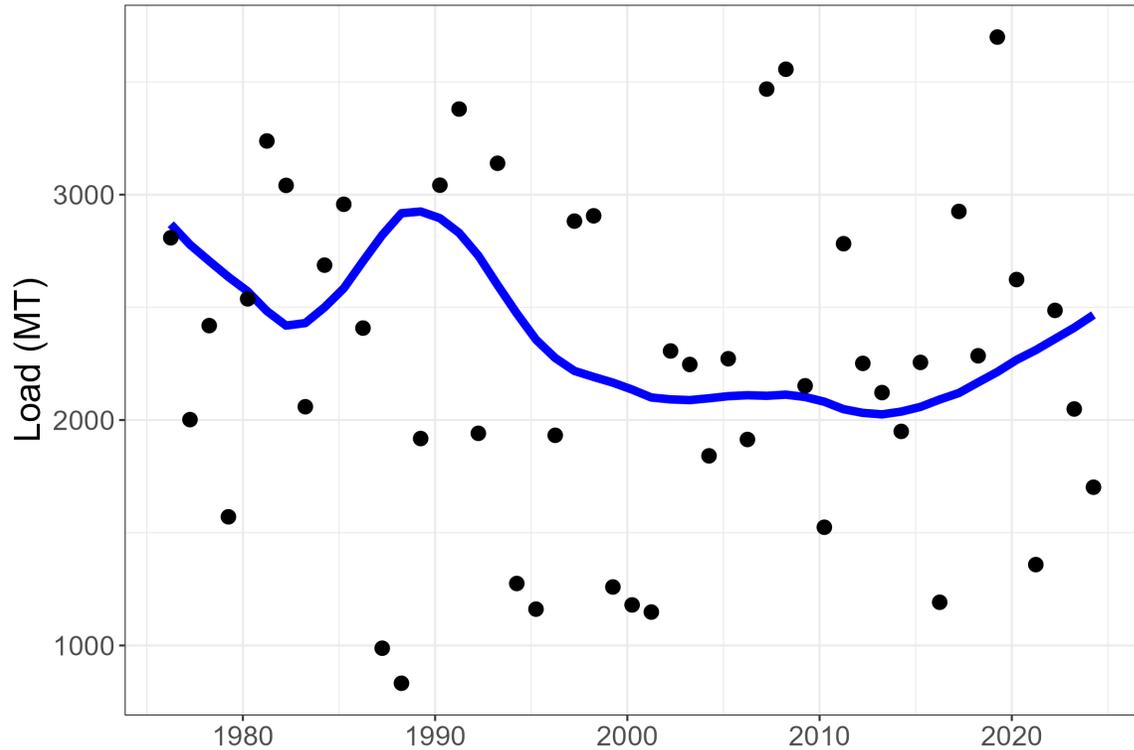
Requires at least 10 years and 100 nutrient concentrations

Maumee River SRP Concentration Trends

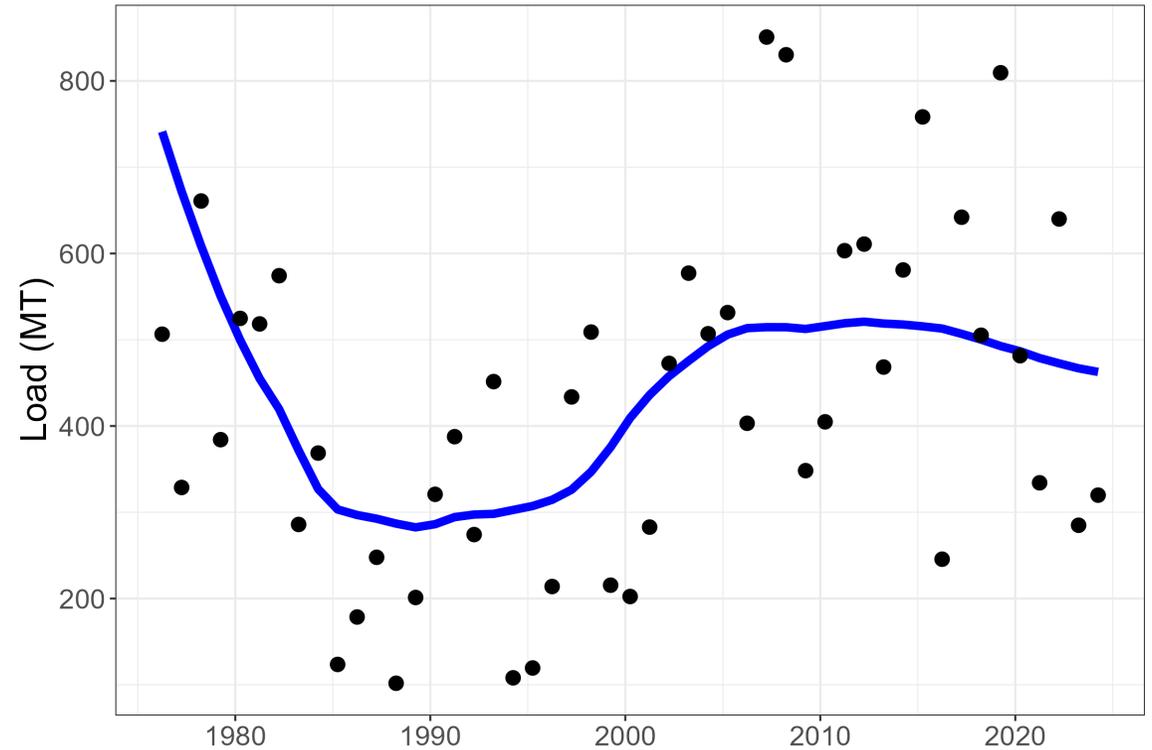


Flow-Normalized Loads: Maumee River

Maumee TP



Maumee SRP



Using data through 2024, Maumee River flow-normalized loads of TP have increased about 17%, while SRP has decreased about 10% since 2008

Flow-Normalized Loads Summary

These tables show the percent change in flow-normalized load since 2008, sorted by mean load.

TP

| Tributary | Avg. Load (MT) | 2023 WY | 2024 WY |
|--------------|----------------|---------|---------|
| Maumee | 2230 | +15 | +17 |
| Sandusky | 506 | +38 | +43 |
| Thames | 358 | +61 | +48 |
| Grand-ON | 293 | +16 | +17 |
| Cattaraugus* | 263 | -58 | -66 |
| Cuyahoga | 191 | -21 | -18 |
| Grand-OH | 171 | | +116 |
| Portage | 157 | +40 | +55 |
| Black-OH | 144 | | +30 |
| Raisin | 131 | +30 | +27 |
| Huron-OH | 121 | +84 | +105 |
| Vermilion | 115 | +31 | +90 |
| Sydenham | 80 | +80 | +70 |
| Big Otter | 67 | -21 | -9 |
| Kettle | 40 | +33 | +55 |
| Canard | 28 | +13 | +23 |
| Big | 21 | +13 | +17 |
| Nanticoke | 12 | -6 | -9 |
| Lynn | 3 | -58 | -60 |
| Turkey | 1 | | -5 |

14 increases,
6 decreases

Take note:

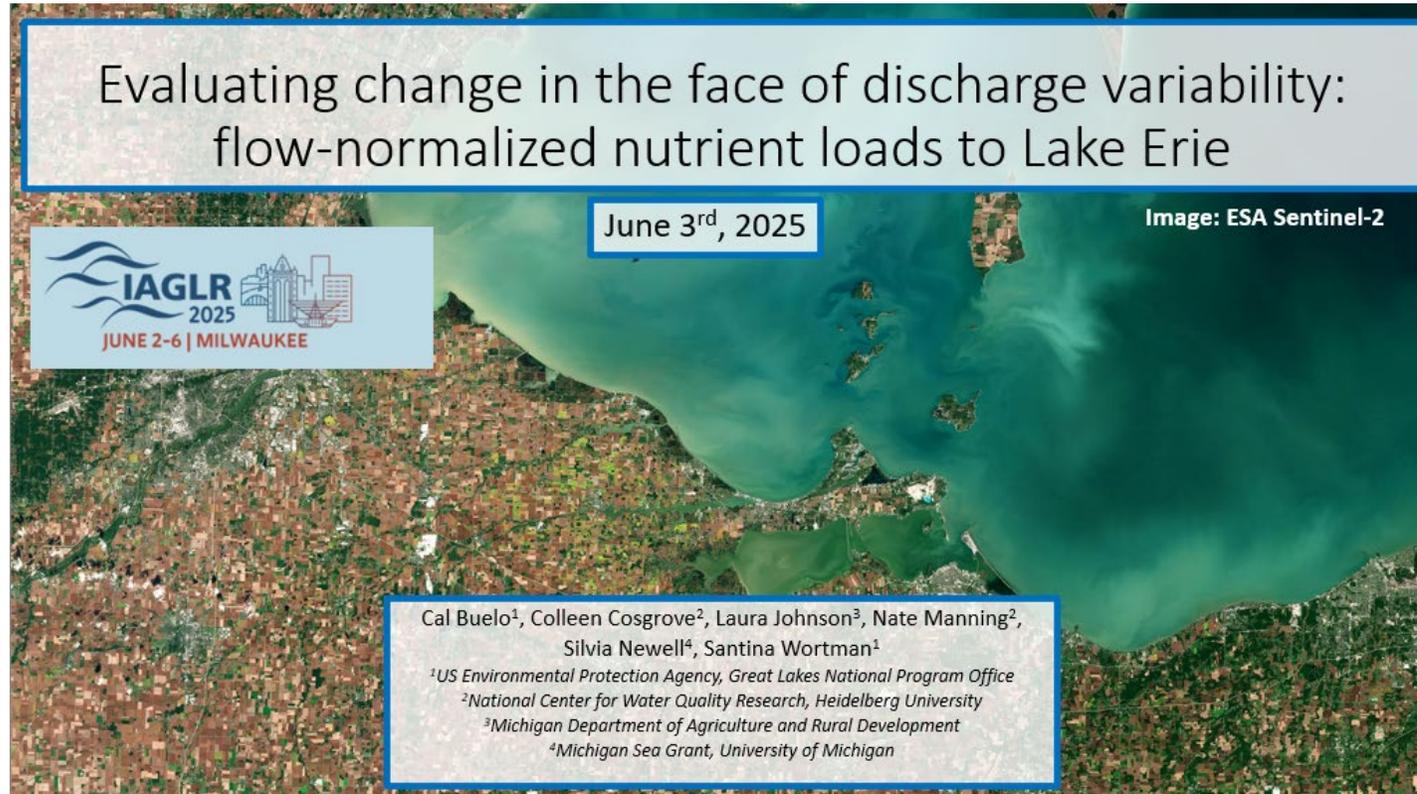
- The result changes each year, as new data are added
- Diverging TP/SRP trends seen in many Lake Erie tributaries, as well as different patterns (both increasing; both decreasing)

SRP

| Tributary | Avg. Load (MT) | 2023 WY | 2024 WY |
|-----------|----------------|---------|---------|
| Maumee | 509 | -9 | -10 |
| Thames | 118 | -26 | -15 |
| Sandusky | 111 | +15 | +15 |
| Grand-ON | 74 | -27 | -25 |
| Portage | 40 | +18 | +26 |
| Raisin | 31 | -14 | -7 |
| Sydenham | 28 | -15 | -6 |
| Cuyahoga | 24 | -50 | -46 |
| Big Otter | 16 | +31 | +34 |
| Kettle | 12 | +2 | +13 |
| Big | 8 | +186 | +245 |
| Lynn | 1 | -64 | -66 |

5 increases,
7 decreases

Findings presented at June 2025 IAGLR



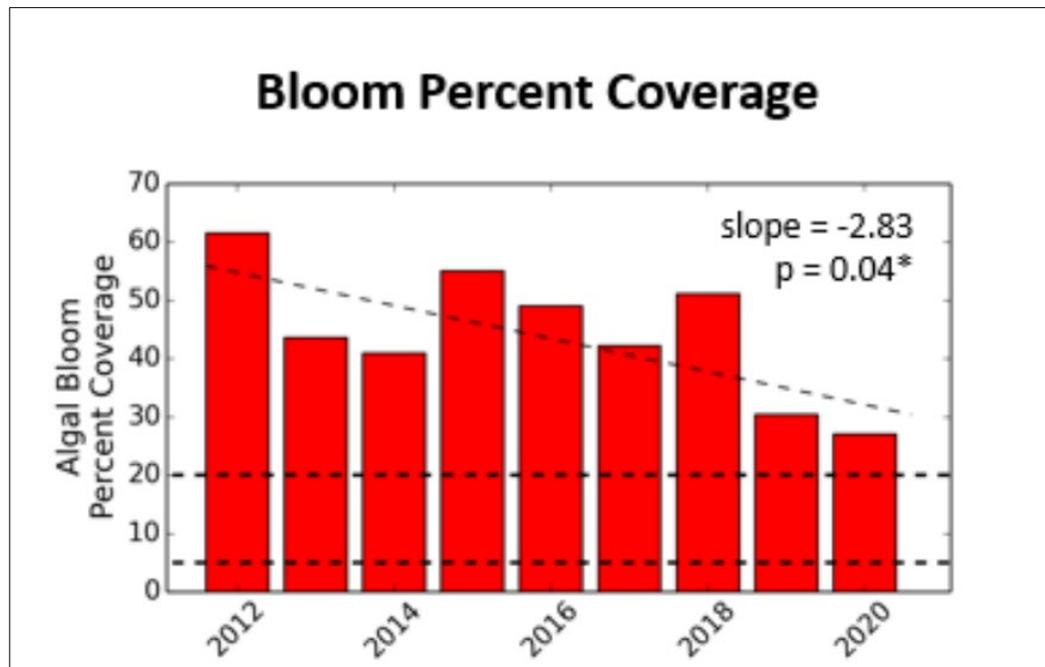
- Since 2008, Maumee River flow-normalized loads of TP have increased about 17%, while SRP has decreased about 10%
 - SRP trend is encouraging as this form of phosphorus is highly bioavailable to algae
- Total flow-normalized load trends mirror changes to estimated concentrations at high flows
 - Changes to concentrations at high flows have the largest impact on total loads
- A single season of higher- or lower- than expected concentrations can have relatively large impacts on flow normalized loads (e.g., SRP decline would be 6% without 2019)

An aerial photograph of a large body of water, likely a lake, showing a significant greenish tint to the water, suggesting an algal bloom. The shoreline is visible on the left and bottom, featuring residential houses, trees, and a marina with several boats. The text "Is the lake responding?" is overlaid in the center of the image.

Is the lake responding?

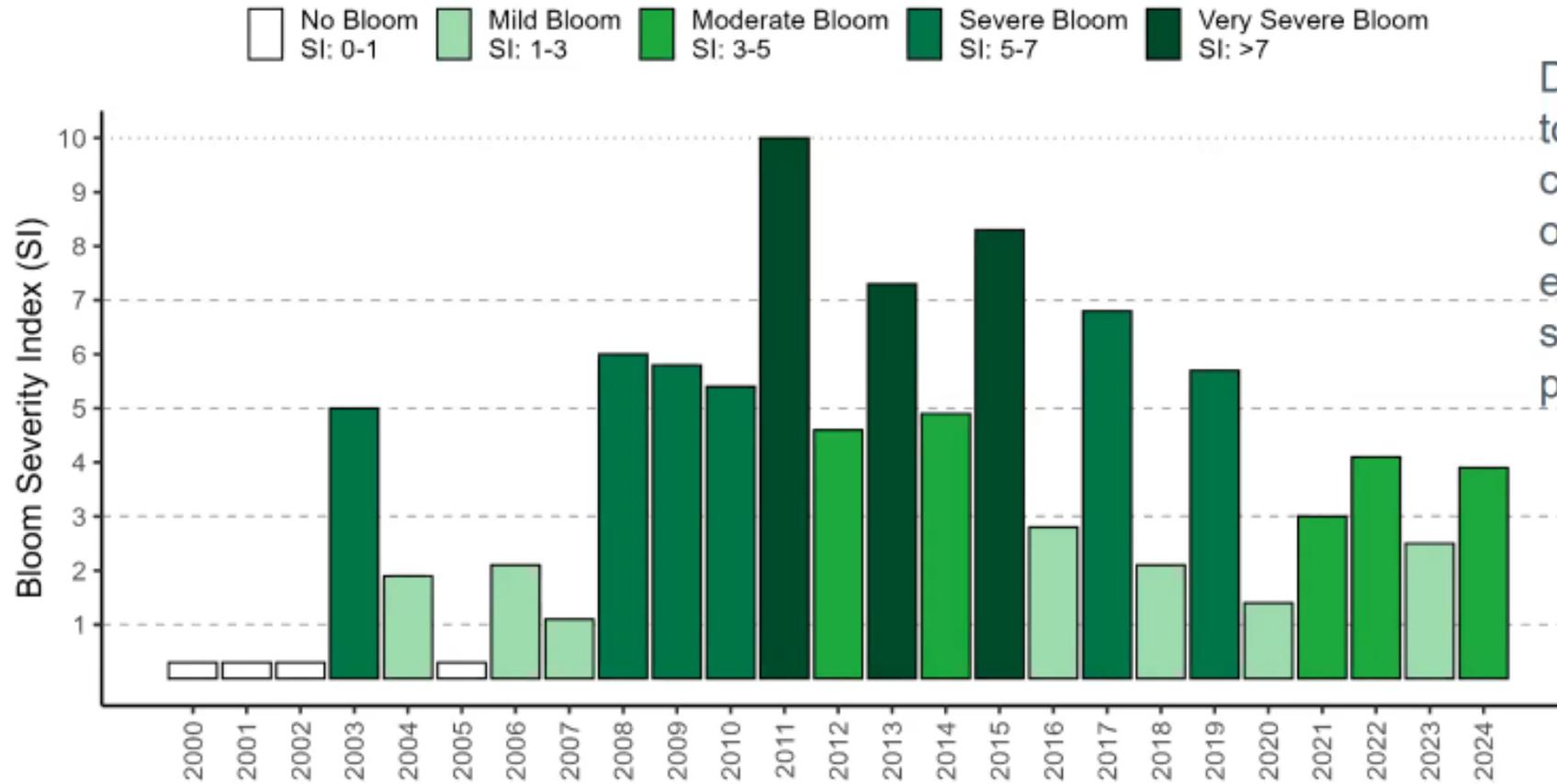
Many ways to assess HABs

- According to 2022 State of the Great Lakes report:
 - Spatial extent of blooms declined between 2012 and 2020
 - Algal scums appear to be declining too



Data and photo from Michigan Tech Research Institute

NOAA HABs Severity Index



Describes total lake condition. Any one area can experience scum for long periods

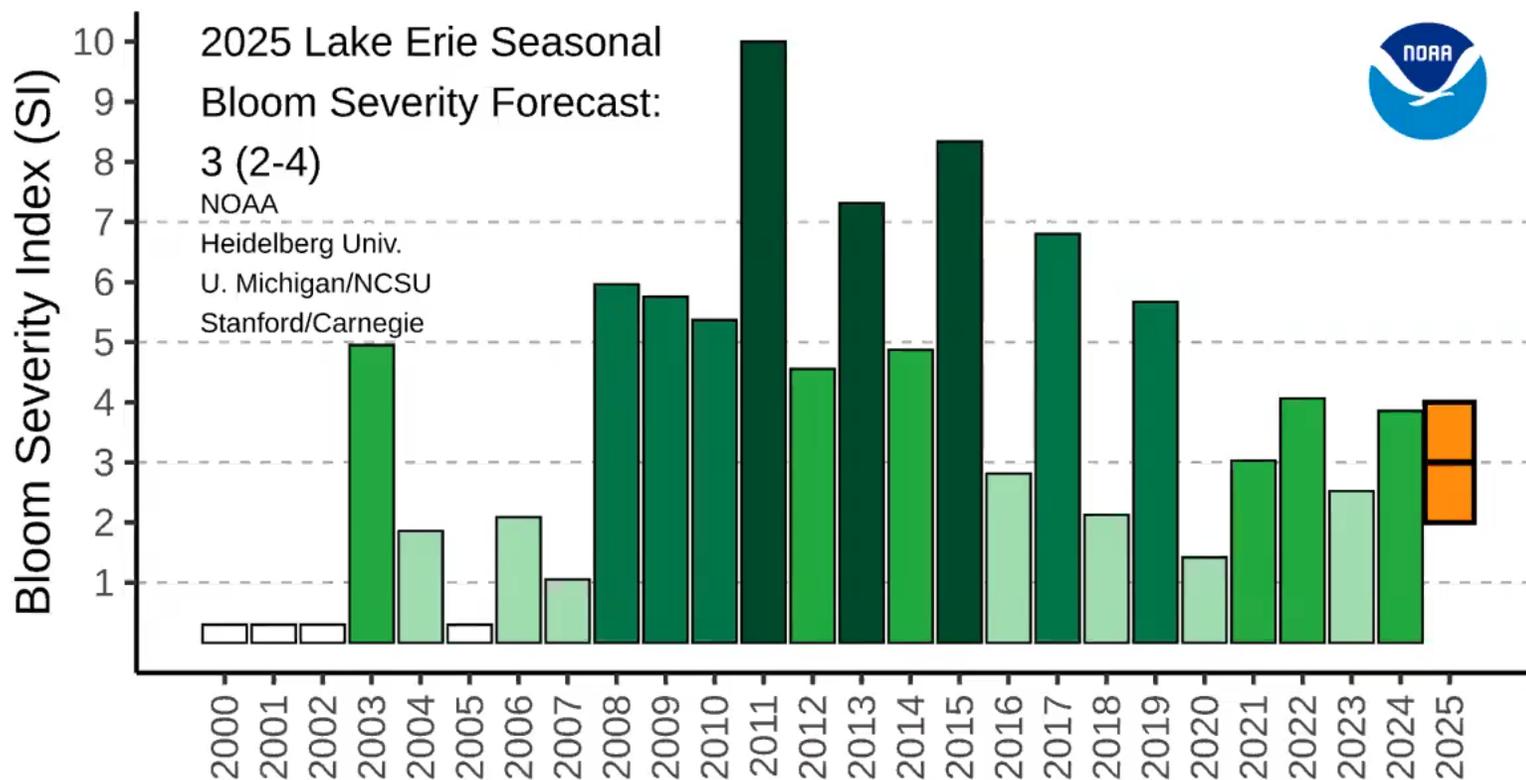
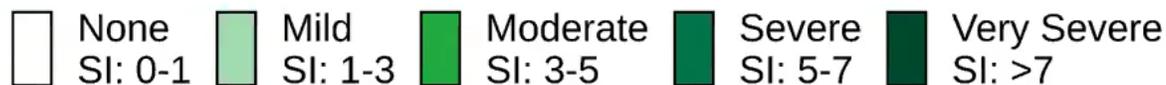




2025 Western Lake Erie HAB Seasonal Forecast

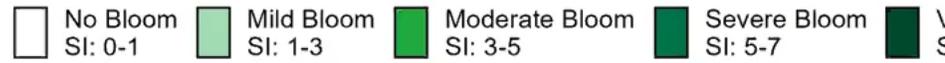
(From Rick Stumpf's presentation at the 2025 Lake Erie HABs Forecast)

- Forecast mild to moderate bloom of 3 (2-4)
- Near-average TBP loads during spring (March-June)
- Accounts for normal July rainfall
 - small risk of excessive rainfall in July

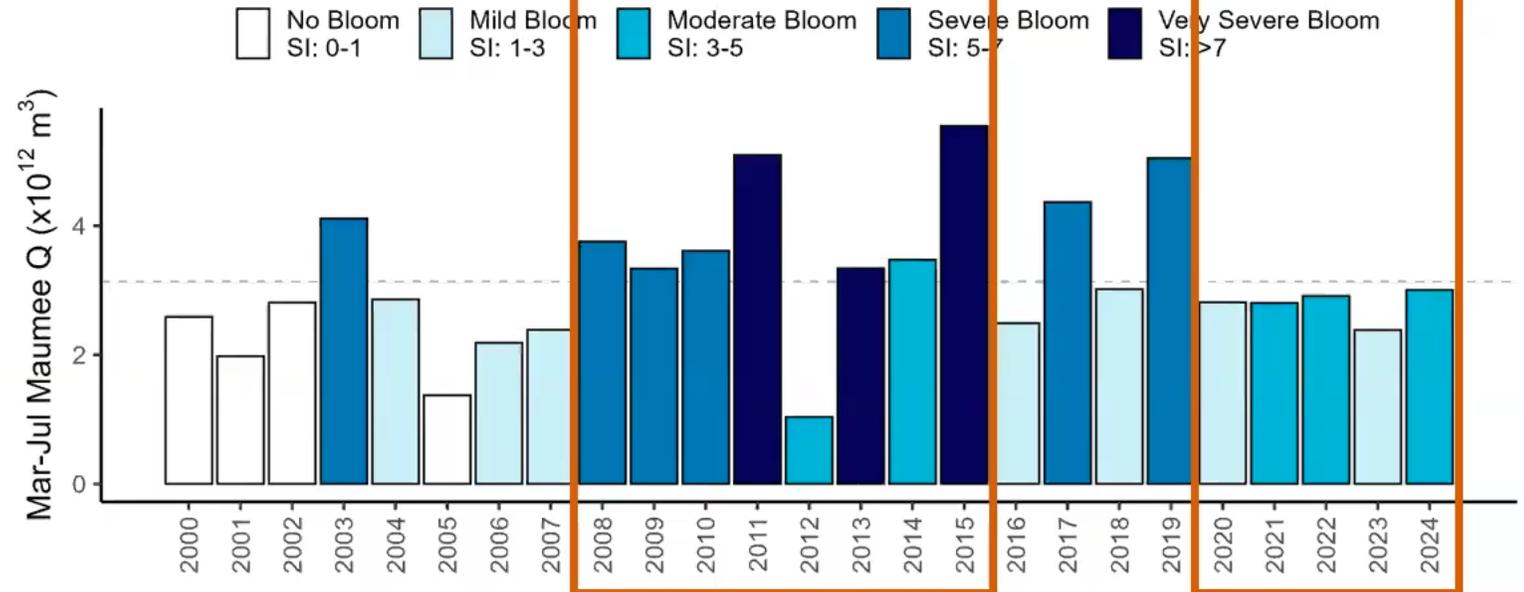
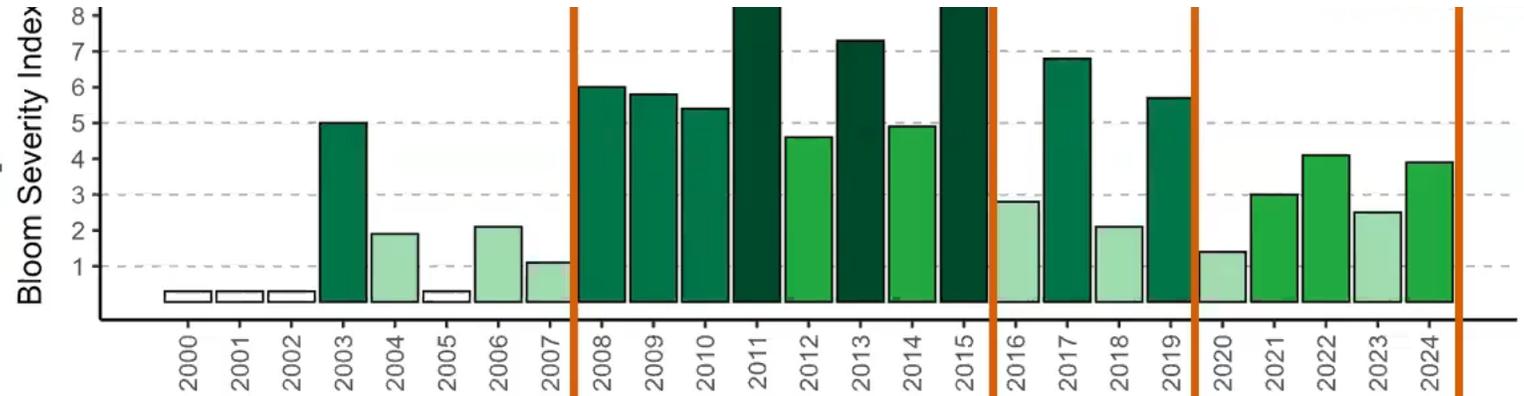


Maumee River Discharge (Q, Mar-Jul)

- 2020-2024 blooms were less severe than 2008-2015
- Most difference is mostly caused by decreased river flow
- However, bioavailable P concentrations have decreased by ~5-10%



(Slide borrowed from Rick Stumpf's presentation at the 2025 Lake Erie HABs Forecast)



Conclusions

(From Nate Manning's presentation at the 2025 Lake Erie HABs Forecast)

- **April and May both contributed to cumulative load in 2025**
- **TPP is above target, and loads and concentrations are above the 5-year average/ similar to 2010 to 2015**
- **DRP and TBP loads and concentrations are at or below target, even with increased discharge in 2025 compared to 2020-2024**
- **Based on 2002 – 2018 relationships of load vs flow:**
 - **DRP and TBP loads are lower than expected**
 - **TPP is higher than expected possibly due to high discharge early in the season/ pre-planting**
- **Concentrations of DRP and TBP are continuing to decrease even when correcting for changes in discharge**

MOVING FORWARD



5-YEAR BINATIONAL ADAPTIVE MANAGEMENT EVALUATION FOR LAKE ERIE (2017-2021)

- Current conditions should not be interpreted as a lack of progress, because an observable response in water quality will require significant and sustained reductions in phosphorus loads.
- There is an expected lag between implementation of best management practices and observable load reductions from watersheds, and the timeframe for current actions has been relatively short.
- Time and continued efforts are needed to reduce loads and draw down legacy phosphorus from the system and allow the lake to respond and recover.
- A challenge moving forward will be to reduce and maintain phosphorus loads despite changes in tributary discharge patterns driven by variations in weather conditions, including storm events.

Wet soil + Heavy rainfall =  Discharge

Challenges

- The magnitude of reduction needed → over 3,000 metric tons or 7.3 million lbs/yr.
- Reliance on voluntary adoption of conservation practices
- Increased discharge from rivers
- Legacy sources can mask current progress

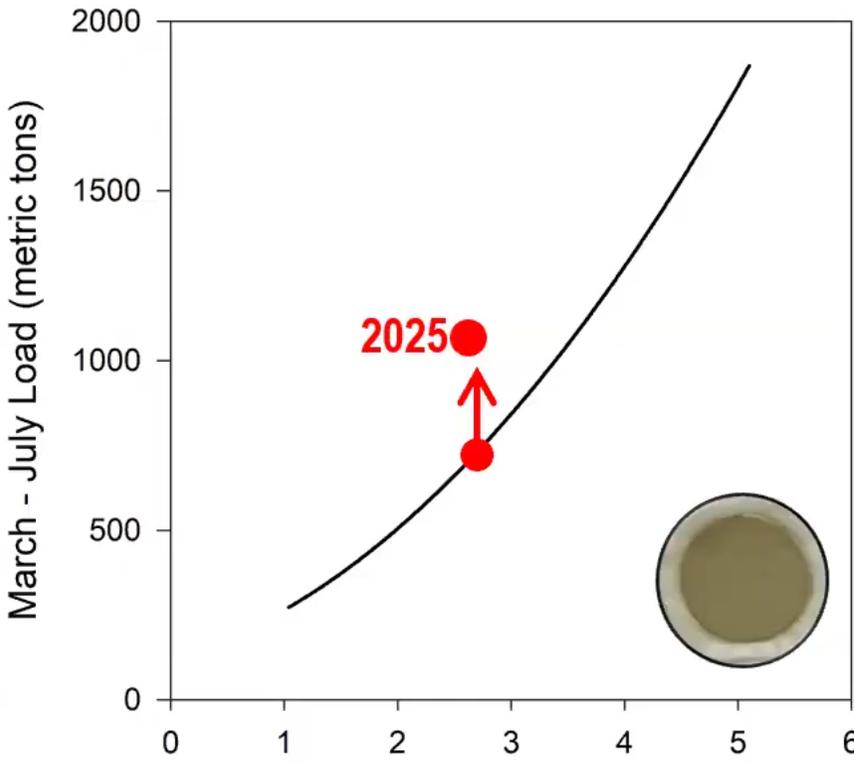




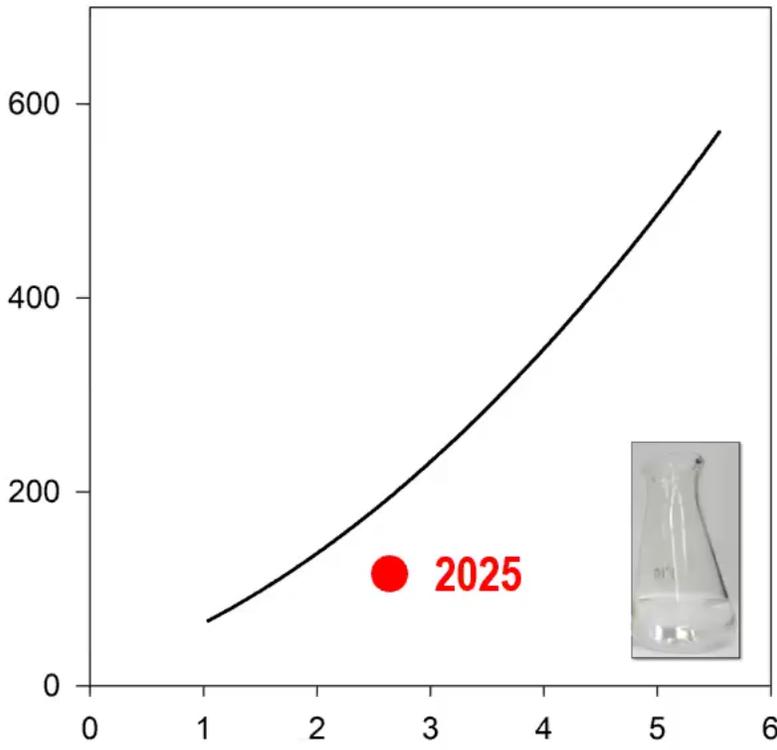
Are 2025 loads where we would expect based on 2020?

(From Nate Manning's presentation at the 2025 Lake Erie HABs Forecast)

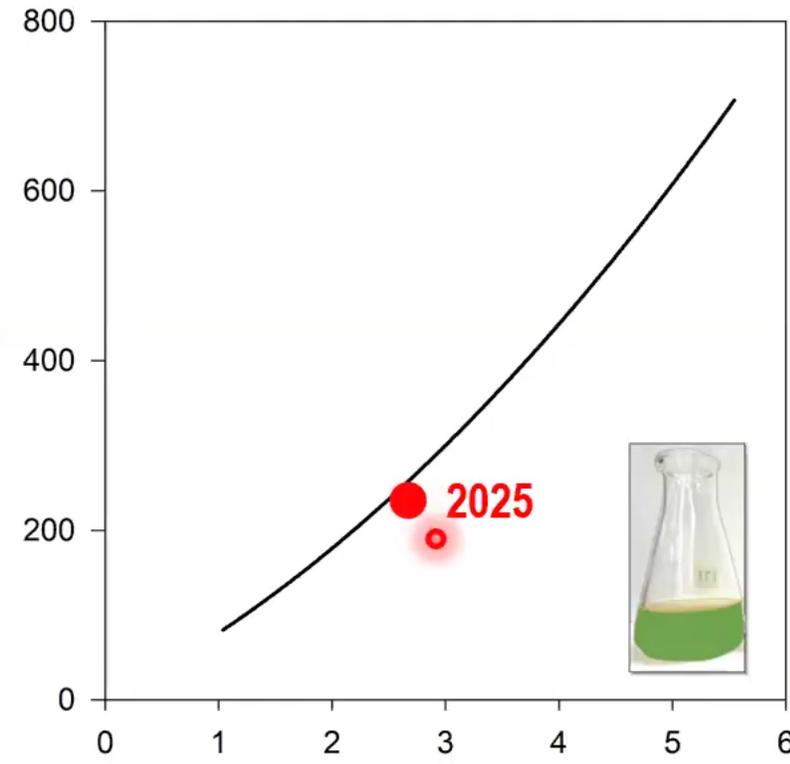
Total Particulate P



Dissolved Reactive P



Total Bioavailable P



Streamflow discharge (km³)

$$0.08 * (TPP) + DRP = TBP$$



Stay Tuned

EPA Lake Erie Nutrients:

<https://www.epa.gov/glwqa/lake-erie-nutrients>

Lake Erie Algae (ErieStat):

<https://www.blueaccounting.org/issue/eriestat/>

The screenshot shows the EPA website's navigation bar with links for Environmental Topics, Laws & Regulations, Report a Violation, and About EPA. The main heading is "Great Lakes Water Quality Agreement (GLWQA)" with a "CONTACT US" link. A sidebar on the left lists navigation options: GLWQA Home, What is GLWQA?, GLWQA Annexes (with "Annex 4: Lake Erie Nutrients" highlighted), About Annex 4, Domestic Action Plans (DAPs), U.S. Action Plan for Lake Erie, Status and Progress, and Lake Erie Water Quality Data. The main content area features the "Lake Erie Nutrients" section, which includes a paragraph about cyanobacteria blooms and their threats to the ecosystem and human health. Below the text are three columns: "About Annex 4" (with a map of Lake Erie), "Domestic Action Plans" (with an aerial view of a landscape), and "Status and Progress" (with a bar chart showing an upward trend).

an official website of the United States government [Here's how you know](#) ▾

EPA United States Environmental Protection Agency

Search EPA.gov 🔍

Environmental Topics ▾ Laws & Regulations ▾ Report a Violation ▾ About EPA ▾

Great Lakes Water Quality Agreement (GLWQA) CONTACT US

GLWQA Home

What is GLWQA?

GLWQA Annexes

Annex 4: Lake Erie Nutrients

About Annex 4

Domestic Action Plans (DAPs)

U.S. Action Plan for Lake Erie

Status and Progress

Lake Erie Water Quality Data

Lake Erie Nutrients

In Lake Erie, excessive growth of cyanobacteria, or blue-green algae, poses significant threats to the ecosystem and human health. Algae can grow rapidly, usually triggered by an excess of phosphorus and nitrogen. This rapid overgrowth is called an algal bloom, which can be harmful if ingested or touched. Sometimes dense blooms of algae form mats or scums at the lake surface. When the algae die and sink to the bottom of the lake, oxygen is consumed as the algae decompose. To prevent harmful and nuisance algal blooms and formation of low oxygen “dead zones” in the lake, the U.S. and Canada are working in partnership with states in the Lake Erie watershed and the province of Ontario to reduce the amount of phosphorus entering Lake Erie.

About Annex 4

The [Great Lakes Water Quality Agreement Nutrients Annex \(Annex 4\)](#) is a commitment between the U.S. and Canada to manage

Domestic Action Plans

[Domestic Action Plans](#) are the “road map” for phosphorus control efforts undertaken by states, provinces, and both federal

Status and Progress

The U.S. and Canada are tracking progress under the Domestic Action Plans to achieve water quality goals.