Western Lake Erie Tributary Water Monitoring Summary

March 1, 2014 - July 31, 2014

lakeerie.ohio.gov

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 surface and ground waters and shares data with the public and other agencies involved with managing our water resources.

Ohio EPA conducts water monitoring for Total Maximum Daily Load development and to assess trends in impairment.

ODNR is interested in protecting recreation, fish, and wildlife water uses.

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

What do we measure?

A large number of components are measured. This summary focuses on total phosphorus, dissolved reactive phosphorus, and nitrogen in the form of nitrate (NO_3) + nitrite (NO_2).

The amount of water in the rivers is measured by USGS at their streamflow gaging stations.

Why this summary?

This summary provides a simplified overview of nutrient loads and concentrations that have been shown to be highly correlated with harmful algal blooms in Lake Erie.

Summarizing the results of these water monitoring efforts provides critical information to agencies and the public. This summary is a tool for tracking annual changes and comparisons to water quality goals established by Annex 4 of the Great Lakes Water Quality Agreement and the Western Basin of Lake Erie Collaborative Agreement.

Where is the water monitored?

Ohio EPA, ODNR, USGS, and Heidelberg University have established many sampling stations in the Lake Erie watershed. Some of these stations are in the same locations to take advantage of USGS streamflow gage locations.

The stations in Figure 1 were chosen from a larger set to indicate the nutrient contributions upstream of the lake influenced sections of the rivers. Due to its large size, several tributaries to the Maumee River were also included.

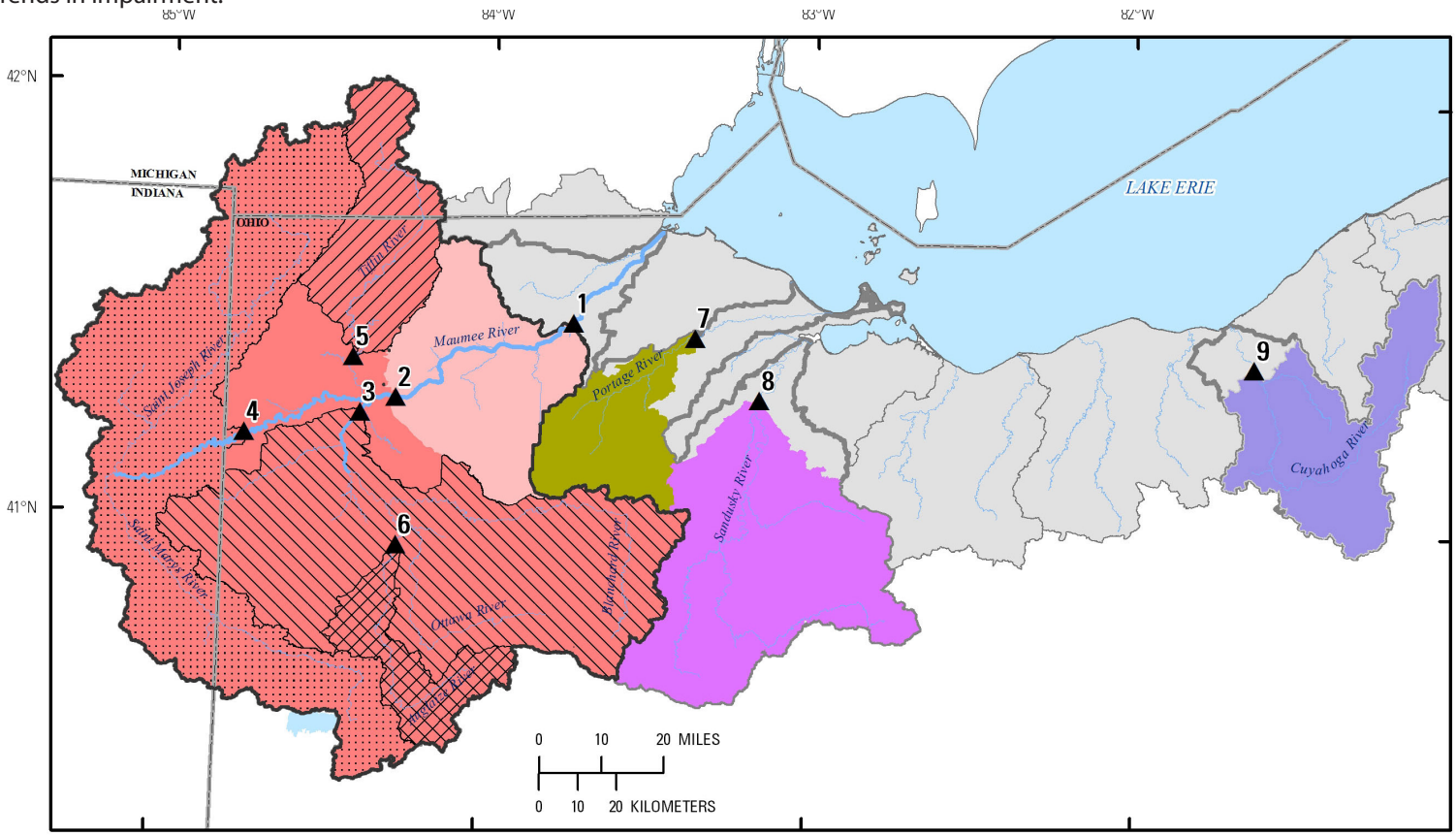

Figure 1: Sampling stations discussed in this report.

Station 1: Gage 04193500 - Maumee River at Waterville
Station 2: Gage 04192500 - Maumee River near Defiance
Station 3: Gage 04191500a - Auglaize River near Defiance d/s Dam
Station 4: Gage 04183500 - Maumee River at Antwerp
Station 5: Gage 04185318 - Tiffin River near Evansport
Station 6: Gage 04186500 - Auglaize River near Fort Jennings
Station 7: Gage 04195500 - Portage River at Woodville
Station 8: Gage 04198000 - Sandusky River near Fremont
Station 9: Gage 04208000 - Cuyahoga River at Independence

What were the nutrient levels for Spring 2014?

This set of charts compares nutrient levels at these stations for the spring months of March through July. This period is used because the Annex 4 subcommittee determined that phosphorus contributions in the spring correlate well with the occurrence of harmful algae blooms. Nitrogen is included because of its potential role in augmenting the blooms or their toxicity. The six Maumee River stations are grouped together to the left of the vertical line for ease of comparison, going roughly upstream to downstream from the left to right.

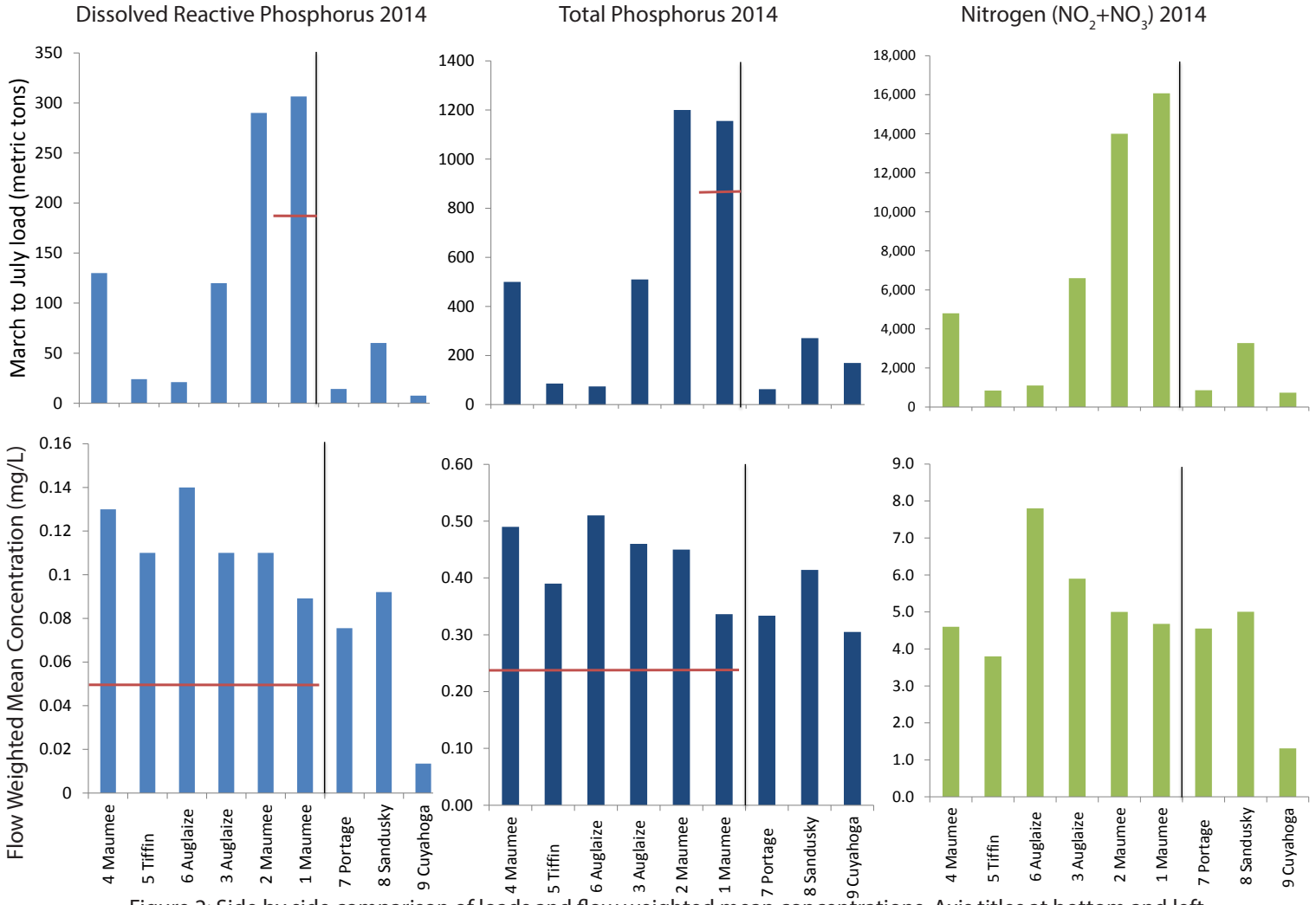

Figure 2: Side by side comparison of loads and flow weighted mean concentrations. Axis titles at bottom and left. Red lines indicate target levels at the points where they apply (not all targets are the same at all locations).

March-July Load (MT)

The three graphs across the top show that the two farthest downstream sites on the main stem of the Maumee River have the largest nutrient loads. The Portage, Sandusky, and Cuyahoga have a much lower contribution to the overall nutrient loading.

In 2014, the Annex 4 target loads were exceeded for both dissolved reactive phosphorus (64% over) and total phosphorus (28% over) as indicated by the red lines at the Maumee River near Waterville station where the target is applied.

Flow Weighted Mean Concentration (mg/L)

Dissolved reactive phosphorus ranged from 0.09 to 0.14 milligrams/liter (mg/L) in the Maumee River and compared closely to the Portage and Sandusky Rivers.

Total phosphorus flow weighted mean concentrations for all stations ranged from 0.30 to 0.50 mg/L.

The Auglaize River at Ft Jennings had the highest flow weighted mean concentration for all three constituents, but was less than 10 percent of the total load at the Maumee River at Waterville due to low flows.

In 2014, the Annex 4 target flow weighted mean concentrations were exceeded at all Maumee River stations for both total phosphorus and dissolved reactive phosphorus. This target applies throughout the watershed. It is a way of finding watersheds that may have low total load contributions, but high relative load contributions.

Nutrient levels in the Cuyahoga River were typically lower in part because the watershed is dominated by urban and forested land use rather than agricultural.

What is Flow Weighted Mean Concentration (FWMC)?

The FWMC represents the total load for the time period divided by the total discharge 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.

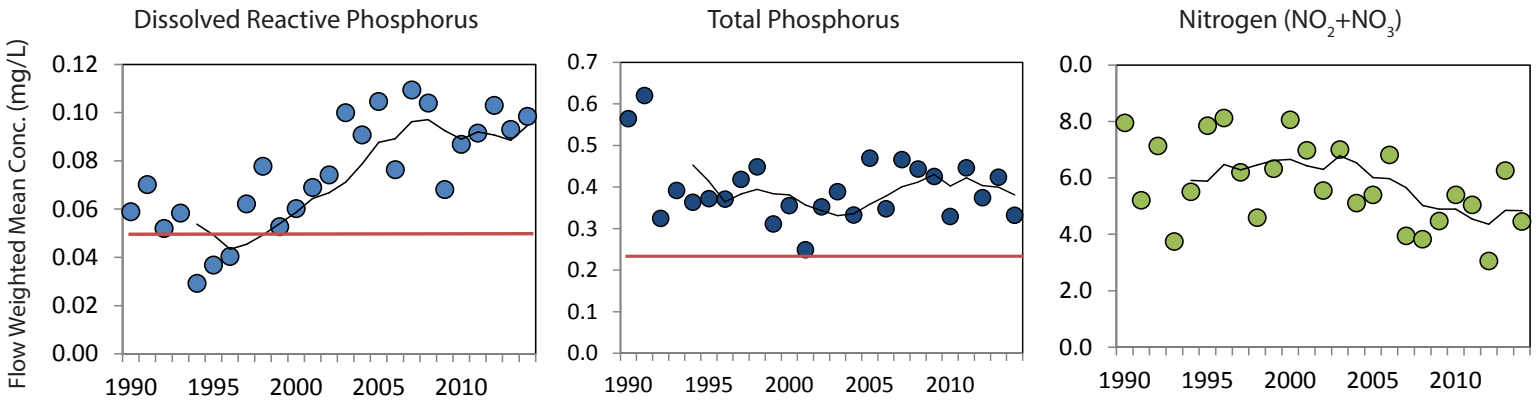

Figure 3: Annual nutrient flow weighted mean concentrations for the Maumee River at Waterville by water year.The five-year running average (black line) smooths out the annual variation and gives an indication of the trends. The red line indicates the Annex 4 target flow weighted mean concentrations.

How does 2014 compare to previous years?

Figure 3 shows that total phosphorus and nitrogen have been decreasing, and dissolved reactive phosphorus has been at about 0.09 mg/L since 2003, after increasing from its recent lows in the mid-1990s. Note that in the mid-1990s, the dissolved reactive phosphorus flow weighted mean concentrations were below the 0.05 mg/L Annex 4 target level, but more recently are nearly twice as high.

Where are the nutrients coming from?

This map shows the spatial distribution of dissolved reactive phosphorus flow weighted mean concentrations (triangles) superimposed on total phosphorus load (circles) across the nine stations. Dissolved reactive phosphorus was highest in the Maumee River at Antwerp: 0.13 mg/L (4) and the Auglaize River at Ft. Jennings: 0.14 mg/L (6), but the total phosphorus was highest on the Maumee River main stem at Defiance: 1200 MT (2) and at Waterville: 1100 MT (1). Thus, the load increased as watershed area increased, but dissolved reactive phosphorus concentrations decreased, possibly due to assimilation by aquatic plants and dilution as more water enters the system in the middle part of the watershed. The Sandusky River at Fremont (8) had higher dissolved reactive phosphorus concentrations than the Maumee at Waterville (1), but a lower total phosphorus load (260 MT). The Cuyahoga River (9) had the lowest dissolved reactive phosphorus concentrations (0.01 mg/L) and a lower load (150 MT) than either the Sandusky River at Fremont: 260 MT (8) or the Maumee River at Waterville (1).

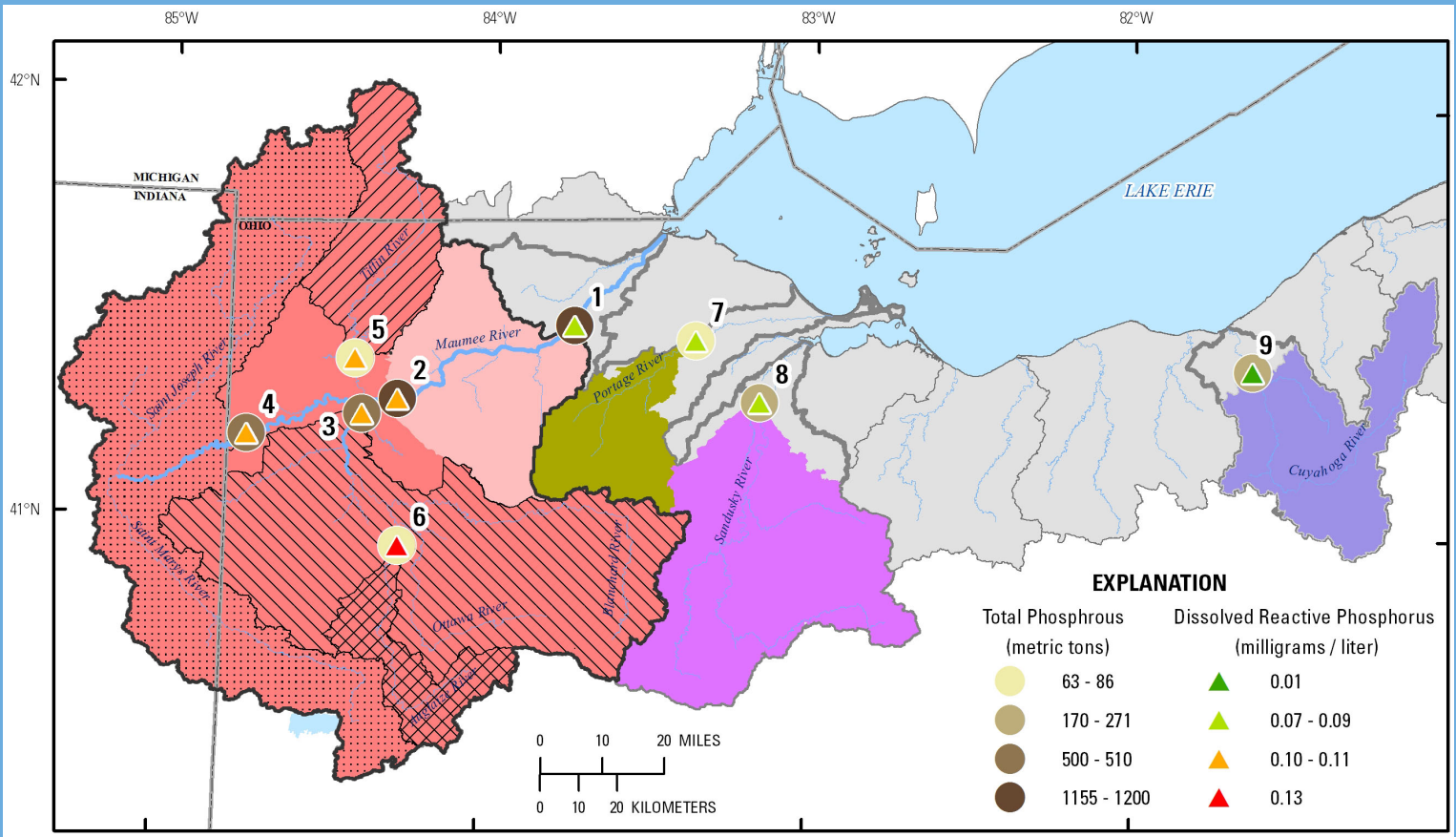

Figure 4: Phosphorus monitoring in the Lake Erie watershed. Data from March 1, 2014 - July 31, 2014.

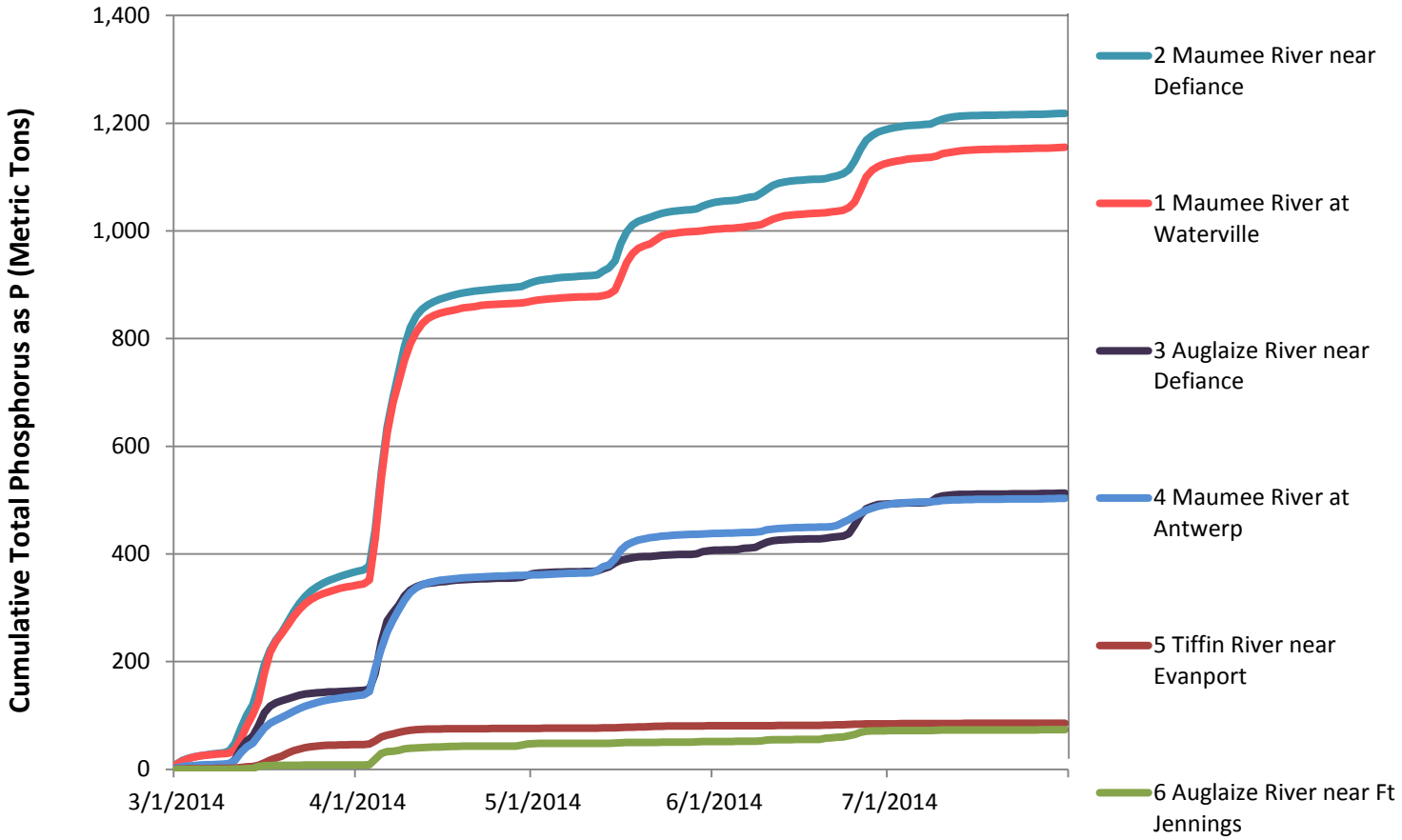

Figure 5: Cumulative total phosphorus loads at monitoring stations in the Maumee River watershed.

When does total phosphorus enter the rivers?

This graph shows a comparison of the cumulative load of total phosphorus at each of the Maumee River stations for March 1 to July 31, 2014. It is apparent that total phosphorus moves through the system closely coupled to the timing of rainfall in the spring.

Each day, the water carries additional load past the monitoring station which is summed to create the running cumulative total. When the amount of water moving through the river network increases dramatically due to rainfall, the load increases, as can be seen by the large jumps on the figure in mid-March and early April.

In 2014, rains in March and April increased the total phosphorus load in the Maumee River at Waterville above the 860 MT Annex 4 target load by the end of April. More rainfall through July led to a final total over 1100 MT, 28% above the target.

The cumulative total phosphorus loads were similar for sites with similar watershed areas: Maumee River near Defiance and at Waterville both have drainage areas over 5,500 square miles, Auglaize River near Defiance and Maumee River at Antwerp have drainage areas between 2,100 and 2,400 square miles, and Tiffin River near Evanport and Auglaize River near Ft. Jennings have drainage areas under 600 square miles.

While Tiffin River near Evansport has more square miles than Auglaize River near Ft. Jennings, 563 and 332 square miles, respectively, Tiffin River near Evansport had a lower flow-weighted mean concentration than Auglaize River near Ft. Jennings for total phosphorus, which calculates to a lower load.

The total load in the Maumee River at Waterville is not a simple sum of the loads from the five upstream stations. Transport is not instant. This may, for example, be due to particulates settling out along the way.

How wet was spring 2014 in comparison to spring in the target year of 2008?

The amount of flow for the period is a major factor influencing how much phosphorus and nitrogen moves down the river into the lake as runoff. For the period March 1-July 31, 2014, flow in the Maumee River at Waterville was 3.44 km^3. By comparison, flow for March 1-July 31, 2008 (base year for the target loads and concentrations) was 3.76 km^3. Flows at this station for these months for the period 2000-2014 averaged 2.93 km^3. So, 2014 was not as wet as the target year, but it was somewhat wetter than a recent typical year. The target year 2008 is a useful benchmark to demonstrate that even in a wet spring lower nutrient loadings can result in a smaller bloom.

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USGS science for a changing world

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