

Lake Macatawa Water Quality Dashboard

2022

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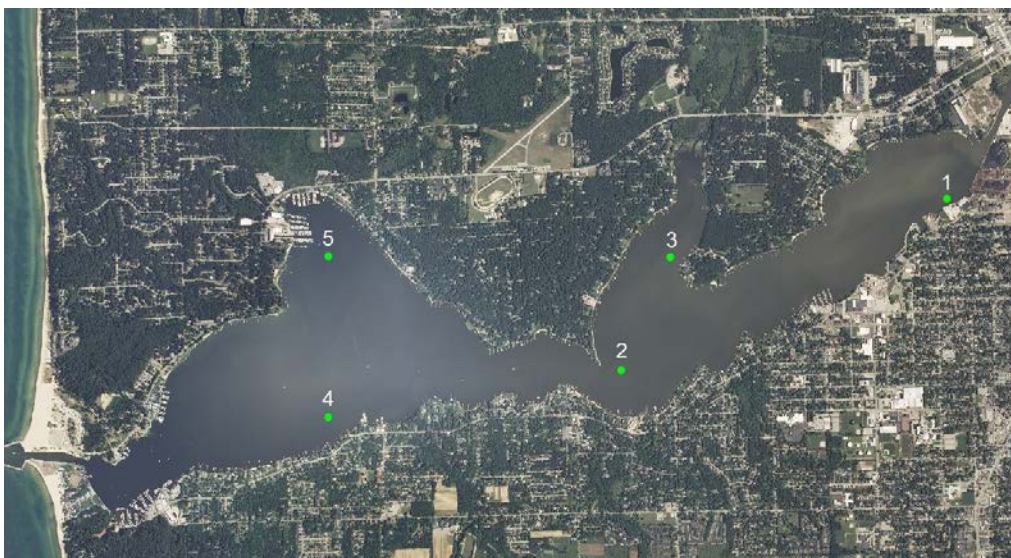


Introduction

As part of Project Clarity, Grand Valley State University's Annis Water Resources Institute (AWRI) established a monitoring program on Lake Macatawa in 2013. The goal of the monitoring program is to evaluate and document the progress toward achieving Project Clarity's goal of improved water quality in Lake Macatawa. The monitoring program involves sampling the lake 3 times per year for a suite of biological, physical, and chemical parameters. Hence, information is not collected continuously and may either capture or miss episodic, short-term conditions. The value of the dashboard is an assessment of long-term trends, not of short-term events.

Key water quality indicators were selected from the many parameters that are monitored to create a water quality dashboard for Lake Macatawa (see full annual report for all parameters). The goal of the dashboard is to provide a visual representation of the current status and historical trends in Lake Macatawa water quality, by rating each indicator along a scale from desirable (green) to undesirable (red) conditions. Each scale also includes a category that indicates the water quality goal for the lake is being met (yellow). The indicators that were chosen are commonly used to assess lake health: total phosphorus concentration, chlorophyll *a* concentration, and Secchi disk depth (water clarity). Each indicator is described in more detail below.

Historical data are included in the dashboard to facilitate comparison of current findings with past status of the selected water quality indicators. Sources for historical data include U.S. EPA (1972; STORET), Michigan Department of Environment, Great Lakes, and Energy (formerly MDEQ; 1982-2012; S. Holden, personal communication), and AWRI (since 2013). All current and historical data shown represent the annual average value of an indicator across Sites 1 (east basin), 2 (central basin), and 4 (west basin; see map below). Data are also collected for Sites 3 and 5 (northern bays) and are available in the full annual report but are excluded from the dashboard because they are more heavily influenced by local conditions in the bay and can bias the dashboard readings.

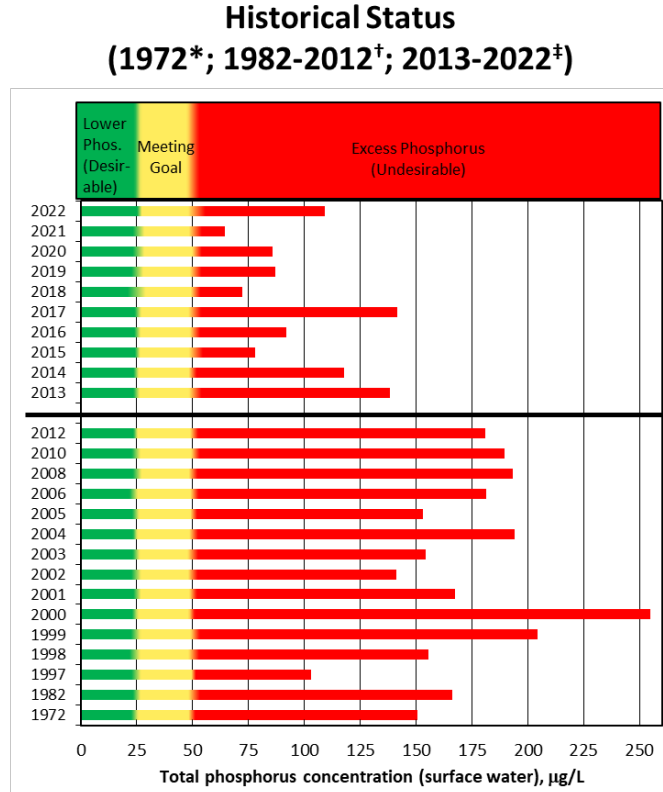
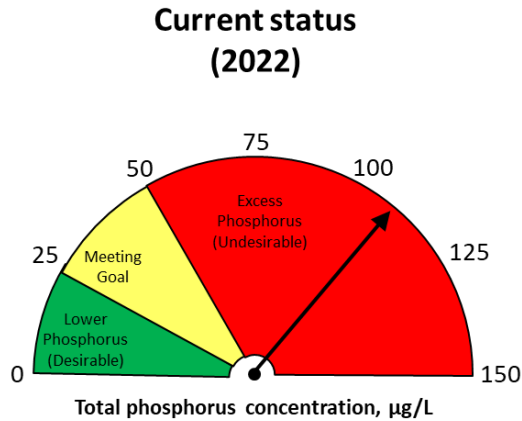


Map of Lake Macatawa showing the 5 sampling locations (green dots) for long-term water quality monitoring. Dashboard indicators were calculated based on data from Sites 1, 2, and 4.

Total Phosphorus

2022 Mean Concentration: 109 µg/L

Target Concentration: 50 µg/L



*U.S. EPA; †EGLE; ‡AWRI

Phosphorus (P) is an essential element for living organisms. In many freshwater systems, P is the element that limits algal growth. However, when it becomes too abundant, it can help stimulate undesirable algal blooms. Phosphorus comes in many forms; we selected Total Phosphorus (TP) as the dashboard indicator because it includes all the forms of P in the lake (i.e., particulate and dissolved).

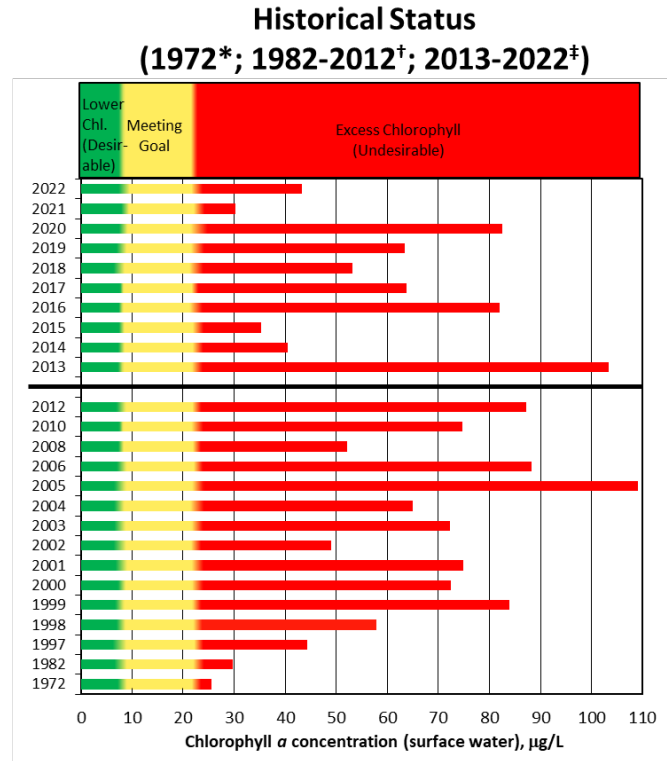
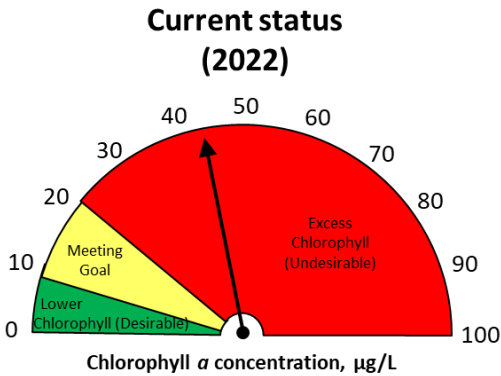
Lake Macatawa has a history of extremely high TP concentrations (i.e., > 100 µg/L), placing it in the past in the “hypereutrophic” trophic state. As a result of this nutrient enrichment, the State of Michigan established an interim target TP concentration of 50 µg/L in Lake Macatawa. Thus, the TP dashboard shows the water quality goal as being met when TP concentrations are < 50 µg/L. While attaining this goal would be a significant improvement in water quality from current conditions, Lake Macatawa would still be in an impaired “eutrophic” state, which we define as TP concentration > 24 µg/L. Therefore, the TP dashboard shows the ultimate desired TP concentration as < 24 µg/L.

The current status for the total phosphorus indicator is **Undesirable**, indicating that the average TP concentration in 2022 exceeded the water quality goal and represents a reversal from the past four years. Although high summer TP was likely a result of an algae bloom and low dissolved oxygen, spring and fall mean TP also exceeded the 50 µg/L restoration goal.

Chlorophyll *a*

2022 Mean Concentration: 43 µg/L

Target Concentration: 22 µg/L



Chlorophyll *a* is the green pigment found in photosynthetic plants and algae. Measuring chlorophyll *a* is a relatively simple way to estimate the amount of algal biomass present in lake water, although it has some limitations. First, chlorophyll *a* does not provide information on whether or not the algae present produce toxins. Second, chlorophyll concentrations can change depending upon environmental conditions, such as light or nutrient level. Finally, chlorophyll *a* concentrations may be low due to very active predation by grazers (zooplankton), so the measurement may give an underestimate of how much algal biomass would otherwise be present.

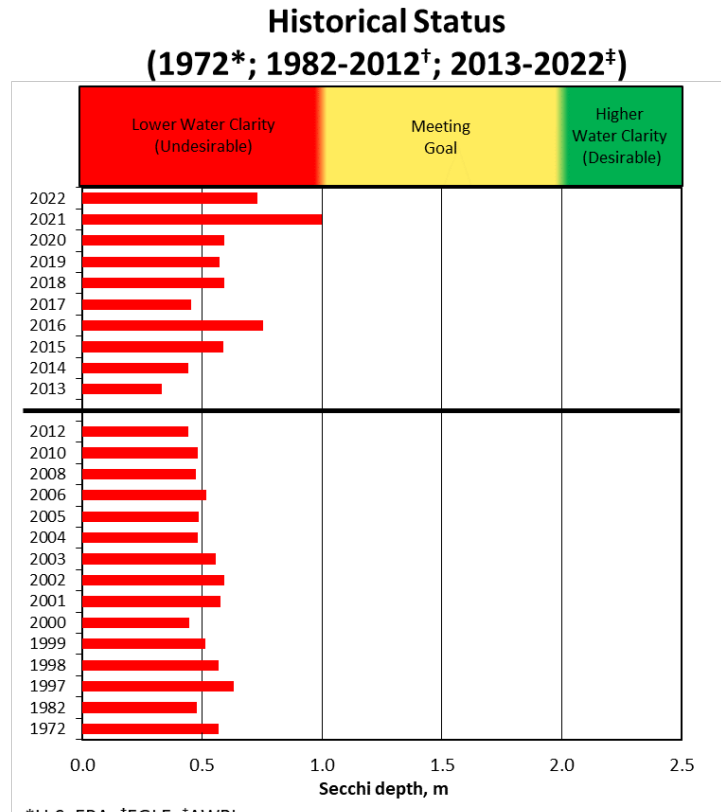
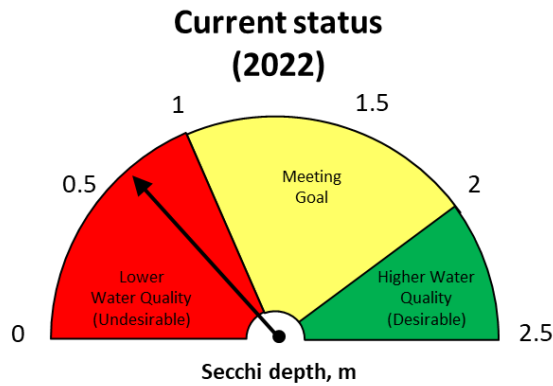
Lake Macatawa has a history of excess algal biomass and high chlorophyll *a* concentrations, typically exceeding the “hypereutrophic” threshold commonly used by EGLE (22 µg/L) in its assessments of the lake. The chlorophyll *a* dashboard shows that the concentration will meet the water quality goal once it is < 22 µg/L. Although meeting the chlorophyll *a* goal would be a significant improvement in water quality, Lake Macatawa would still be categorized as “eutrophic” (i.e., > 7 µg/L chlorophyll *a*). Thus, the chlorophyll *a* dashboard shows that the ultimate desired chlorophyll *a* concentration is < 7 µg/L.

The current status for the chlorophyll *a* indicator is **Undesirable** due in part to the algae bloom in July 2022; although the dashboard reflects an increase compared to 2021, chlorophyll *a* levels remained lower than the 2016-2020 concentrations.

Secchi Disk Depth (Water Clarity)

2022 Mean Depth: 0.73 m (~2.4 ft)

Target Depth: 1 m (~3.3 ft)



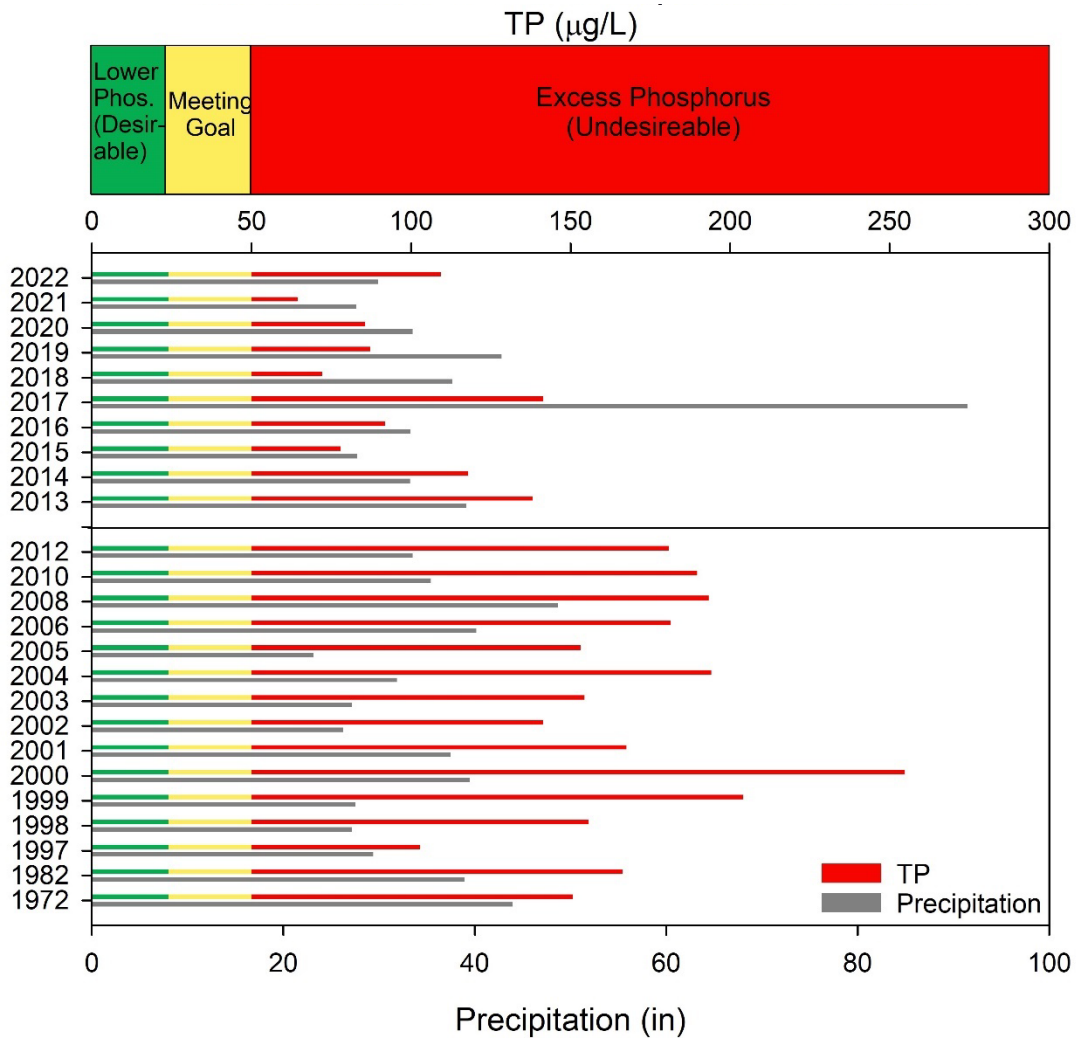
*U.S. EPA; †EGLE; ‡AWRI

Secchi disk depth is an estimate of water clarity. It is measured using a standard black and white disk, named after the Italian priest Angelo Secchi, who first used an all-white disk for marine waters in 1865. Lake ecologists modified it to black and white in the late 1800s. The Secchi disk is a simple and easy way to measure water clarity, although if waters are cloudy, the disk depth tells you nothing about why the lake is turbid (e.g., is it due to suspended algae, suspended sediment, or dissolved organic matter?).

Along with excess phosphorus and chlorophyll *a* concentrations, Secchi depths have historically reflected extremely impaired conditions in Lake Macatawa. Oligotrophic lakes, such as Lake Tahoe, have Secchi disk depths down to 21 m (~70 ft) or deeper. Conversely, hypereutrophic lakes, such as Lake Macatawa, typically have Secchi depths shallower than 1 m (~3 ft). The water clarity goal for Lake Macatawa is modest, with a Secchi depth > 1 m. Because Secchi depths between 1 and 2 m are indicative of a eutrophic state, a desirable Secchi depth is > 2 m.

The current status for the Secchi depth indicator is **Undesirable**, meaning that the average Secchi slightly worsened from last year and currently does not meet the criteria of the water quality goal. However, the water clarity is still improved compared to prior years.

Total Phosphorus and Precipitation



Phosphorus concentrations in Lake Macatawa are influenced by many variables, but one of the most significant is precipitation because rain and snow events create runoff from farms and urban areas, when phosphorus can be transported to Lake Macatawa either in the dissolved form or as attached to sediment particles; precipitation also results in atmospheric deposition, which can contribute phosphorus directly to the lake and landscape. As a consequence, it is of interest to know if annual changes in lake phosphorus concentrations are related to precipitation.

To answer this question, we examined total phosphorus (TP) concentrations in the lake, based on data from EGLE and AWRI (sampled 3x per year at 3 sites), and compared them to precipitation data from the Tulip City Airport in Holland. As seen above, between 1972 and 2022, the relationship between precipitation and TP concentration in the lake is not directly related; for example, some years have very high TP concentrations but relatively low precipitation (e.g., 2000 and 2004), whereas other years have modest levels of TP but relatively high precipitation (e.g., 2017). Indeed, past Project Clarity dashboards have shown that the statistical relationship between the two is not statistically significant.

The relationship between TP and precipitation is much improved by considering only the rainfall in the previous day instead of the entire year and is statistically significant (for 2013-2022, $R^2 = 0.32$; $p = 0.003$). We view these data as appropriate only for screening purposes, as the TP concentrations are means of seasonal lake sampling events, which likely miss pulses of high P concentrations after storm events throughout the rest of the non-monitored season.