Lake Macatawa Water Quality Dashboard

2014

February 2015

Mary E. Ogdahl
Alan D. Steinman, Ph.D.

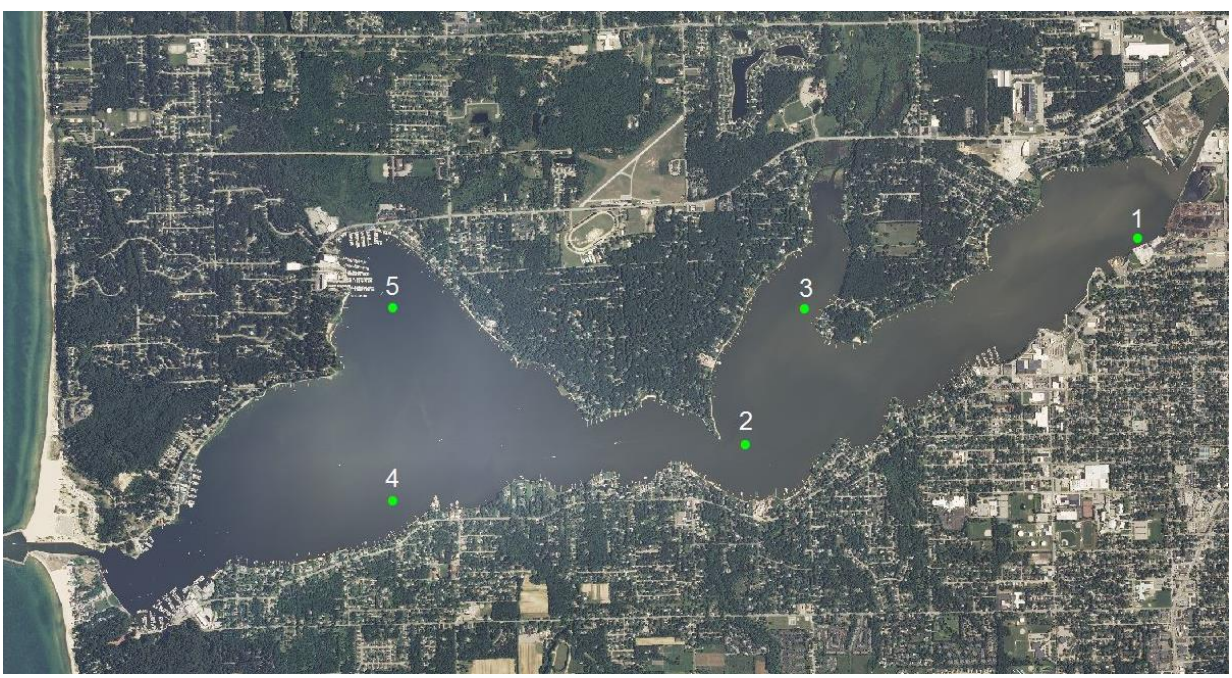
Grand Valley State University
Robert B. Annis Water Resources Institute

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; these data are then averaged to give a visual representation of the lakewide conditions over the entire year.

Key water quality indicators were selected from the many parameters that are monitored to create a water quality dashboard for Lake Macatawa. 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 trophic status: total phosphorus, chlorophyll *a*, and Secchi disk depth. Each indicator is described in more detail below.

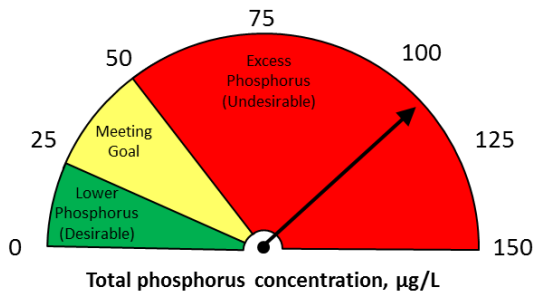
Historical data are included in the dashboard to facilitate comparison of current findings with past status of the selected water quality indicators. Sources for historical data include U.S. EPA (1972; STORET) and Michigan Department of Environmental Quality (1982-2012; S. Holden, personal communication). All current (AWRI) and historical (EPA, MDEQ) data shown represent the annual average value of an indicator across Sites 1 (east basin), 2 (central basin), and 4 (west basin; see figure below).



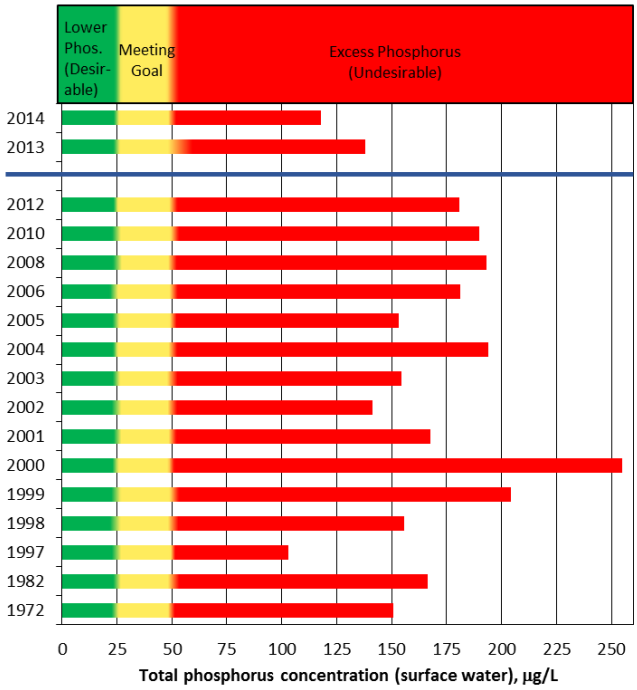
Map of Lake Macatawa showing the 5 sampling locations (green dots) for long-term water quality monitoring. Dashboard indicators were calculated based on data from Sites 1, 2, and 4.

Total Phosphorus

Current status (2014)



Historical Status (1972*; 1982-2012†; 2013-2014‡)



*U.S. EPA; †MDEQ; ‡AWRI

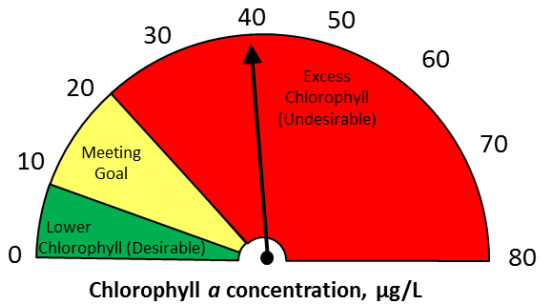
Phosphorus (P) is an essential element for living organisms. In many freshwater systems, P is the element that limits algal growth. However, when it becomes too abundant, it can help stimulate undesirable algal blooms. Phosphorus comes in many forms; total phosphorus (TP) was chosen as the dashboard indicator. TP, as the name suggests, includes all the forms of P in the lake (i.e., particulate and dissolved). Some indices use dissolved inorganic phosphorus (DIP), which is the form readily available for algal use. However, DIP can be misleading. A lake with very low DIP can have a massive algal bloom because all the DIP has been taken up by the algae and transformed into algal cells.

Lake Macatawa has a history of extremely high TP concentrations (i.e., > 100 µg/L), placing it in the "hypereutrophic" trophic state. As a result of this nutrient enrichment, the State of Michigan has 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 is < 24 µg/L.

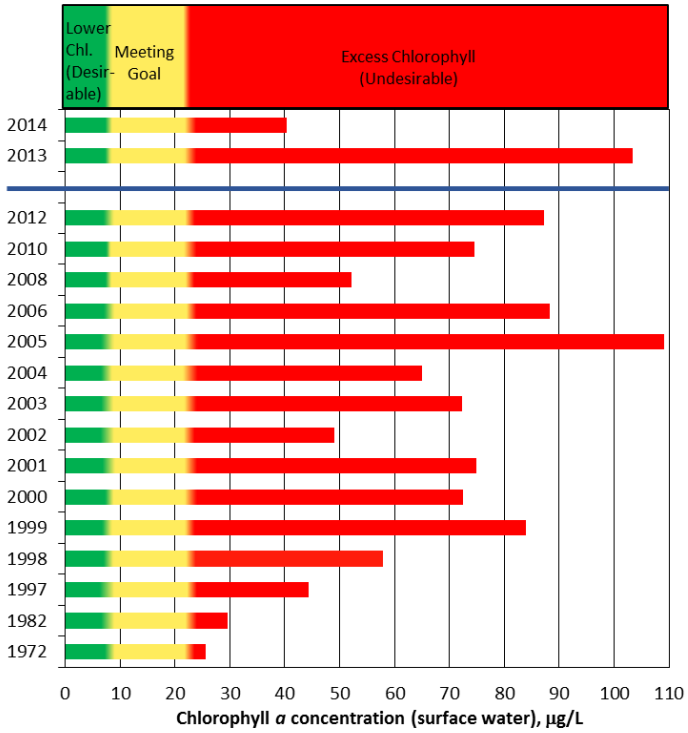
The current status for the total phosphorus indicator is **Undesirable**, meaning that the average TP concentration in 2014 exceeded the water quality goal. Current TP concentrations fall within the range of historical values, which all exceeded the 100 µg/L hypereutrophic threshold.

Chlorophyll *a*

Current status (2014)



Historical Status (1972*; 1982-2012†; 2013-2014‡)



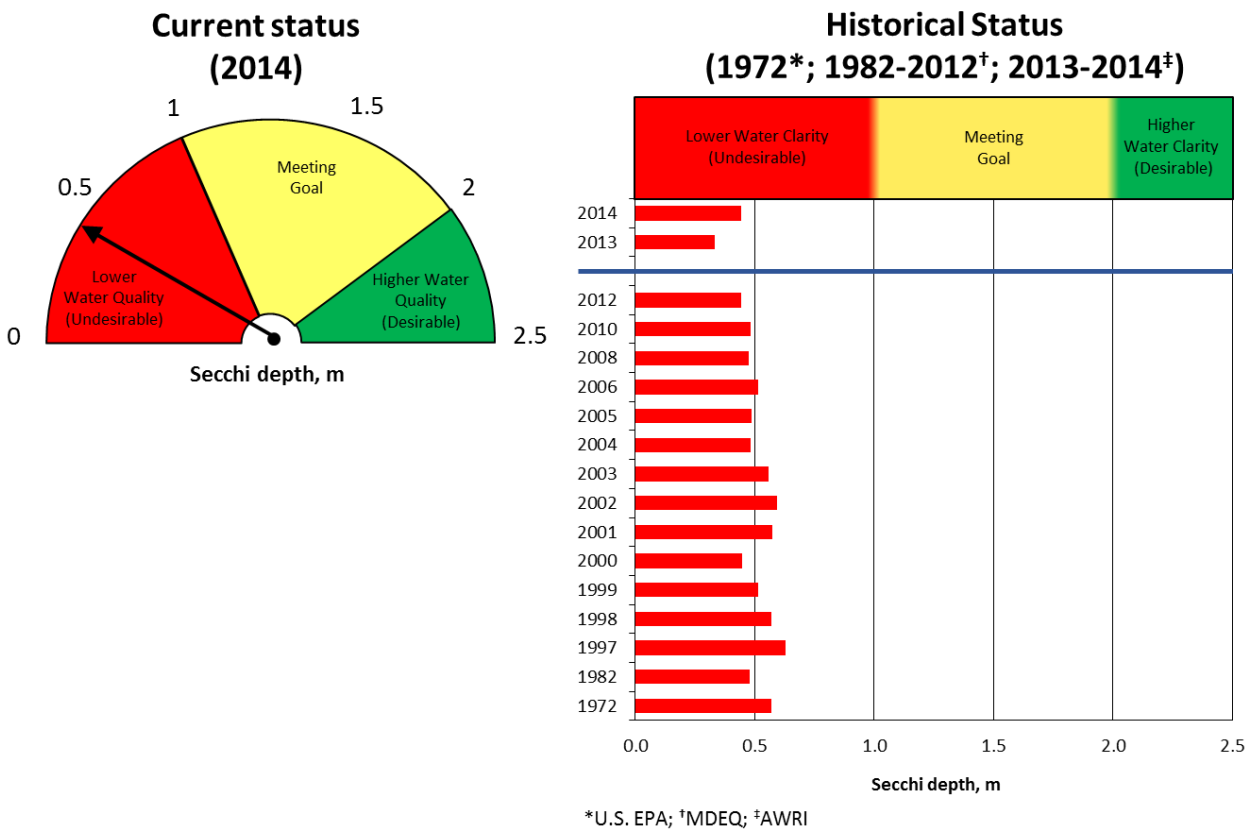
*U.S. EPA; †MDEQ; ‡AWRI

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 the type of algae present (e.g., is it a harmful species or not?). 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, 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 MDEQ (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**, meaning that the average chlorophyll *a* concentration in 2014 exceeded the water quality goal. Current chlorophyll *a* concentrations fall within the range of historical values, which all exceeded the 22 µg/L hypereutrophic threshold.

Secchi Disk Depth (Water Clarity)



Secchi disk depth is an estimate of water clarity. It is measured using a standard black and white disk, named after 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 or suspended sediment?).

Along with excessive 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. 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 depth in 2014 was shallower (i.e., less clarity) than the water quality goal. Current Secchi depths fall within the range of historical values, which all were shallower than the 1 m hypereutrophic threshold.