# Lake Metonga

**Forest County, Wisconsin**

# Comprehensive Management Plan

**March 2021**

Sponsored by:

**Lake Metonga Association, Inc.**

WDNR Surface Water Grant Program

LPL-1662-18


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Onterra, LLC
Lake Management Planning

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Forest County, Wisconsin

# Comprehensive Management Plan

March 2021


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Funded by: Lake Metonga Association, Inc.
Wisconsin Dept. of Natural Resources
(LPL 1662-18)

## Acknowledgements

This management planning effort was truly a team-based project and could not have been completed without the input of the following individuals:

### Lake Metonga Planning Committee

| | | |
|---|---|---|
| Mark Truyman - Chair | Susan Samz | Steph Mattson |
| Julie Janquart | Edward Smith | Stacy Karcz |
| Julie Van Lannen | Mark Pellegrini | |
| Grant Reed | Lynne Black | |

### Lake Metonga Board of Directors

| | | |
|---|---|---|
| Gary Mueller - President | Steve Parks - Treasurer | |
| Gary Goeman – Vice President | Mark Truyman | |
| Julie Janquart - Secretary | Lynn Smith | |

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G. Comment Response Document for the Official First Draft

# 1.0 INTRODUCTION

According to the 1971 recording sonar WDNR Lake Survey Map, Lake Metonga is 1,991.1 acres. The WDNR website lists the lake as 2,038 acres. At the time of this report, the most current orthophoto (aerial photograph) was from the *National Agriculture Imagery Program* (NAIP) collected in 2017. Based on heads-up digitizing of the water level from that photo, the lake was determined to be 2,051.7 acres. Lake Metonga, Forest County, is a deep lowland drainage lake with a maximum depth of 79 feet and a mean depth of 25 feet. This oligotrophic lake has a relatively small watershed when compared to the size of the lake. Lake Metonga contains 22 native plant species, of which wild celery is the most common. Eurasian watermilfoil is the only submerged exotic plant species known from Lake Metonga.

**Lake Notes**

*Lake Metonga is an Area of Special Natural Resource Interest outstanding/exceptional resource water under NR 102. With two public boat launches, a public swimming beach, an ADA fishing pier, a campground, Veterans Memorial Park, and the Wolf River State Trail along its shores, a wide variety of recreational opportunities exist here.*

**Photograph 1.0-1 Lake Metonga, Forest County**

## Lake at a Glance - Lake Metonga

| | |
|---|---|
| **Morphology** | |
| Acreage | 2,051.7 |
| Maximum Depth (ft) | 79 |
| Mean Depth (ft) | 25 |
| Shoreline Complexity | 1.7 |
| **Vegetation** | |
| Number of Native Species | 22 |
| Exotic Plant Species | Eurasian watermilfoil |
| Simpson's Diversity | 0.81 |
| Average Conservatism | 6.1 |
| **Water Quality** | |
| Trophic State | Oligotrophic |
| Limiting Nutrient | Phosphorus |
| Water Acidity (pH) | 8.7 |
| Sensitivity to Acid Rain | Not sensitive |
| Watershed to Lake Area Ratio | 3:1 |

The Lake Metonga Association (LMA), founded in 1970, is a 501(c)3 nonprofit, volunteer organization dedicated to preserving Lake Metonga. The Association works with the community and property owners to protect the aesthetic beauty, water quality, wildlife habitats, and fisheries for future generations.

Lake Metonga, by virtue of its size, clear water, and sandy beaches, is a popular recreational lake and tourist destination. Arguably, it is this factor which has caused Lake Metonga to become infested with invasive species such as rusty crayfish, zebra mussels, and Eurasian watermilfoil (EWM). Since 1998, the LMA has conducted a range of AIS management, monitoring, and prevention activities. The LMA has also led numerous lake management planning projects, including the latest *Comprehensive Management Plan* completed in December 2007 and an *Aquatic Plant Management Plan Update* in January 2014.

The LMA successfully received a WDNR Lake Planning Grant to construct an updated comprehensive management plan starting in 2018. This report serves as the final deliverable for this grant-funded project (LPL-1662-18).

# 2.0 STAKEHOLDER PARTICIPATION

Stakeholder participation is an important part of any management planning exercise. During this project, stakeholders were not only informed about the project and its results, but also introduced to important concepts in lake ecology. The objective of this component in the planning process is to accommodate communication between the planners and the stakeholders. The communication is educational in nature, both in terms of the planners educating the stakeholders and vice-versa. The planners educate the stakeholders about the planning process, the functions of their lake ecosystem, their impact on the lake, and what can realistically be expected regarding the management of the aquatic system. The stakeholders educate the planners by describing how they would like the lake to be, how they use the lake, and how they would like to be involved in managing it. All of this information is communicated through multiple meetings that involve the lake group as a whole or a focus group called a Planning Committee, the completion of a stakeholder survey, and a project update approximately half way through the project.

The highlights of this component are described below. Materials used during the planning process can be found in Appendix A.

**Planning Committee Meeting**

On August 15, 2019, Eddie Heath of Onterra met with six members of the LMA Planning Committee and five additional LMA board of directs for approximately 4 hours. In advance of the meeting, attendees were provided an early draft of the study report sections to facilitate better discussion. The primary focus of this meeting was the delivery of the study results and conclusions to the committee. All study components including Eurasian watermilfoil (EWM) management results, aquatic plant inventories, water quality analysis, and watershed modeling were presented and discussed. The meeting also discussed the stakeholder survey results and the perceptions of Lake Metonga riparian stakeholders. The presentation materials from this meeting are included in Appendix A.

**Planning Committee Meeting II**

On September 12, 2019, Eddie Heath of Onterra met with seven members of the LMA Planning Committee for approximately four hours. The meeting started with a brief discussion of the Lake Metonga fisheries, and then transitioned towards the development of management goals and management actions. This included a brainstorming session of the "challenges" facing Lake Metonga, conversion of the challenges into management goals, and the creation of management actions to meet the management goals. The presentation materials from this meeting are included in Appendix A.

## *Wrap-Up Meeting*

Delayed due to Covid-19, the Wrap-Up Meeting is scheduled for May 8, 2021.

**Management Plan Review and Adoption Process**

On October 23, 2019, a draft outline of the Implementation Plan was provided to the Planning Committee for review. Comments were received from the Planning in mid-December and incorporated into a full-text version of the Implementation Plan Section. This section was provided to the Planning Committee in mid-January for further discussion. The Planning Committee provided additional perspective that was incorporated into the Implementation Plan.

On February 28, 2020, an early draft of the Comprehensive Management Plan was provided to the LMA Planning Committee for review before becoming the official first draft. Comments were received a few days later and integrated into the Official First Draft.

On March 6, 2020, an official first draft of the LMA's Comprehensive Management Plan for Lake Metonga was supplied to the WDNR (lakes and fisheries programs), Mole Lake Sokaogon Chippewa Community, and Great Lakes Indian Fish and Wildlife Commission (GLIFWC).

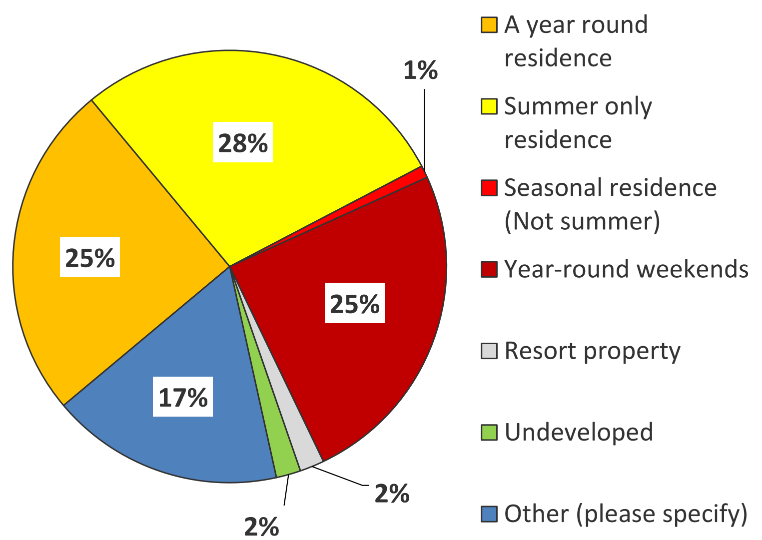
Written review of the draft plan was received on April 20, 2020 from Greg Matzke (WDNR fisheries biologist) and August 3, 2020 from Scott Van Egeren (WDNR lakes coordinator). The WDNR comments and how they are addressed in the final plan are contained in Appendix G. An official second draft was created and shared with the WDNR on November 12, 2019. The WDNR indicated that all comments were adequately addressed and the plan was approved.

**Riparian Stakeholder Survey**

As a part of this project, a stakeholder survey was distributed to riparian property owners and Lake Metonga Association members around Lake Metonga. The survey was designed by Onterra staff and the Lake Metonga Association planning committee and reviewed by a WDNR social scientist. During the review process numerous drafts were exchanged along with two in person meetings held on January 18, 2019 and March 13, 2019 between Onterra and the Lake Metonga planning committee. A final draft of the stakeholder survey was adopted and WDNR approved on April 5$^{th}$ 2019. In late-April 2019, the four-page, 38-question survey was posted online through Survey Monkey for property owners to answer electronically. If requested, a hard copy was sent to the property owner with a self-addressed stamped envelope for returning the survey anonymously. A week following the reminder postcard distribution, a paper survey was also mailed to all non-respondents. The returned hardcopy surveys were entered into the online version by a Lake Metonga Association volunteer for analysis.

Please note that typically a benchmark of a 60% response rate is required to portray population projections accurately, and make conclusions with statistical validity. Sixty-nine percent of the surveys for Lake Metonga were returned and therefore are statistically representative of the population that was sampled. The data were analyzed and summarized by Onterra for use at the planning meetings and within the management plan. The full survey and results can be found in Appendix B, while discussion of those results is integrated within the appropriate sections of the management plan and a general summary is discussed below.

Based upon the results of the Stakeholder Survey, much was learned about the people that use and care for Lake Metonga. A plurality of stakeholders (28%) live on the lake during the summer months only, while 25% are year-round residents, 24% visit year-round weekends, and 2% have undeveloped property (Figure 2.0-1, left frame). The majority of stakeholders use their Lake Metonga property between 0 and 100 days per year (Figure 2.0-1, right frame).




| # of days per year | Responses | |
|---|---|---|
| 0 to 100 | 117 | 56% |
| 101 to 200 | 41 | 20% |
| 201 to 300 | 10 | 5% |
| 301 to 365 | 42 | 20% |

**Figure 2.0-1. Stakeholder survey response Question #3 & #4.** How is your property on Lake Metonga utilized (left); How many days each year is your property used by you or others (right).

Open water and ice-fishing where the two highest ranked activities when riparians were asked why the own property on Lake Metonga (Figure 2.0-2). Riparians also ranked pleasure boating and jet skiing/skiing/tubing as important factors for choosing to be a Lake Metonga riparian.

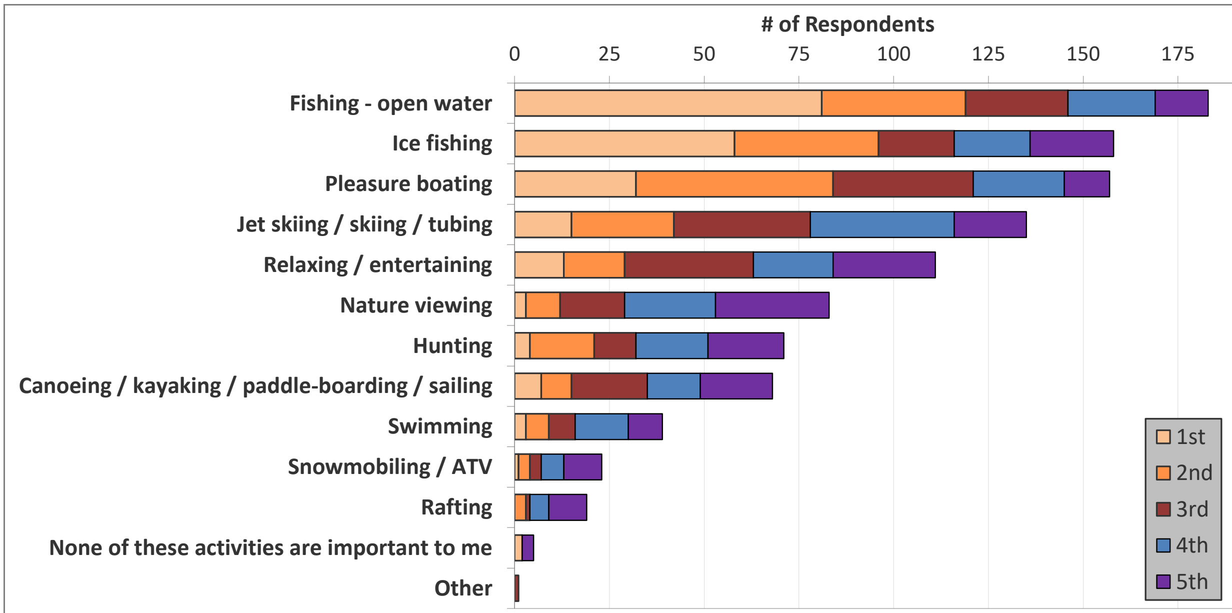



**Figure 2.0-2. Stakeholder survey response Question #10.** Please rank up to five activities that are important reasons for owning or renting your property on or near Lake Metonga.

The following sections (Water Quality, Watershed, Aquatic Plants and Fisheries Data Integration) discuss the stakeholder survey data with respect these particular topics. A concern of stakeholders noted throughout the stakeholder survey (see Question 29 and survey comments – Appendix B) was aquatic invasive species introduction (Figure 2.0-3). The Lake Metonga Association has been involved in the Clean Boat Clean Waters Program since 2013. Having inspectors regularly designated at boat landings will help prevent aquatic invasive species from leaving and entering Lake Metonga.

*Question 29: Please rank your top five concerns regarding Lake Metonga.*

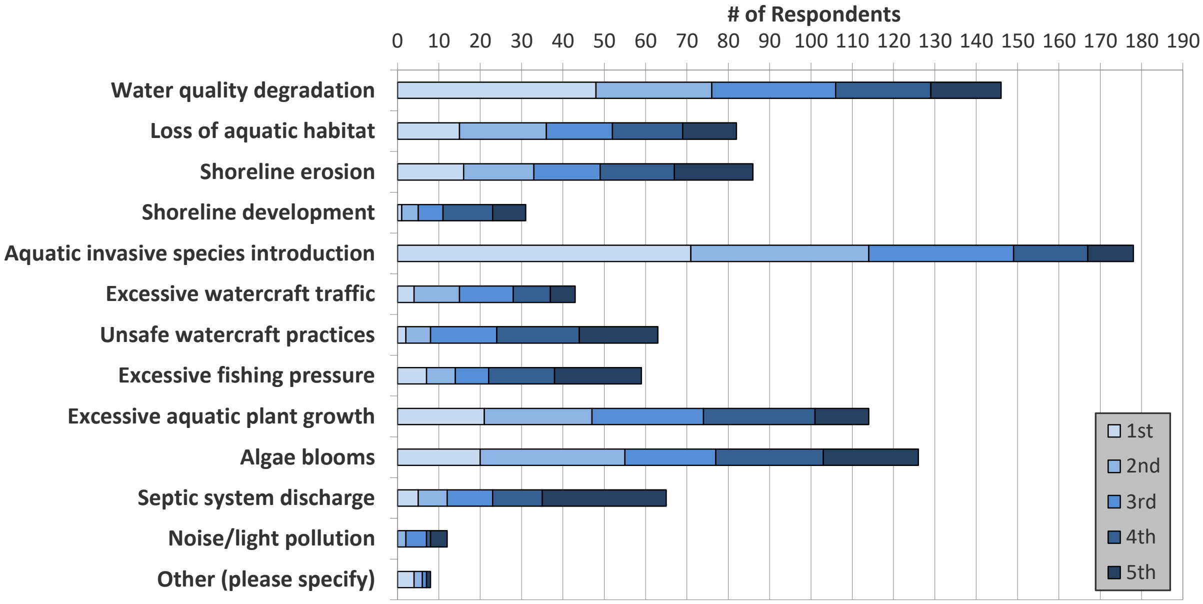



**Figure 2.0-3. Select survey responses from the Lake Metonga Stakeholder Survey, continued.** Additional questions and response charts may be found in Appendix B.

# 3.0 RESULTS & DISCUSSION

## 3.1 Lake Water Quality

### *Water Quality Data Analysis and Interpretation*

Reporting of water quality assessment results can often be a difficult and ambiguous task. Foremost is that the assessment inherently calls for a baseline knowledge of lake chemistry and ecology. Many of the parameters assessed are part of a complicated cycle and each element may occur in many different forms within a lake. Furthermore, water quality values that may be considered poor for one lake may be considered good for another because judging water quality is often subjective. However, focusing on specific aspects or parameters that are important to lake ecology, comparing those values to similar lakes within the same region and historical data from the study lake provides an excellent method to evaluate the quality of a lake's water.

Many types of analyses are available for assessing the condition of a particular lake's water quality. In this document, the water quality analysis focuses upon attributes that are directly related to the productivity of the lake. In other words, the water quality that impacts and controls the fishery, plant production, and even the aesthetics of the lake are related here. Specific forms of water quality analyses are used to indicate not only the health of the lake, but also to provide a general understanding of the lake's ecology and assist in management decisions. Each type of available analysis is elaborated on below.

As mentioned above, chemistry is a large part of water quality analysis. In most cases, listing the values of specific parameters really does not lead to an understanding of a lake's water quality, especially in the minds of non-professionals. A better way of relating the information is to compare it to lakes with similar physical characteristics and lakes within the same regional area. In this document, a portion of the water quality information collected on Lake Metonga is compared to other lakes in the state with similar characteristics as well as to lakes within the northern region (Appendix C). In addition, the assessment can also be clarified by limiting the primary analysis to parameters that are important in the lake's ecology and trophic state (see below). Three water quality parameters are focused upon in the Lake Metonga water quality analysis:

> **Phosphorus** is the nutrient that controls the growth of plants in the vast majority of Wisconsin lakes. It is important to remember that in lakes, the term "plants" includes both algae and macrophytes. Monitoring and evaluating concentrations of phosphorus within the lake helps to create a better understanding of the current and potential growth rates of the plants within the lake.
>
> **Chlorophyll-*a*** is the green pigment in plants used during photosynthesis. Chlorophyll-*a* concentrations are directly related to the abundance of free-floating algae in the lake. Chlorophyll-*a* values increase during algal blooms.
>
> **Secchi disk transparency** is a measurement of water clarity. Of all limnological parameters, it is the most used and the easiest for non-professionals to understand. Furthermore, measuring Secchi disk transparency over long periods of time is one of the best methods of monitoring the health of a lake. The measurement is conducted by lowering a weighted, 20-cm diameter disk with alternating black and white quadrants (a Secchi disk) into the water and recording the depth just before it disappears from sight.

The parameters described above are interrelated. Phosphorus controls algal abundance, which is measured by chlorophyll-*a* levels. Water clarity, as measured by Secchi disk transparency, is directly affected by the particulates that are suspended in the water. In the majority of natural Wisconsin lakes, the primary particulate matter is algae; therefore, algal abundance directly affects water clarity. In addition, studies have shown that water clarity is used by most lake users to judge water quality – clear water equals clean water (Canter et al. 1994, Dinius 2007, and Smith et al. 1991).

## Trophic State

Total phosphorus, chlorophyll-*a*, and water clarity values are directly related to the trophic state of the lake. As nutrients, primarily phosphorus, accumulate within a lake, its productivity increases and the lake progresses through three trophic states: oligotrophic, mesotrophic, and finally eutrophic. Every lake will naturally progress through these states and under natural conditions (i.e. not influenced by the activities of humans) this progress can take tens of thousands of years. Unfortunately, human influence has accelerated this natural aging process in many Wisconsin lakes. Monitoring the trophic state of a lake gives stakeholders a method by which to gauge the productivity of their lake over time. Yet, classifying a lake into one of three trophic states often does not give clear indication of where a lake really exists in its trophic progression because each trophic state represents a range of productivity. Therefore, two lakes classified in the same trophic state can actually have very different levels of production.

> Trophic states describe the lake's ability to produce plant matter (production) and include three continuous classifications: Oligotrophic lakes are the least productive lakes and are characterized by being deep, having cold water, and few plants. Eutrophic lakes are the most productive and normally have shallow depths, warm water, and high plant biomass. Mesotrophic lakes fall between these two categories.

However, through the use of a trophic state index (TSI), an index number can be calculated using phosphorus, chlorophyll-*a*, and clarity values that represent the lake's position within the eutrophication process. This allows for a more clear understanding of the lake's trophic state while facilitating clearer long-term tracking. Carlson (1977) presented a trophic state index that gained great acceptance among lake managers.

## Limiting Nutrient

The limiting nutrient is the nutrient which is in shortest supply and controls the growth rate of algae and some macrophytes within the lake. This is analogous to baking a cake that requires four eggs, and four cups each of water, flour, and sugar. If the baker would like to make four cakes, he needs 16 of each ingredient. If he is short two eggs, he will only be able to make three cakes even if he has sufficient amounts of the other ingredients. In this scenario, the eggs are the limiting nutrient (ingredient).

In most Wisconsin lakes, phosphorus is the limiting nutrient controlling the production of plant biomass. As a result, phosphorus is often the target for management actions aimed at controlling plants, especially algae. The limiting nutrient is determined by calculating the nitrogen to phosphorus ratio within the lake. Normally, total nitrogen and total phosphorus values from the surface samples taken during the summer months are used to determine the ratio. Results of this ratio indicate if algal growth within a lake is limited by nitrogen or phosphorus. If the ratio is greater than 15:1, the lake is considered phosphorus limited; if it is less than 10:1, it is considered nitrogen limited. Values between these ratios indicate a transitional limitation between nitrogen and phosphorus.

### Temperature and Dissolved Oxygen Profiles

Temperature and dissolved oxygen profiles are created simply by taking readings at different water depths within a lake. Although it is a simple procedure, the completion of several profiles over the course of a year or more provides a great deal of information about the lake. Much of this information relates to whether the lake thermally stratifies or not, which is determined primarily through the temperature profiles. Lakes that show strong stratification during the summer and winter months need to be managed differently than lakes that do not. Normally, deep lakes stratify to some extent, while shallow lakes (less than 17 feet deep) do not.

**Lake stratification** occurs when temperature gradients are developed with depth in a lake. During stratification the lake can be broken into three layers: The epilimnion is the top layer of water which is the warmest water in the summer months and the coolest water in the winter months. The hypolimnion is the bottom layer and contains the coolest water in the summer months and the warmest water in the winter months. The metalimnion, often called the thermocline, is the middle layer containing the steepest temperature gradient.

Dissolved oxygen is essential in the metabolism of nearly every organism that exists within a lake. For instance, fish kills are often the result of insufficient amounts of dissolved oxygen. However, dissolved oxygen's role in lake management extends beyond this basic need by living organisms. In fact, its presence or absence impacts many chemical process that occur within a lake. Internal nutrient loading is an excellent example that is described below.

### Internal Nutrient Loading*

In lakes that support stratification, whether throughout the summer or periodically between mixing events, the hypolimnion can become devoid of oxygen both in the water column and within the sediment. When this occurs, iron changes from a form that normally binds phosphorus within the sediment to a form that releases it to the overlaying water. This can result in very high concentrations of phosphorus in the hypolimnion. Then, during turnover events, these high concentrations of phosphorus are mixed within the lake and utilized by algae and some macrophytes. In lakes that mix periodically during the summer (polymictic lakes), this cycle can *pump* phosphorus from the sediments into the water column throughout the growing season. In lakes that only mix during the spring and fall (dimictic lakes), this burst of phosphorus can support late-season algae blooms and even last through the winter to support early algal blooms the following spring. Further, anoxic conditions under the winter ice in both polymictic and dimictic lakes can add smaller loads of phosphorus to the water column during spring turnover that may support algae blooms long into the summer. This cycle continues year after year and is termed "internal phosphorus loading"; a phenomenon that can support nuisance algal blooms decades after external sources are controlled.

The first step in the analysis is determining if the lake is a candidate for significant internal phosphorus loading. Water quality data and watershed modeling are used to determine actual and predicted levels of phosphorus for the lake. When the predicted phosphorus level is well below the actual level, it may be an indication that the modeling is not accounting for all of the phosphorus sources entering the lake. Internal nutrient loading may be one of the additional contributors that may need to be assessed with further water quality analysis and possibly additional, more intense studies.

*Non-Candidate Lakes*

- Lakes that do not experience hypolimnetic anoxia.
- Lakes that do not stratify for significant periods (i.e. days or weeks at a time).
- Lakes with hypolimnetic total phosphorus values less than 200 µg/L.

*Candidate Lakes*

- Lakes with hypolimnetic total phosphorus concentrations exceeding 200 µg/L.
- Lakes with epilimnetic phosphorus concentrations that cannot be accounted for in watershed phosphorus load modeling.

Specific to the final bullet-point, during the watershed modeling assessment, the results of the modeled phosphorus loads are used to estimate in-lake phosphorus concentrations. If these estimates are much lower than those actually found in the lake, another source of phosphorus must be responsible for elevating the in-lake concentrations. Normally, two possibilities exist: 1) shoreland septic systems, and 2) internal phosphorus cycling. If the lake is considered a candidate for internal loading, modeling procedures are used to estimate that load.

## Comparisons with Other Datasets

The WDNR document *Wisconsin 2018 Consolidated Assessment and Listing Methodology* (WDNR 2017) is an excellent source of data for comparing water quality from a given lake to lakes with similar features and lakes within specific regions of Wisconsin. Water quality among lakes, even among lakes that are located in close proximity to one another, can vary due to natural factors such as depth, surface area, the size of its watershed and the composition of the watershed's land cover. For this reason, the water quality of Lake Metonga will be compared to lakes in the state with similar physical characteristics. The WDNR groups Wisconsin's lakes into ten natural communities (Figure 3.1-1).

First, the lakes are classified into three main groups: (1) lakes and reservoirs less than 10 acres, (2) lakes and reservoirs greater than or equal to 10 acres, and (3) a classification that addresses special waterbody circumstances. The last two categories have several sub-categories that provide attention to lakes that may be shallow, deep, play host to cold water fish species or have unique hydrologic patterns. Overall, the divisions categorize lakes based upon their size, stratification characteristics, and hydrology. An equation developed by Lathrop and Lillie (1980), which incorporates the maximum depth of the lake and the lake's surface area, is used to predict whether the lake is considered a shallow (mixed) lake or a deep (stratified) lake. The lakes are further divided into classifications based on their hydrology and watershed size:

> **Seepage Lakes** have no surface water inflow or outflow in the form of rivers and/or streams.
>
> **Drainage Lakes** have surface water inflow and/or outflow in the form of rivers and/or streams.

Headwater drainage lakes have a watershed of less than 4 square miles.

Lowland drainage lakes have a watershed of greater than 4 square miles.

Because of its depth, a watershed which greater than four square miles, and hydrology, Lake Metonga is classified as a lowland drainage lake (category 5 on Figure 3.1-1).

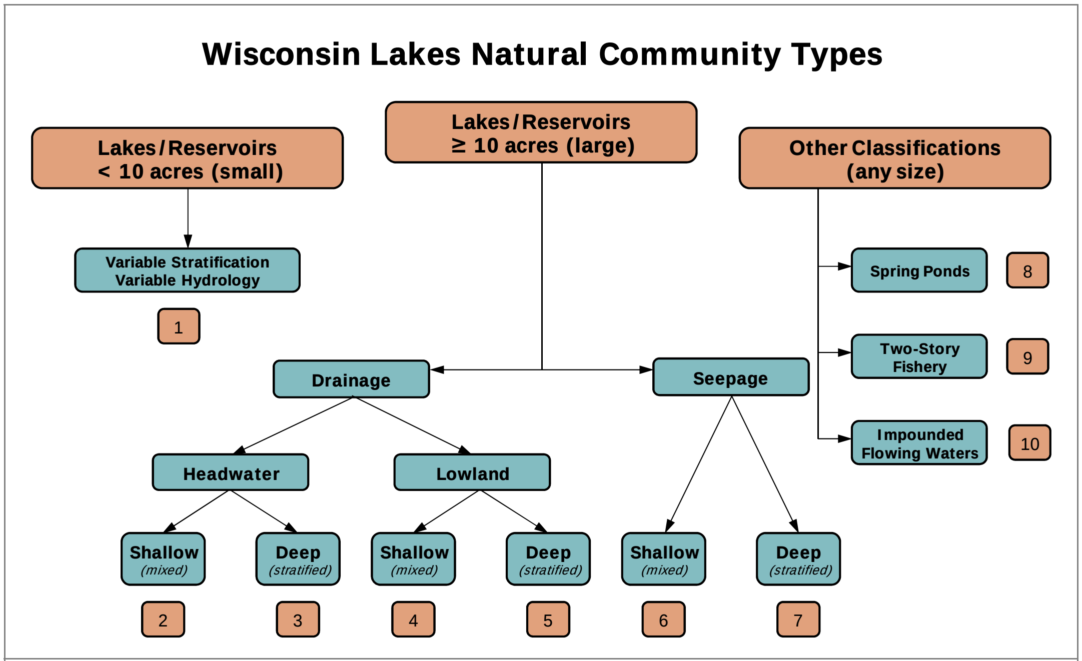



**Figure 3.1-1. Wisconsin Lake Natural Communities.** Adapted from WDNR 2017.

Garrison, et. al (2008) developed state-wide median values for total phosphorus, chlorophyll-*a*, and Secchi disk transparency for six of the lake classifications. Though they did not sample sufficient lakes to create median values for each classification within each of the state's ecoregions, they were able to create median values based on all of the lakes sampled within each ecoregion (Figure 3.1-2). Ecoregions are areas related by similar climate, physiography, hydrology, vegetation and wildlife potential. Comparing ecosystems in the same ecoregion is sounder than comparing systems within manmade boundaries such as counties, towns, or states. Lake Metonga is within the Northern Lakes and Forest ecoregion.

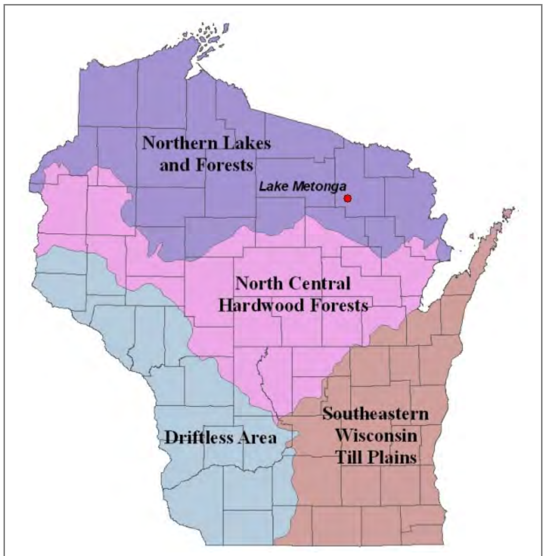



**Figure 3.1-2. Location of Lake Metonga within the ecoregions of Wisconsin.** After Nichols 1999.

The Wisconsin 2018 Consolidated Assessment and Listing Methodology document also helps stakeholders understand the health of their lake compared to other lakes within the state. Looking at pre-settlement diatom population compositions from sediment cores collected from numerous lakes around the state, they were able to infer a reference condition for each lake's water quality prior to human development within their watersheds. Using these reference conditions and current water quality data, the assessors were able to rank phosphorus, chlorophyll-*a*, and Secchi disk transparency values for each lake class into categories ranging from excellent to poor.

These data along with data corresponding to statewide natural lake means, historic, current, and average data from Lake Metonga is displayed in Figures 3.1-3 - 3.1-7. Please note that the data in these graphs represent concentrations and depths taken only during the growing season (April-October) or summer months (June-August). Furthermore, the phosphorus and chlorophyll-*a* data represent only surface samples. Surface samples are used because they represent the depths at which algae grow and depths at which phosphorus levels are not greatly influenced by phosphorus being released from bottom sediments.

## *Lake Metonga Water Quality Analysis*

### Lake Metonga Long-term Trends

Lake Metonga has a long record of water quality data with Secchi disc depth being available from 1992 through 2018 while total phosphorus and chlorophyll-*a* data is available for 1999-2018. The summer mean total phosphorus (TP) is 15.0 µg/L (Figure 3.1-3) and the growing season mean concentration is nearly the same at 15.7 µg/L. Both of these averages fall within the *excellent* category and are better than the Northern Lakes and Forests ecoregion (NLF) median value and the median value for lakes of this type in the state.

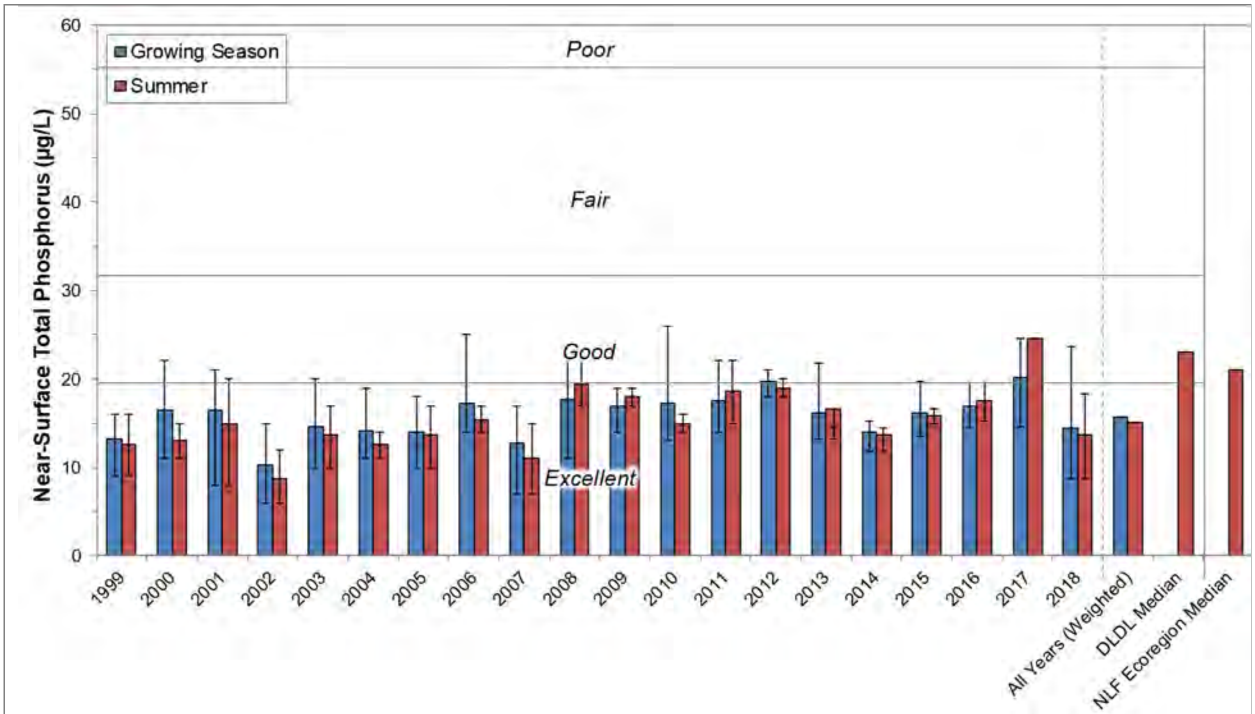



**Figure 3.1-3. Lake Metonga, state-wide class 5 lakes, and regional total phosphorus concentrations.** Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

The regression analysis of summer mean phosphorus concentrations for the years 1999 to the present indicate an increase that is statistically significant (Figure 3.1-4). There appears to have been a step increase after 2007. The mean phosphorus concentration for the period 1999-2007 was 12.9 µg/L while for the period 2008-2018 the summer mean concentration was higher at 17.5 µg/L. Franklin Lake, Oneida County is in the same region as Lake Metonga and has a long record of all three trophic parameters. Over the time period 1999-2018 its trophic parameters have not changed. While Franklin Lake is smaller and shallower than Lake Metonga, it is hypothesized that the changes in Lake Metonga are not climate driven but instead are in response to changes with Lake Metonga's watershed or within the lake itself.

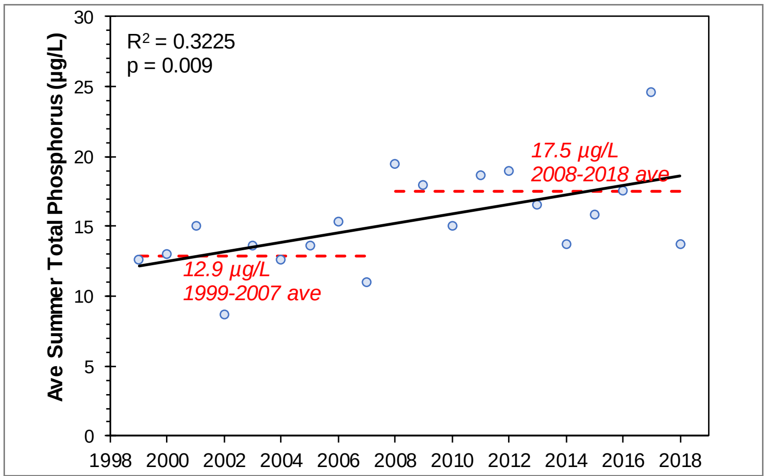



**Figure 3.1-4. Lake Metonga linear regression for total phosphorus from 1999-2018.** Solid black line indicates regression line. Red dashed lines indicate period averages.

The summer mean chlorophyll-*a* is 1.7 µg/L (Figure 3.1-5) and the growing season mean concentration is slightly higher at 2.2 µg/L. Both of these averages fall within the *excellent* category and are considerably better than the Northern Lakes and Forests ecoregion (NLF) median value and the median value for lakes of this type throughout the state. (Figure 3.1-4). Unlike phosphorus, there is not a statistically significant trend of increasing chlorophyll-*a*. The summer mean chlorophyll-*a* concentrations are similar for the periods 1999-2007 and 2008-2018.

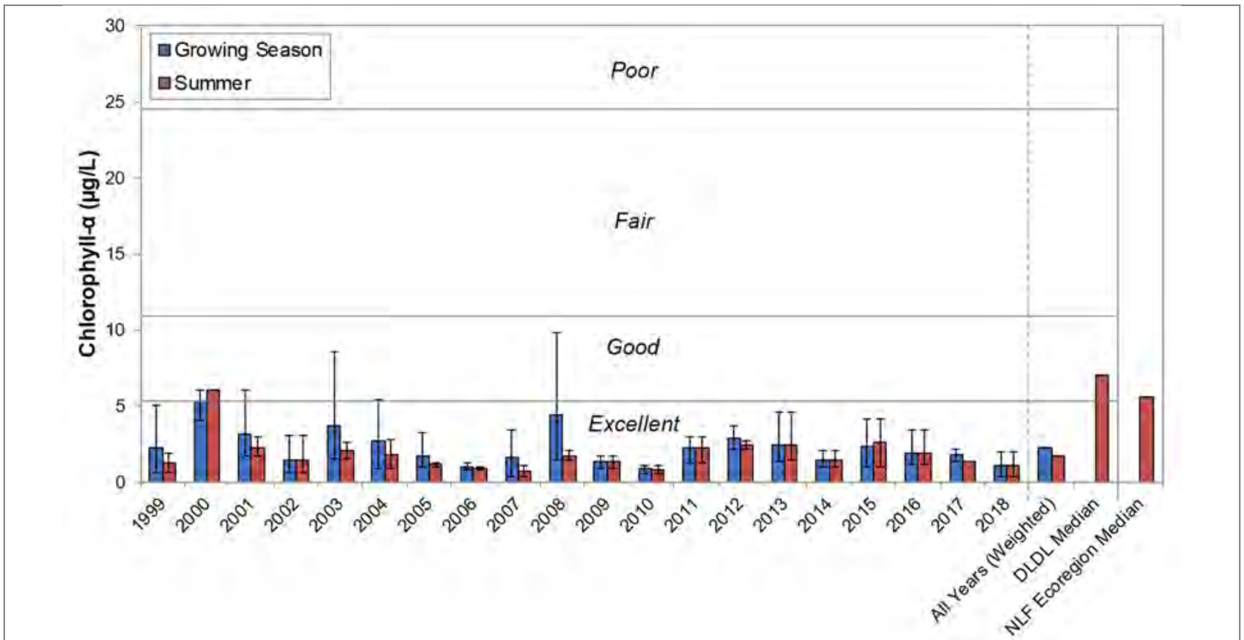



**Figure 3.1-5. Lake Metonga, state-wide class 5 lakes, and regional chlorophyll-*a* concentrations.** Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

There is a longer record for Secchi disc clarity which begins in 1992 (Figure 3.1-6). The long term mean summer water clarity is 21.9 feet which places the lake in the *excellent* category. The mean depth is much deeper than the median value for other deep lowland drainage lakes in the state and is considerably better than the median value of all lakes in the NLF ecoregion.

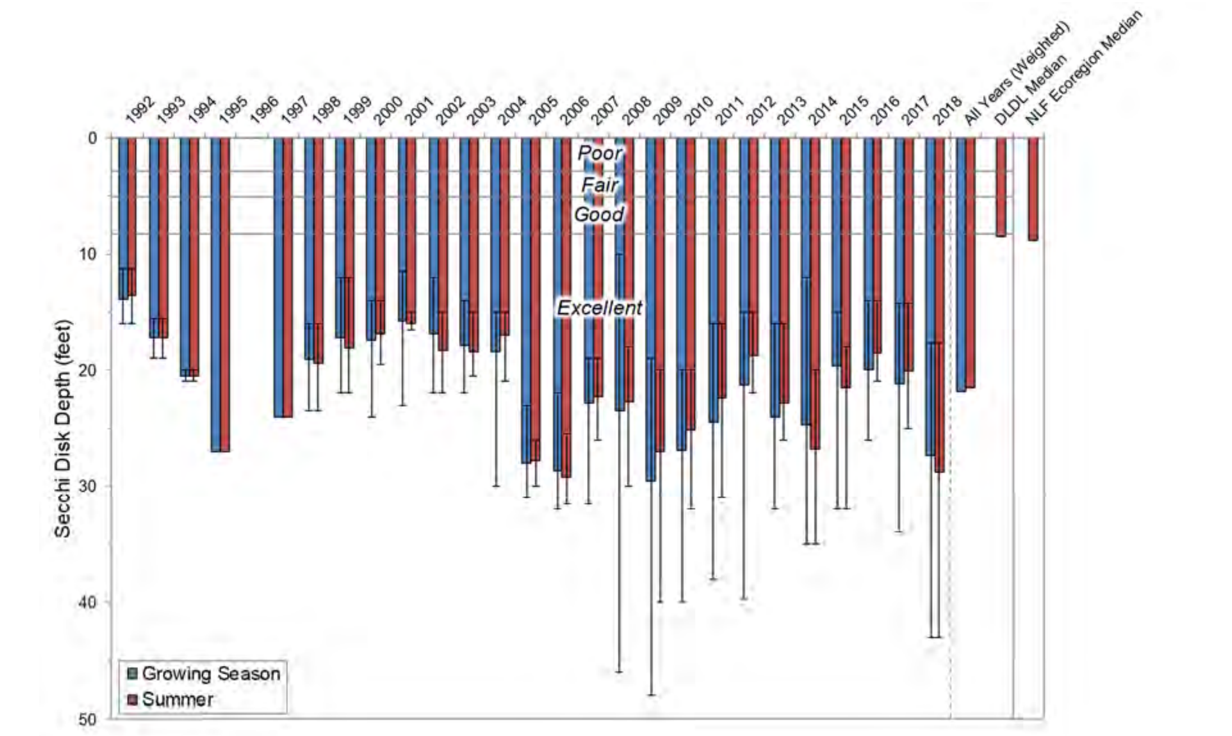



**Figure 3.1-6. Lake Metonga, state-wide class 5 lakes, and regional Secchi disk clarity values.** Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

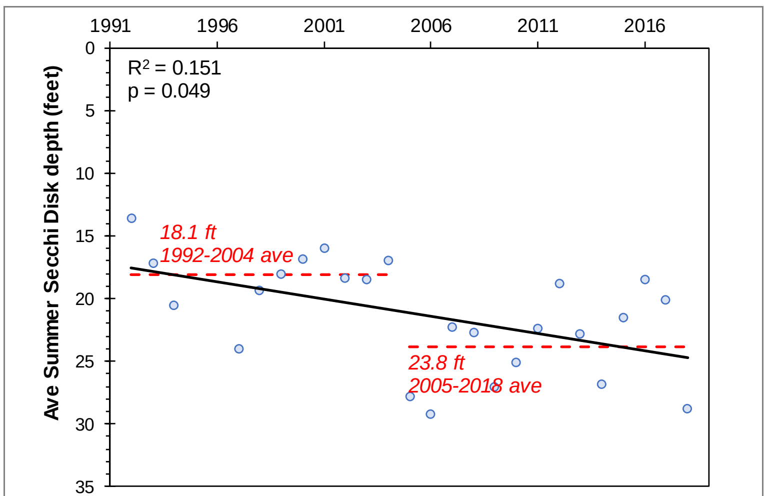



**Figure 3.1-7. Lake Metonga linear regression for Secchi disk clarity from 1992-2018.** Solid black line indicates regression line. Red dashed lines indicate period averages.

As with phosphorus, there is a statistically significant change in Secchi disc clarity for the period of record (Figure 3.1-7). As with phosphorus, there was a step change increase in water clarity, but for water clarity it occurred after 2004 which was three years earlier than for phosphorus. As mentioned above, it is unlikely this change is the result of climatic factors. It is unclear what caused the changes in water clarity and phosphorus but one possibility is the establishment of zebra mussels after they were first detected in 2001. These organisms are prolific filter feeders which remove particulates from the water resulting in clearer water. Even though they remove particulates from the water, phosphorus levels can increase from the their excretions. "High reproduction and [zebra mussel] survival in 2003 resulted in a substation increase in adult densities in 2004," Michael Preul, Mole Lake Sokaogon Chippewa Community fisheries biologists was quoted as stating in a Great Lakes Indian Fish and Wildlife (GLIFWC) article. Zebra mussel populations were thought to be highest in 2005-2006 (Gary Mueller, personal comm.).

To determine if internal nutrient loading (discussed in the primer section) is a significant source of phosphorus in Lake Metonga, near-bottom (approximately 3 feet above the bottom) phosphorus concentrations are compared against those collected from the near-surface for samples collected in 2018. The higher concentrations of phosphorus near the bottom (Figure 3.1-8) occurred when Lake Metonga was stratified but the bottom waters were not anoxic. It is likely the elevated concentrations are the result of decaying organic matter that falls through the water column.

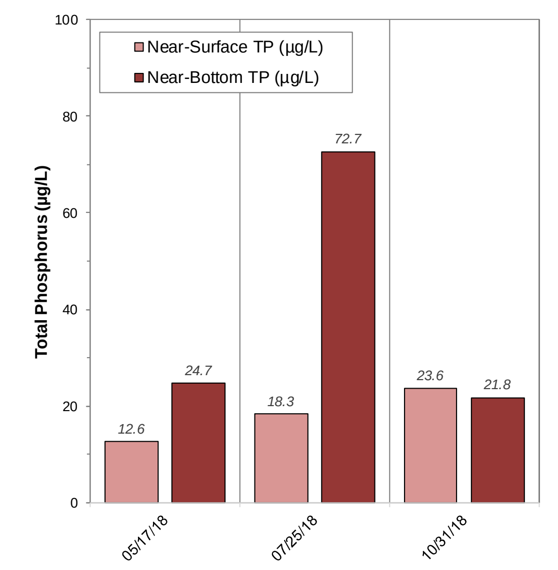



**Figure 3.1-8. Lake Metonga near-surface and near-bottom total phosphorus concentrations in 2018.**

## Limiting Plant Nutrient of Lake Metonga

Using midsummer nitrogen and phosphorus concentrations from Lake Metonga, a nitrogen:phosphorus ratio of 16:1 was calculated. This finding indicates that Lake Metonga is indeed phosphorus limited as are the vast majority of Wisconsin lakes. In general, this means that cutting phosphorus inputs may limit plant and algae growth within the lake.

## Lake Metonga Trophic State

Figure 3.1-9 contains the Trophic State Index (TSI) values for Lake Metonga. The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus concentrations do not agree very well. In all years the TSI value for total phosphorus is higher than the other parameters and places the lake in the *mesotrophic* category. The TSI value for chlorophyll- *a* generally was higher than TSI value for Secchi disk transparency, but both of these values were in the *oligotrophic* category. Since WDNR uses chlorophyll-*a* for determining a lake's impairment status, Lake Metonga should be considered an *oligotrophic* lake. It is unclear why chlorophyll-*a* and Secchi disc clarity is better than would be expected given the phosphorus concentrations. As discussed above, zebra mussel establishment occurred in the early 2000s. While limited historical data exists prior to the detection of zebra mussels, what is available suggests that the decoupling of phosphorus and water clarity parameters was occurring prior to zebra mussels.

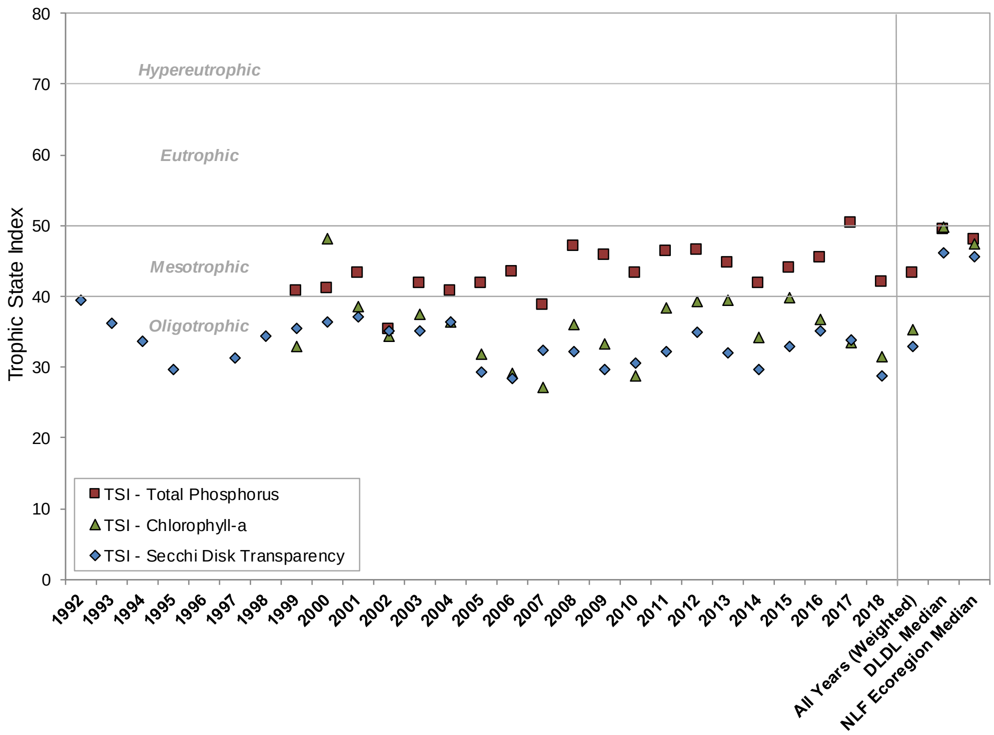



**Figure 3.1-9. Lake Metonga, state-wide class 5 lakes, and regional Trophic State Index values.** Values calculated with summer month surface sample data using WDNR PUB-WT-193.

## Dissolved Oxygen and Temperature in Lake Metonga

Dissolved oxygen and temperature were measured during water quality sampling visits to Lake Metonga by Onterra staff. Profiles depicting these data are displayed in Figure 3.1-10. Lake Metonga is *dimictic*, meaning the lake remains stratified during the summer (and winter) and completely mixes, or turns over, during the spring and fall. During the summer, the surface of the lake warms and becomes less dense than the cold layer below, and the lake thermally stratifies. Given Lake Metonga's deep nature, wind and water movement are not sufficient during the summer to mix these layers together, only the warmer upper layer will mix. As a result, the bottom layer of water no longer receives atmospheric diffusion of oxygen and decomposition of organic matter within this layer depletes available oxygen. In late July dissolved oxygen was still present in the deepest waters. It is possible the deepest waters became anoxic later in the summer.

In the fall, as surface temperatures cool, the entire water column is again able to mix, which re-oxygenates the hypolimnion. During the winter, the coldest temperatures are found just under the overlying ice as water is densest at 39 °F, while oxygen gradually declines once again towards the bottom of the lake. The data also indicate that there was sufficient oxygen throughout the water column under the ice to support the fishery during late-winter sampling (Figure 3.1-10).

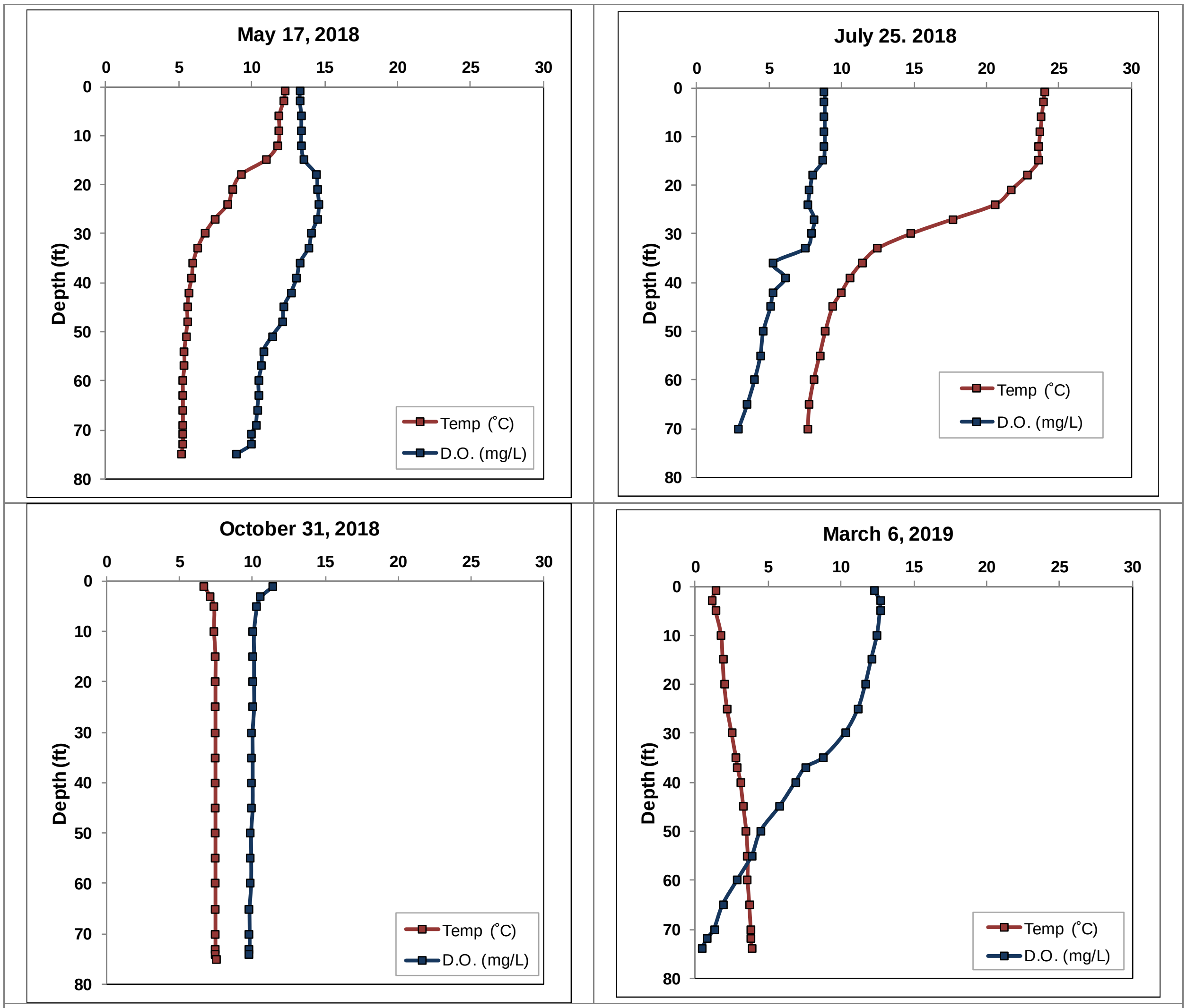



**Figure 3.1-10. Lake Metonga dissolved oxygen and temperature profiles.**

## Additional Water Quality Data Collected at Lake Metonga

The water quality section is centered on lake eutrophication. However, parameters other than water clarity, nutrients, and chlorophyll-*a* were collected as part of the project. These other parameters were collected to increase the understanding of Lake Metonga's water quality and are recommended as a part of the WDNR long-term lake trends monitoring protocol. These parameters include pH, alkalinity, and calcium.

The pH scale ranges from 0 to 14 and indicates the concentration of hydrogen ions ($H^+$) within the lake's water and is an index of the lake's acidity. Water with a pH value of 7 has equal amounts of hydrogen ions and hydroxide ions ($OH^-$), and is considered to be neutral. Water with a pH of less than 7 has higher concentrations of hydrogen ions and is considered to be acidic, while values greater than 7 have lower hydrogen ion concentrations and are considered basic or alkaline. The pH scale is logarithmic; meaning that for every 1.0 pH unit the hydrogen ion concentration changes tenfold. The normal range for lake water pH in Wisconsin is about 5.2 to 8.4, though values lower than 5.2 can be observed in some acid bog lakes and higher than 8.4 in some marl lakes. In lakes with a pH of 6.5 and lower, the spawning of certain fish species such as walleye becomes inhibited (Shaw and Nimphius 1985). The mid-summer pH of the water in Lake Metonga was found to be 8.7 which is at the upper range of the normal range for Wisconsin Lakes but it is not a concern (Figure 3.1-11).

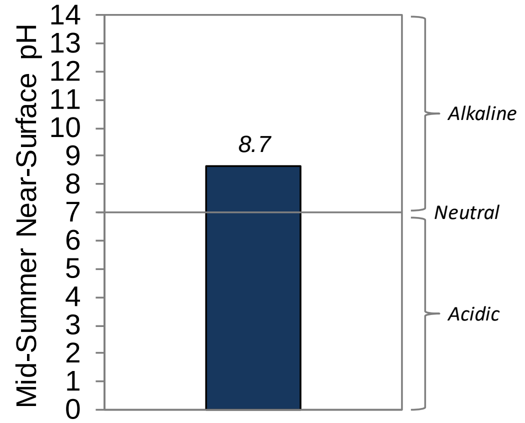



**Figure 3.1-11. Lake Metonga mid-summer near-surface pH value.**

Alkalinity is a lake's capacity to resist fluctuations in pH by neutralizing or buffering against inputs such as acid rain. The main compounds that contribute to a lake's alkalinity in Wisconsin are bicarbonate ($HCO_3^-$) and carbonate ($CO_3^-$), which neutralize hydrogen ions from acidic inputs. These compounds are present in a lake if the groundwater entering it comes into contact with minerals such as calcite ($CaCO_3$) and/or dolomite ($(CaMgCO_3)_2$). A lake's pH is primarily determined by the amount of alkalinity. Rainwater in northern Wisconsin is slightly acidic naturally due to dissolved carbon dioxide from the atmosphere with a pH of around 5.0. Consequently, lakes with low alkalinity have lower pH due to their inability to buffer against acid inputs. The alkalinity in Lake Metonga was measured at 89.5 (mg/L as $CaCO_3$), indicating that the lake has a substantial capacity to resist fluctuations in pH and has a low sensitivity to acid rain (Figure 3.1-12).

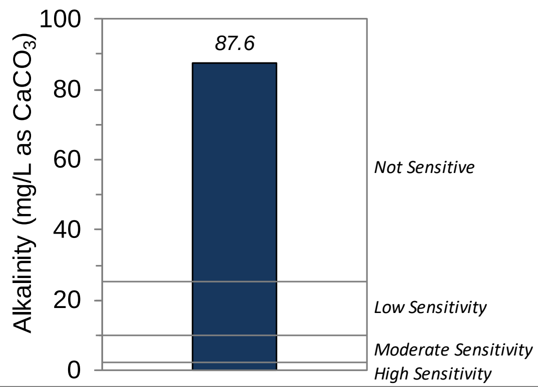



**Figure 3.1-12. Lake Metonga average alkalinity and sensitivity to acid rain.** Samples collected from near-surface.

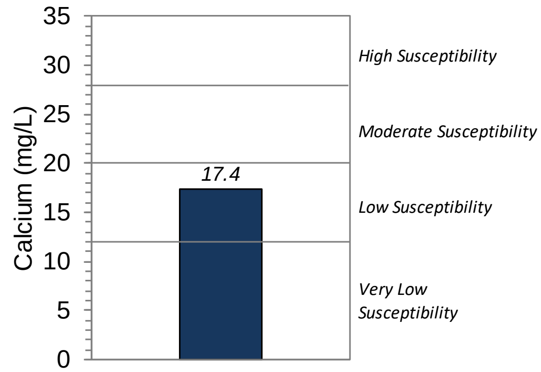



**Figure 3.1-13. Lake Metonga spring calcium concentration and zebra mussel susceptibility.** Samples collected from near-surface.

Like associated pH and alkalinity, the concentration of calcium within a lake's water depends on the geology of the lake's watershed. Recently, the combination of calcium concentration and pH has been used to determine what lakes can support zebra mussel populations if they are introduced. The commonly accepted pH range for zebra mussels is 7.0 to 9.0, so Lake Metonga's pH of 8.6 falls within this range. Lakes with calcium concentrations of less than 12 mg/L are considered to have very low susceptibility to zebra mussel establishment. The calcium concentration of Lake Metonga was found to be 17.4 mg/L, falling within the low susceptibility range for zebra mussels although as noted below, Lake Metonga has an established population of zebra mussels (Figure 3.1-13).

Lake Metonga contains an established population of zebra mussels. Michael Preul, Mole Lake Sokaogon Chippewa Community fisheries biologists is currently monitoring five zebra mussel samplers from Lake Metonga, as well as various chemical and biological parameters from the lake. This includes understanding changes in calcium levels within the lake, perhaps in response to zebra mussel populations. Changes in calcium concentrations, potentially as it is being used by zebra mussels, may have a controlling factor on the maximum zebra mussel biomass within the lake (Whittier et al. 2008).

**Photograph 3.1-1. Zebra mussels attached to a native mussel.** Photo credit: Onterra.

Zebra mussels (*Dreissena polymorpha*) are a small bottom-dwelling mussels, native to Europe and Asia, that found their way to the Great Lakes region in the mid-1980s. They are thought to have come into the region through ballast water of ocean-going ships entering the Great Lakes, and they have the capacity to spread rapidly. Zebra mussels can attach themselves to boats, boat lifts, and docks, and can live for up to five days after being taken out of the water. These mussels can be identified by their small size, D-shaped shell and yellow-brown striped coloring (Photograph 3.1-1). Once zebra mussels have entered and established in a waterway, they are nearly impossible to eradicate. Best practice methods for cleaning boats that have been in zebra mussel infested waters is inspecting and removing any attached mussels, spraying your boat down with diluted bleach, power-washing, and letting the watercraft dry for at least five days. More information on decontamination procedures can be found here: https://dnr.wi.gov/topic/Invasives/disinfection.html.

Preliminary accounts from the work being conducted by the Mole Lake Tribe indicate that the zebra mussel population within Lake Metonga is stabilizing, with anticipated population changes on an approximate 2-3 year cycle. Zebra mussels in recent years have been noted as smaller in size and having softer shells.

### *Stakeholder Survey Responses to Lake Metonga Water Quality*

As discussed in section 2.0, the stakeholder survey asks many questions pertaining to perception of the lake and how it may have changed over the years. Figures 3.1-14 and 3.1-15 display the responses of members of Lake Metonga stakeholders (riparian and association members) to questions regarding water quality and how it has changed over their years visiting Lake Metonga.

The response rate to the stakeholder survey was 69% which is considered very good and therefore the responses can be used to make statistical inferences. In response to the question about the overall water quality conditions of the lake, 73 percent of the respondents felt the water quality was good or excellent. This is roughly in agreement with the trophic parameters which placed the lake in the excellent category. When survey recipients were asked what was the single most important aspect when they think about water quality, approximately 41% indicated water clarity and 23% indicated algae blooms. In response to the question how the lake's water quality has changed since first visiting the lake, 73 percent of the respondents felt the water quality had somewhat or greatly improved. The trend analysis indicates that the water clarity has increased, which matches the stakeholder perceptions. Interestingly, 29% of stakeholder respondents indicated aquatic plant growth was the single most important aspect of water quality. As will be discussed in the next section, most aquatic plant parameters are not increasing in Lake Metonga.

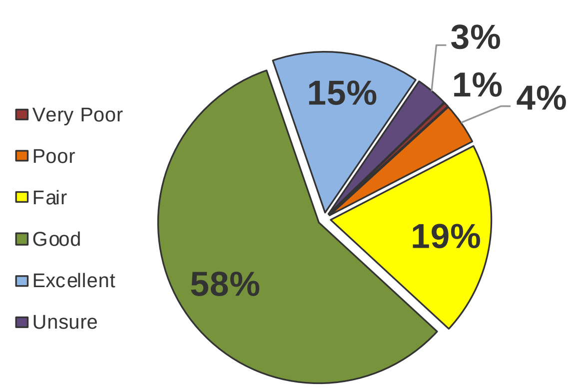



**Figure 3.1-14. Stakeholder survey response Question #25.** How would you describe the overall current water quality of Lake Metonga?

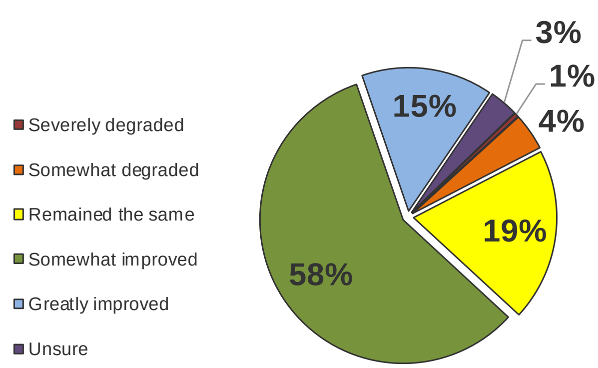



**Figure 3.1-15. Stakeholder survey response Question #17.** How as the water quality changed in Lake Metonga since you first visited the lake?

## 3.2 Watershed Assessment

### Watershed Modeling

A lake's **flushing rate** is simply a determination of the time required for the lake's water volume to be completely exchanged. **Residence time** describes how long a volume of water remains in the lake and is expressed in days, months, or years. The parameters are related and both determined by the volume of the lake and the amount of water entering the lake from its watershed. Greater flushing rates equal shorter residence times.

Two aspects of a lake's watershed are the key factors in determining the amount of phosphorus the watershed exports to the lake; 1) the size of the watershed, and 2) the land cover (land use) within the watershed. The impact of the watershed size is dependent on how large it is relative to the size of the lake. The watershed to lake area ratio (WS:LA) defines how many acres of watershed drains to each surface-acre of the lake. Larger ratios result in the watershed having a greater role in the lake's annual water budget and phosphorus load.

The type of land cover that exists in the watershed determines the amount of phosphorus (and sediment) that runs off the land and eventually makes its way to the lake. The actual amount of pollutants (nutrients, sediment, toxins, etc.) depends greatly on how the land within the watershed is used. Vegetated areas, such as forests, grasslands, and meadows, allow the water to permeate the ground and do not produce much surface runoff. On the other hand, agricultural areas, particularly row crops, along with residential/urban areas, minimize infiltration and increase surface runoff. The increased surface runoff associated with these land cover types leads to increased phosphorus and pollutant loading; which, in turn, can lead to nuisance algal blooms, increased sedimentation, and/or overabundant macrophyte populations. For these reasons, it is important to maintain as much natural land cover (forests, wetlands, etc.) as possible within a lake's watershed to minimize the amount runoff (nutrients, sediment, etc.) from entering the lake.

In systems with lower WS:LA ratios, land cover type plays a very important role in how much phosphorus is loaded to the lake from the watershed. In these systems, the occurrence of agriculture or urban development in even a small percentage of the watershed (less than 10%) can unnaturally elevate phosphorus inputs to the lake. If these land cover types are converted to a cover that does not export as much phosphorus, such as converting row crop areas to grass or forested areas, the phosphorus load and its impacts to the lake may be decreased. In fact, if the phosphorus load is reduced greatly, changes in lake water quality may be noticeable, (e.g. reduced algal abundance and better water clarity) and may even be enough to cause a shift in the lake's trophic state.

In systems with high WS:LA ratios, like those 10-15:1 or higher, the impact of land cover may be tempered by the sheer amount of land draining to the lake. Situations actually occur where lakes with completely forested watersheds have sufficient phosphorus loads to support high rates of plant production. In other systems with high ratios, the conversion of vast areas of row crops to vegetated areas (grasslands, meadows, forests, etc.) may not reduce phosphorus loads sufficiently to see a change in plant production. Both of these situations occur frequently in impoundments.

Regardless of the size of the watershed or the makeup of its land cover, it must be remembered that every lake is different and other factors, such as flushing rate, lake volume, sediment type, and many others, also influence how the lake will react to what is flowing into it. For instance, a deeper lake with a greater volume can dilute more phosphorus within its waters than a less voluminous lake and as a result, the production of a lake is kept low. However, in that same lake, because of its low flushing rate (a residence time of years), there may be a buildup of phosphorus in the sediments that may reach sufficient levels over time and lead to a problem such as internal nutrient loading. On the contrary, a lake with a higher flushing rate (low residence time, i.e., days or weeks) may be more productive early on, but the constant flushing of its waters may prevent a buildup of phosphorus and internal nutrient loading may never reach significant levels.

A reliable and cost-efficient method of creating a general picture of a watershed's effect on a lake can be obtained through modeling. The WDNR created a useful suite of modeling tools called the Wisconsin Lake Modeling Suite (WiLMS). Certain morphological attributes of a lake and its watershed are entered into WiLMS along with the acreages of different types of land cover within the watershed to produce useful information about the lake ecosystem. This information includes an estimate of annual phosphorus load and the partitioning of those loads between the watershed's different land cover types and atmospheric fallout entering through the lake's water surface. WiLMS also calculates the lake's flushing rate and residence times using county-specific average precipitation/evaporation values or values entered by the user. Predictive models are also included within WiLMS that are valuable in validating modeled phosphorus loads to the lake in question and modeling alternate land cover scenarios within the watershed. Finally, if specific information is available, WiLMS will also estimate the significance of internal nutrient loading within a lake and the impact of shoreland septic systems.

### *Lake Metonga Watershed Assessment*

Lake Metonga has a concrete dam located on the south end of the lake which rebuilt in 1969 and was fixed at a level (weir of 99.42) that could artificially increase the lake's water level up to four feet (LMA 2002a). During drought years, such as the late-2000s, insufficient groundwater was present to hold the lake at this level. Outlet Creek, Lake Metonga's outlet, leads to the Swamp Creek which flows through Rice Lake on its way to the Wolf River.

**Photograph 3.2-1. Lake Metonga dam.** Photo courtesy LMA.

The Wolf River watershed is approximately 2,388,00 acres (3,730 square miles) and includes portions of eleven counties. The watershed originates in Pine Lake and discharges into Lake Poygan of the Lake Winnebago System. The Wolf River watershed is subdivided into twenty sub-watersheds, with Lake Metonga and its direct watershed being located in the headwater sub-watershed (Figure 3.2-1 and Map 2).

| Code | Name | Acres |
|---|---|---|
| WR20 | Upper Wolf River and Post Lake | 131,503 |
| WR19 | Lily River | 132,673 |
| WR18 | Wolf River - Langlade and Evergreen River | 115,035 |
| WR17 | West Branch Wolf River | 161,114 |
| WR16 | Red River | 132,556 |
| WR15 | Shawano Lake | 45,544 |
| WR14 | Middle Wolf River | 85,619 |
| WR13 | Shioc River | 121,447 |
| WR12 | Wolf River - New London and Bear Creek | 91,191 |
| WR11 | Middle and South Branches Embarrass River | 160,004 |
| WR10 | Pigeon River | 74,444 |
| WR09 | North Branch and Mainstem Embarrass River | 200,074 |
| WR08 | South Branch Little Wolf River | 102,586 |
| WR07 | Upper Little Wolf River | 116,512 |
| WR06 | Lower Little Wolf River | 98,307 |
| WR05 | Waupaca River | 186,096 |
| WR04 | Lower Wolf River | 76,768 |
| WR03 | Walla Walla and Alder Creeks | 71,739 |
| WR02 | Pine and Willow Rivers | 193,329 |
| WR01 | Arrowhead River and Daggets Creek | 91,463 |


**Figure 3.2-1. Wolf River Watershed.**

The City of Crandon straddles the Wolf River watershed divide, with part of the City draining into Lake Metonga, and part draining away from Lake Metonga into the Upper Peshtigo River sub-watershed of the Upper Green Bay watershed basin (Figure 3.2-2). The City of Crandon, like most urban areas, has a storm sewer system designed to drain surface water away from the city. In some instances, the stormwater network of ditches and underground pipes is able to extend a lake's watershed because it has the ability to carry water that would normally fall outside of lake's watershed, into it. Working with the City of Crandon (Mike Smith), it was determined that the majority of the stormwater system is within the City's center. Some of the City, particularly the downtown area, drains to the intermittent outlet from Surprise Lake to Lake Metonga. The residential parts of the city drain into wetland "soak-in areas" within Lake Metonga's watershed. Most of the City of Crandon that is outside of Lake Metonga's watershed is minimally developed and allowed to naturally drain away from the lake.

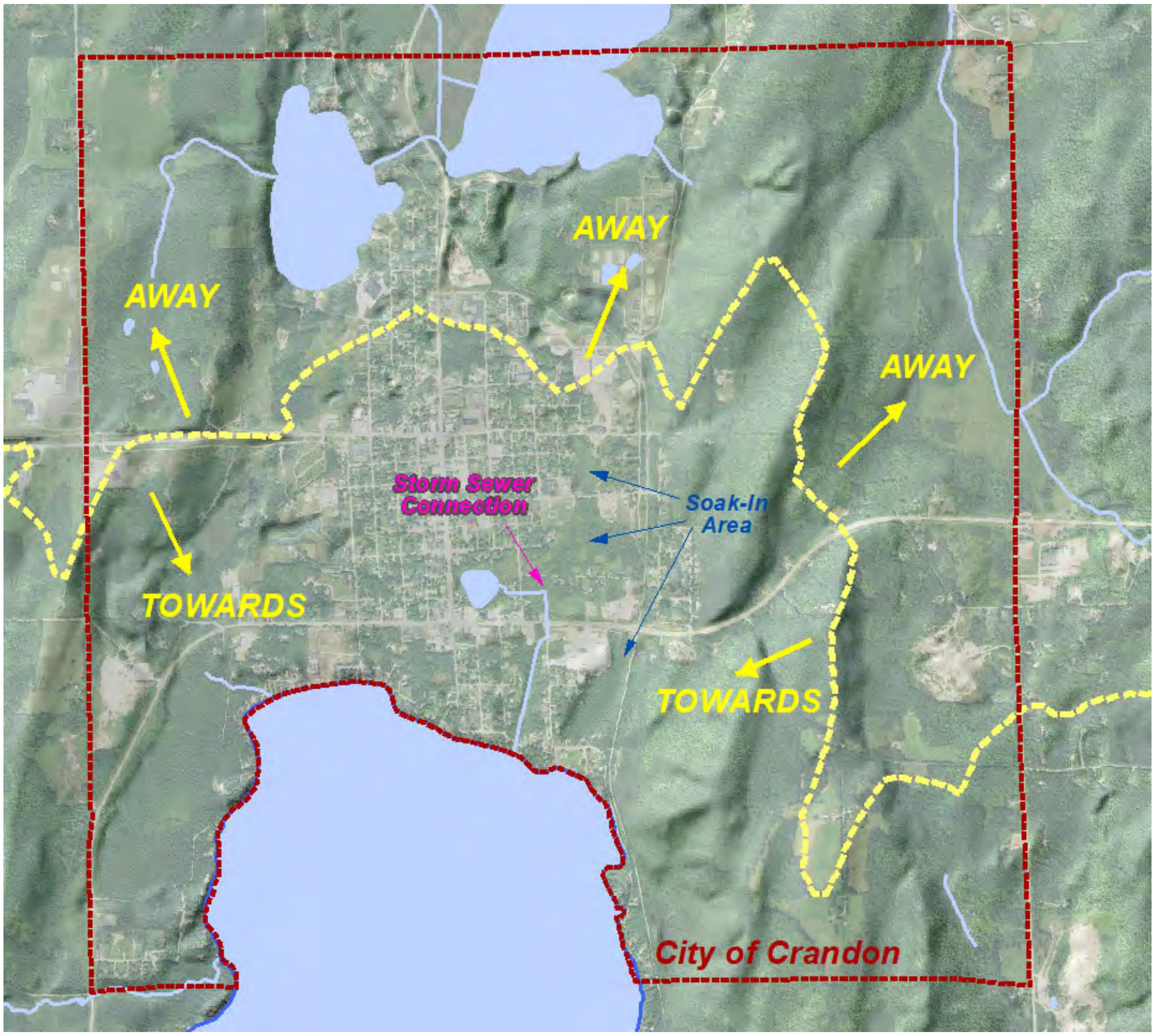



**Figure 3.2-2. City of Crandon drainage.**

Lake Metonga's watershed is 8,386 acres in size. Compared to Lake Metonga's size of 2,052 acres, this makes for a very small watershed to lake area ratio of 3:1. Wisconsin Lakes Modeling Suite (WiLMS) modeling indicates that Lake Metonga's residence time is about 7 years or that the water within the lake is completely replaced 0.14 times per year.

Of the 8,386-acre watershed, 41% is forested, 24% is the lake surface itself, 10% is pasture/grass, 6% are row crops, 3% is shoreland development, 2% is rural residential, and medium- and high-density urban areas each make up less than 1% of the total watershed (Figure 3.2-3).

Of the estimated 1,800 pounds of phosphorus delivered to the lake annually, 549 pounds (30%) is deposited on the lake itself, 448 pounds (25%) is from row crops, 280 pounds (15%) is from forest, 214 pounds (12%) from pasture/grass, 106 pounds (6%) from shoreland development, 32 pounds (2%) from residential septic systems, 31 pounds (2%) from medium density urban, 31 pounds (2%) from high density urban, and 15 pounds (<1%) from rural residential (Figure 8.7.2-4). Although the single highest contributor to phosphorus loading is from the atmosphere, loading from disturbed land contributes about 50 percent of the total loading. Examples of these contributors are row crops, lawns, and urban development.

As mentioned above, Lake Metonga itself is actually the largest source of phosphorus loading through atmospheric phosphorus deposition. This source of phosphorus is obviously not able to be controlled. Although Lake Metonga's large surface area is the largest contributor to its phosphorus loading, its volume is probably its greatest asset in limiting these affects. Lake Metonga's 18 billion gallons (54,547 acre-feet) of water work to dilute the effects caused by access nutrients and pollutants.

Using the estimated annual potential phosphorus load, WiLMS predicted an in-lake growing season average total phosphorus concentration of 19 µg/L, which is slightly higher than the measured growing season average total phosphorus concentration of 16 µg/L. This means the model works reasonably well for Lake Metonga and that there are no significant, unaccounted sources of phosphorus entering the lake, such as internal loading or large-scale faulty septic systems.

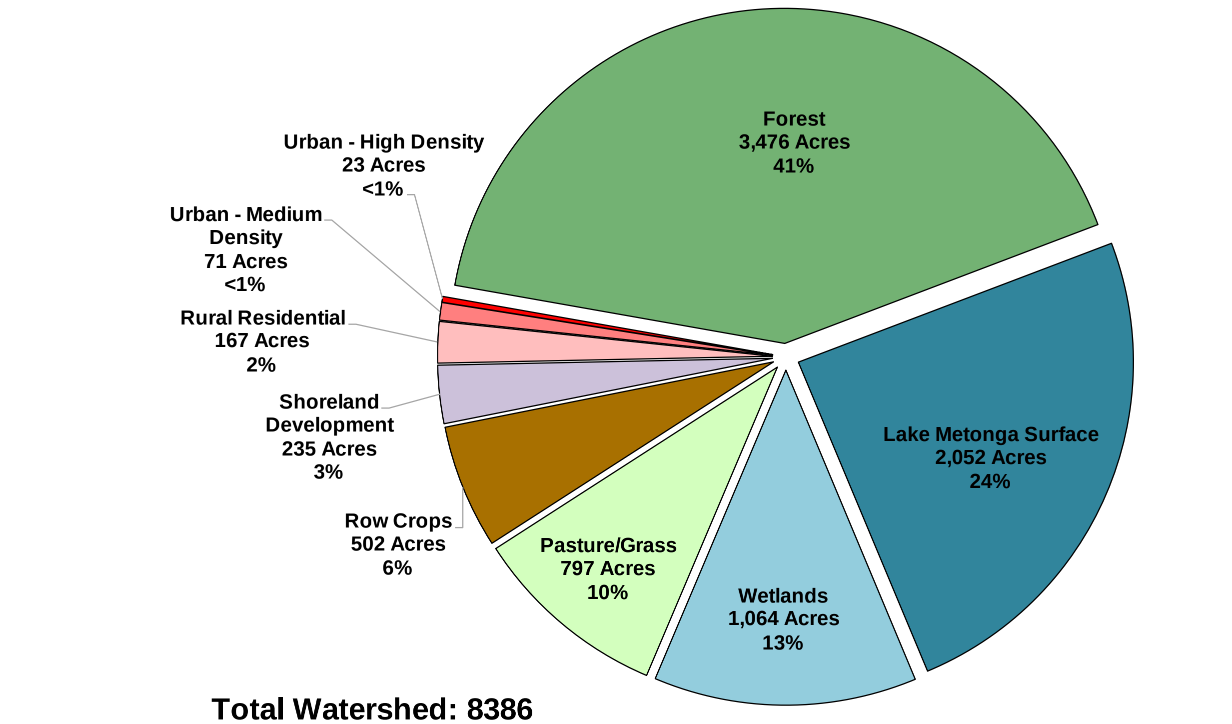



**Figure 3.2-3. Lake Metonga watershed land cover types in acres.** Based upon National Land Cover Database (NLCD – Fry et. al 2011).

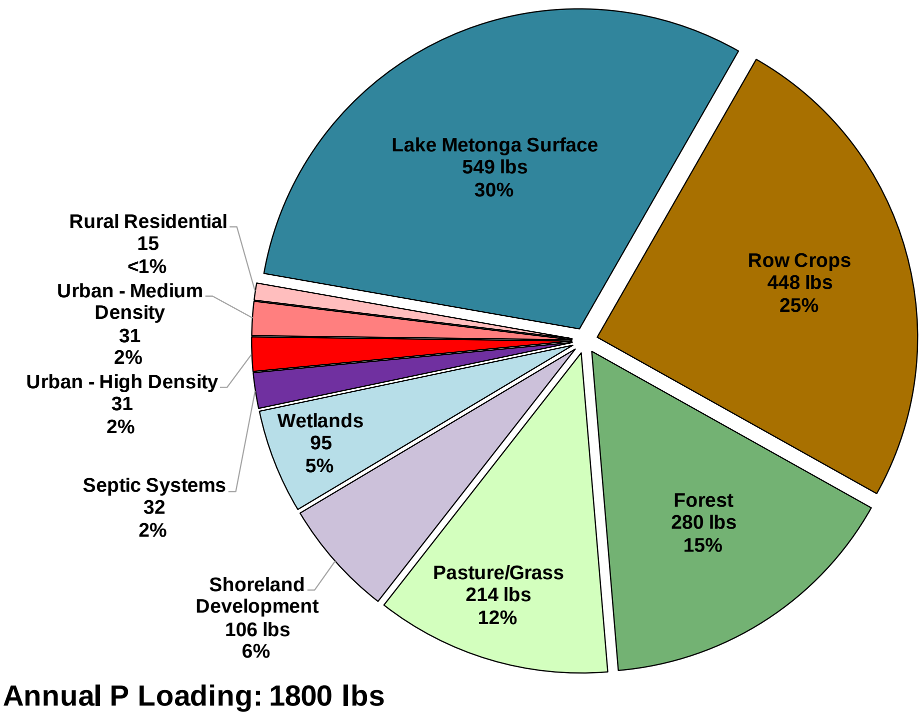



**Figure 3.2-4. Lake Metonga watershed phosphorus loading in pounds.** Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

## 3.3 Shoreland Condition

### *Lake Shoreland Zone and its Importance*

One of the most vulnerable areas of a lake's watershed is the immediate shoreland zone (approximately from the water's edge to at least 35 feet shoreland). When a lake's shoreland is developed, the increased impervious surface, removal of natural vegetation, and other human practices can severely increase pollutant loads to the lake while degrading important habitat. Limiting these anthropogenic (man-made) effects on the lake is important in maintaining the quality of the lake's water and habitat.

The intrinsic value of natural shorelands is found in numerous forms. Vegetated shorelands prevent polluted runoff from entering lakes by filtering this water or allowing it to slow to the point where particulates settle. The roots of shoreland plants stabilize the soil, thereby preventing shoreland erosion. Shorelands also provide habitat for both aquatic and terrestrial animal species. Many species rely on natural shorelands for all or part of their life cycle as a source of food, cover from predators, and as a place to raise their young. Shorelands and the nearby shallow waters serve as spawning grounds for fish and nesting sites for birds. Thus, both the removal of vegetation and the inclusion of development reduces many forms of habitat for wildlife.

Some forms of development may provide habitat for less than desirable species. Disturbed areas are often overtaken by invasive species, which are sometimes termed "pioneer species" for this reason. Some waterfowl, such as geese, prefer to linger upon open lawns near waterbodies because of the lack of cover for potential predators. The presence of geese on a lake resident's beach may not be an issue; however, the feces the geese leave are unsightly and pose a health risk. Geese feces may become a source of fecal coliforms as well as flatworms that can lead to swimmers' itch. Development such as rip rap or masonry, steel or wooden seawalls completely remove natural habitat for most animals, but may also create some habitat for snails; this is not desirable for lakes that experience problems with swimmers' itch, as the flatworms that cause this skin reaction utilize snails as a secondary host after waterfowl.

In the end, natural shorelines provide many ecological and other benefits. Between the abundant wildlife, the lush vegetation, and the presence of native flowers, shorelands also provide natural scenic beauty and a sense of tranquility for humans.

### Shoreland Zone Regulations

Wisconsin has numerous regulations in place at the state level which aim to enhance and protect shorelands. Additionally, counties, townships and other municipalities have developed their own (often more comprehensive or stronger) policies. At the state level, the following shoreland regulations exist:

*Wisconsin-NR 115: Wisconsin's Shoreland Protection Program*

Wisconsin's shoreland zoning rule, NR 115, sets the minimum standards for shoreland development. First adopted in 1966, the code set a deadline for county adoption of January 1, 1968. By 1971, all counties in Wisconsin had adopted the code and were administering the shoreland ordinances it specified. Interestingly, in 2007 it was noted that many (27) counties had recognized inadequacies within the 1968 ordinance and had actually adopted stricter shoreland ordinances. Revised in February of 2010, and again in October of 2014, the finalized NR 115 allowed many standards to remain the same, such as lot sizes, shoreland setbacks and buffer sizes. However, several standards changed as a result of efforts to balance public rights to lake use with private property rights. The regulation sets minimum standards for the shoreland zone, and requires all counties in the state to adopt shoreland zoning ordinances. Counties were previously able to set their own, stricter, regulations to NR 115 but as of 2015, all counties have to abide by state regulations. Minimum requirements for each of these categories are described below.

- Vegetation Removal: For the first 35 feet of property (shoreland zone), no vegetation removal is permitted except for: sound forestry practices on larger pieces of land, access and viewing corridors (may not exceed 35 percent of the shoreline frontage), invasive species removal, or damaged, diseased, or dying vegetation. Vegetation removed must be replaced by replanting in the same area (native species only).

- Impervious surface standards: In general, the amount of impervious surface is restricted to 15% of the total lot size, on lots that are within 300 feet of the ordinary high-water mark of the waterbody. If a property owner treats their run off with some type of treatment system, they may be able to apply for an increase in their impervious surface limit, up to 30% for residential land use. Exceptions to this limit do exist if a county has designated highly-developed areas, so it is recommended to consult county-specific zoning regulations for this standard.

- Nonconforming structures: Nonconforming structures are structures that were lawfully placed when constructed but do not comply with distance of water setback. Originally, structures within 75 ft of the shoreline had limitations on structural repair and expansion. Language in NR-115 allows construction projects on structures within 75 feet. Other specifications must be met as well, and local zoning regulations should be referenced.

Mitigation requirements: Language in NR-115 specifies mitigation techniques that may be incorporated on a property to offset the impacts of impervious surface, replacement of nonconforming structure, or other development projects. Practices such as buffer restorations along the shoreland zone, rain gardens, removal of fire pits, and beaches all may be acceptable mitigation methods. Mitigation requirements are county-specific and any such projects should be discussed with local zoning to determine the requirements.

*Wisconsin Act 31*

While not directly aimed at regulating shoreland practices, the State of Wisconsin passed Wisconsin Act 31 in 2009 in an effort to minimize watercraft impacts upon shorelines. This act prohibits a person from operating a watercraft (other than personal watercraft) at a speed in excess of slow-no-wake speed within 100 feet of a pier, raft, buoyed area or the shoreline of a lake. Additionally, personal watercraft must abide by slow-no-wake speeds while within 200 feet of these same areas. Act 31 was put into place to reduce wave action upon the sensitive shoreland zone of a lake. The legislation does state that pickup and drop off areas marked with regulatory markers and that are open to personal watercraft operators and motorboats engaged in waterskiing/a similar activity may be exempt from this distance restriction. Additionally, a city, village, town, public inland lake protection and rehabilitation district or town sanitary district may provide an exemption from the 100-foot requirement or may substitute a lesser number of feet.

## Shoreland Research

Studies conducted on nutrient runoff from Wisconsin lake shorelands have produced interesting results. For example, a USGS study on several Northwoods Wisconsin lakes was conducted to determine the impact of shoreland development on nutrient (phosphorus and nitrogen) export to these lakes (Graczyk et al. 2003). During the study period, water samples were collected from surface runoff and ground water and analyzed for nutrients. These studies were conducted on several developed (lawn covered) and undeveloped (undisturbed forest) areas on each lake. The study found that nutrient yields were greater from lawns than from forested catchments, but also that runoff water volumes were the most important factor in determining whether lawns or wooded catchments contributed more nutrients to the lake. Groundwater inputs to the lake were found to be significant in terms of water flow and nutrient input. Nitrate plus nitrite nitrogen and total phosphorus yields to the ground-water system from a lawn catchment were three or sometimes four times greater than those from wooded catchments.

A separate USGS study was conducted on the Lauderdale Lakes in southern Wisconsin, looking at nutrient runoff from different types of developed shorelands – regular fertilizer application lawns (fertilizer with phosphorus), non-phosphorus fertilizer application sites, and unfertilized sites (Garn 2002). One of the important findings stemming from this study was that the amount of dissolved phosphorus coming off of regular fertilizer application lawns was twice that of lawns with non-phosphorus or no fertilizer. Dissolved phosphorus is a form in which the phosphorus molecule is not bound to a particle of any kind; in this respect, it is readily available to algae. Therefore, these studies show us that it is a developed shoreland that is continuously maintained in an unnatural manner (receiving phosphorus rich fertilizer) that impacts lakes the greatest. This understanding led former Governor Jim Doyle into passing the Wisconsin Zero-Phosphorus Fertilizer Law (Wis Statue 94.643), which restricts the use, sale, and display of lawn and turf fertilizer which contains phosphorus. Certain exceptions apply, but after April 1 2010, use of this type of fertilizer is prohibited on lawns and turf in Wisconsin. The goal of this action is to reduce the impact of developed lawns, and is particularly helpful to developed lawns situated near Wisconsin waterbodies.

Shorelands provide much in terms of nutrient retention and mitigation, but also play an important role in wildlife habitat. Woodford and Meyer (2003) found that green frog density was negatively correlated with development density in Wisconsin lakes. As development increased, the habitat for green frogs decreased and thus populations became significantly lower. Common loons, a bird species notorious for its haunting call that echoes across Wisconsin lakes, are often associated more so with undeveloped lakes than developed lakes (Lindsay et al. 2002). And studies on shoreland development and fish nests show that undeveloped shorelands are preferred as well. In a study conducted on three Minnesota lakes, researchers found that only 74 of 852 black crappie nests were found near shorelines that had any type of dwelling on it (Reed, 2001). The remaining nests were all located along undeveloped shoreland.


**Photograph 3.3-1. Example of coarse woody habitat in a lake.**

Emerging research in Wisconsin has shown that coarse woody habitat (sometimes called "coarse woody debris"), often stemming from natural or undeveloped shorelands, provides many ecosystem benefits in a lake. Coarse woody habitat describes habitat consisting of trees, limbs, branches, roots and wood fragments at least four inches in diameter that enter a lake by natural or human means. Coarse woody habitat provides shoreland erosion control, a carbon source for the lake, prevents suspension of sediments and provides a surface for algal growth which important for aquatic macroinvertebrates (Sass 2009). While it impacts these aspects considerably, one of the greatest benefits coarse woody habitat provides is habitat for fish species.

Coarse woody habitat has shown to be advantageous for fisheries in terms of providing refuge, foraging area, as well as spawning habitat (Hanchin et al 2003). In one study, researchers observed 16 different species occupying coarse woody habitat areas in a Wisconsin lake (Newbrey et al. 2005). Bluegill and bass species in particular are attracted to this habitat type; largemouth bass stalk bluegill in these areas while the bluegill hide amongst the debris and often feed upon many macroinvertebrates found in these areas, who themselves are feeding upon algae and periphyton growing on the wood surface. Newbrey et al. (2005) found that some fish species prefer different complexity of branching on coarse woody habitat, though in general some degree of branching is preferred over coarse woody habitat that has no branching.

With development of a lake's shoreland zone, much of the coarse woody habitat that was once found in Wisconsin lakes has disappeared. Prior to human establishment and development on lakes (mid to late 1800's), the amount of coarse woody habitat in lakes was likely greater than under completely natural conditions due to logging practices. However, with changes in the logging industry and increasing development along lake shorelands, coarse woody habitat has decreased substantially. Shoreland residents are removing woody debris to improve aesthetics or for recreational opportunities such as boating, swimming, and ironically, fishing.

## National Lakes Assessment

Unfortunately, along with Wisconsin's lakes, waterbodies within the entire United States have shown to have increasing amounts of developed shorelands. The National Lakes Assessment (NLA) is an Environmental Protection Agency sponsored assessment that has successfully pooled together resource managers from all 50 U.S. states in an effort to assess waterbodies, both natural and man-made, from each state. Through this collaborative effort, over 1,000 lakes were sampled in 2007, pooling together the first statistical analysis of the nation's lakes and reservoirs.

Through the National Lakes Assessment, a number of potential stressors were examined, including nutrient impairment, algal toxins, fish tissue contaminants, physical habitat, and others. The 2007 NLA report states that "*of the stressors examined, poor lakeshore habitat is the biggest problem in the nations lakes; over one-third exhibit poor shoreline habitat condition*" (USEPA 2009). Furthermore, the report states that "*poor biological health is three times more likely in lakes with* *poor lakeshore habitat.*" These results indicate that stronger management of shoreline development is absolutely necessary to preserve, protect, and restore lakes. Shoreland protection will become increasingly important as development pressure on lakes continues to grow.

### Native Species Enhancement

The development of Wisconsin's shorelands has increased dramatically over the last century and with this increase in development a decrease in water quality and wildlife habitat has occurred. Many people that move to or build in shoreland areas attempt to replicate the suburban landscapes they are accustomed to by converting natural shoreland areas to the "neat and clean" appearance of manicured lawns and flowerbeds. The conversion of these areas immediately leads to destruction of habitat utilized by birds, mammals, reptiles, amphibians, and insects (Jennings et al. 2003). The maintenance of the newly created area helps to decrease water quality by considerably increasing inputs of phosphorus and sediments into the lake. The negative impact of human development does not stop at the shoreland. Removal of native plants and dead, fallen timbers from shallow, near-shore areas for boating and swimming activities destroys habitat used by fish, mammals, birds, insects, and amphibians, while leaving bottom and shoreland sediments vulnerable to wave action caused by boating and wind (Jennings et al. 2003, Radomski and Goeman 2001, and Elias & Meyer 2003). Many homeowners significantly decrease the number of trees and shrubs along the water's edge in an effort to increase their view of the lake. However, this has been shown to locally increase water temperatures, and decrease infiltration rates of potentially harmful nutrients and pollutants. Furthermore, the dumping of sand to create beach areas destroys spawning, cover and feeding areas utilized by aquatic wildlife (Scheuerell and Schindler 2004).

**Photograph 3.3-2. Example of a biolog restoration site.**

In recent years, many lakefront property owners have realized increased aesthetics, fisheries, property values, and water quality by restoring portions of their shoreland to mimic its unaltered state. An area of shore restored to its natural condition, both in the water and on shore, is commonly called a shoreland buffer zone. The shoreland buffer zone creates or restores the ecological habitat and benefits lost by traditional suburban landscaping. Simply not mowing within the buffer zone does wonders to restore some of the shoreland's natural function.

Enhancement activities also include additions of submergent, emergent, and floating-leaf plants within the lake itself. These additions can provide greater species diversity and may compete against exotic species.

## *Wisconsin's Healthy Lakes & Rivers Action Plan*

Starting in 2014, a program was enacted by the WDNR and UW-Extension to promote riparian landowners to implement relatively straight-forward shoreland restoration activities. This program provides education, guidance, and grant funding to promote installation of best management practices aimed to protect and restore lakes and rivers in Wisconsin. The program has identified five best practices aimed at improving habitat and water quality (Figure 3.3-1).

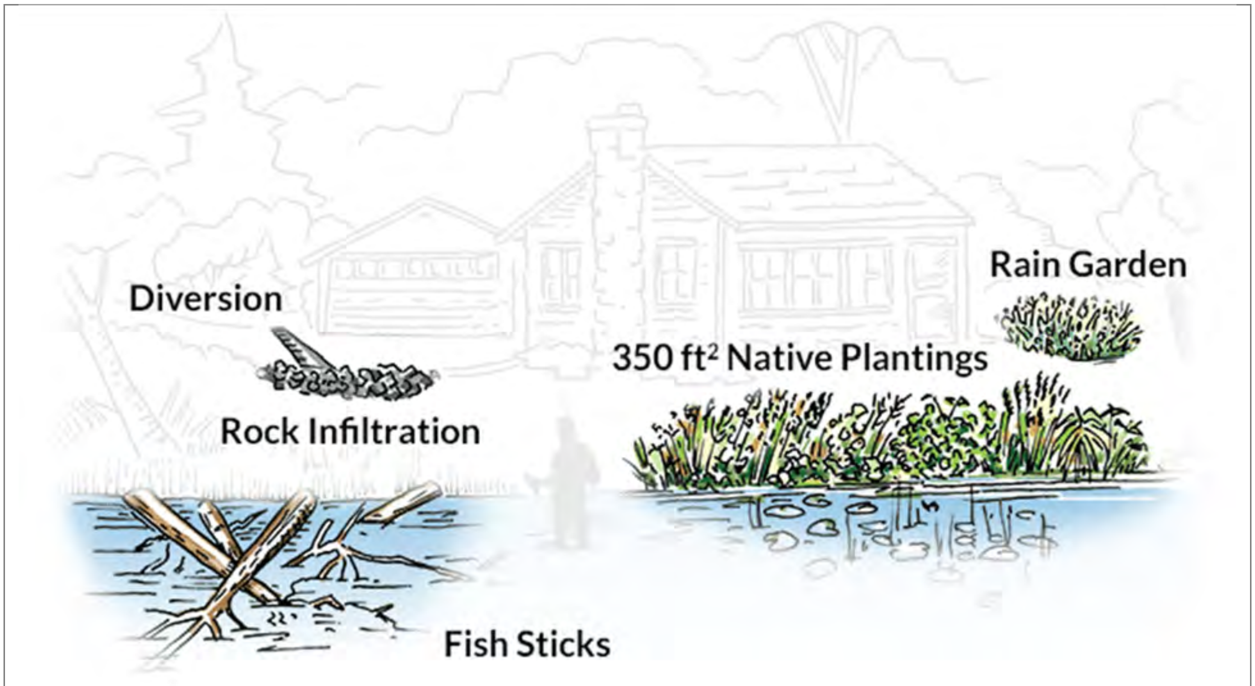



**Figure 3.3-1. Healthy Lakes & Rivers 5 Best Practices.** Illustration by Karen Engelbretson, extracted from healthylakeswi.com.

- Rain Gardens: This upland best practice consists of a landscaped and vegetated shallow depression aimed at capturing water runoff and allowing it to infiltrate into the soil.
- Rock Infiltration: This upland best practice is an excavated pit or trench, filled with rock, that encourages water to infiltrate into the soil. These practices are strategically placed at along a roof line or the downward sloping area of a driveway.
- Diversion: This best practice can occur in the transition or upland zone. These practices use berms, trenches, and/or treated lumber to redirect water that would otherwise move downhill into a lake. Water diversions may direct water into a Rock Infiltration or Rain Garden to provide the greatest reductions in runoff volumes.
- Native Plantings: This best practice aims to installing native plants within at least 350 square-foot shoreland transition area. This will slow runoff water and provide valuable habitat. One native planting per property per year is eligible.
- Fish Sticks: These in-lake best practices (not eligible for rivers) are woody habitat structures that provide feeding, breeding, and nesting areas for wildlife. Fish sticks consist of multiple whole trees grouped together and anchored to the shore. Trees are not felled from the shoreline, as existing trees are valuable in place, but brought from a short distance or dragged across the ice. In order for this practice to be eligible, an existing vegetated buffer or pledge to install one is required.

The Healthy Lakes and Rivers Grant Program allows partial cost coverage for implementing best practices. Competitive grants are available to eligible applicants such as lake associations and lake districts. The program allows a 75% state cost share up to $1,000 per practice. Multiple practices can be included per grant application, with a $25,000 maximum award per year. Eligible projects need to be on shoreland properties within 1,000 feet of a lake or 300 feet from a river. The landowner must sign a Conservation Commitment pledge to leave the practice in place and provide continued maintenance for 10 years. More information on this program can be found here:

https://healthylakeswi.com/

It is important to note that this grant program is intentionally designed for relatively simple, low-cost, and shovel-ready projects, limiting 10% of the grant award for technical assistance. Larger and more complex projects, especially those that require engineering design components may seek alternative funding sources potentially through the County. Small-Scale Lake Planning Grants can provide up to $3,000 to help build a Healthy Lakes and Rivers project. Eligible expenses in this grant program are surveys, planning, and design.

## Lake Metonga Shoreland Zone Condition

### Shoreland Development

Lake Metonga's shoreland zone can be classified in terms of its degree of development. In general, more developed shorelands are more stressful on a lake ecosystem, while definite benefits occur from shorelands that are left in their natural state. Figure 3.3-1 displays a diagram of shoreland categories, from "Urbanized", meaning the shoreland zone is completely disturbed by human influence, to "Natural/Undeveloped", meaning the shoreland has been left in its original state.

On Lake Metonga, the development stage of the entire shoreland was surveyed during October 2018, using a GPS unit to map the shoreland. Onterra staff only considered the area of shoreland 35 feet inland from the water's edge, and did not assess the shoreland on a property-by-property basis. During the survey, Onterra staff examined the shoreland for signs of development and assigned areas of the shoreland one of the five descriptive categories in Figure 3.3-2.

Lake Metonga has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 2.0 miles of natural/undeveloped and developed-natural shoreland were observed during the survey (Figure 3.3-3). These shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the survey, 4.7 miles of urbanized and developed–unnatural shoreland were observed. If restoration of the Lake Metonga shoreland is to occur, primary focus should be placed on these shoreland areas as they currently provide little benefit to, and actually may harm, the lake ecosystem. Map 3 displays the location of these shoreland lengths around the entire lake.



**Urbanized**: This type of shoreline has essentially no natural habitat. Areas that are mowed or unnaturally landscaped to the water's edge and areas that are rip-rapped or include a seawall would be placed in this category.

**Developed-Unnatural**: This category includes shorelines that have been developed, but only have small remnants of natural habitat yet intact. A property with many trees, but no remaining understory or herbaceous layer would be included within this category. Also, a property that has left a small (less than 30 feet), natural buffer in place, but has urbanized the areas behind the buffer would be included in this category.

**Developed-Semi-Natural**: This is a developed shoreline that is mostly in a natural state. Developed properties that have left much of the natural habitat in state, but have added gathering areas, small beaches, etc within those natural areas would likely fall into this category. An urbanized shoreline that was restored would likely be included here, also.

**Developed-Natural**: This category includes shorelines that are developed property, but essentially no modifications to the natural habitat have been made. Developed properties that have maintained the natural habitat and only added a path leading to a single pier would fall into this category.

**Natural/Undeveloped**: This category includes shorelines in a natural, undisturbed state. No signs of anthropogenic impact can be found on these shorelines. In forested areas, herbaceous, understory, and canopy layers would be intact.

**Figure 3.3-2. Shoreland assessment category descriptions.**

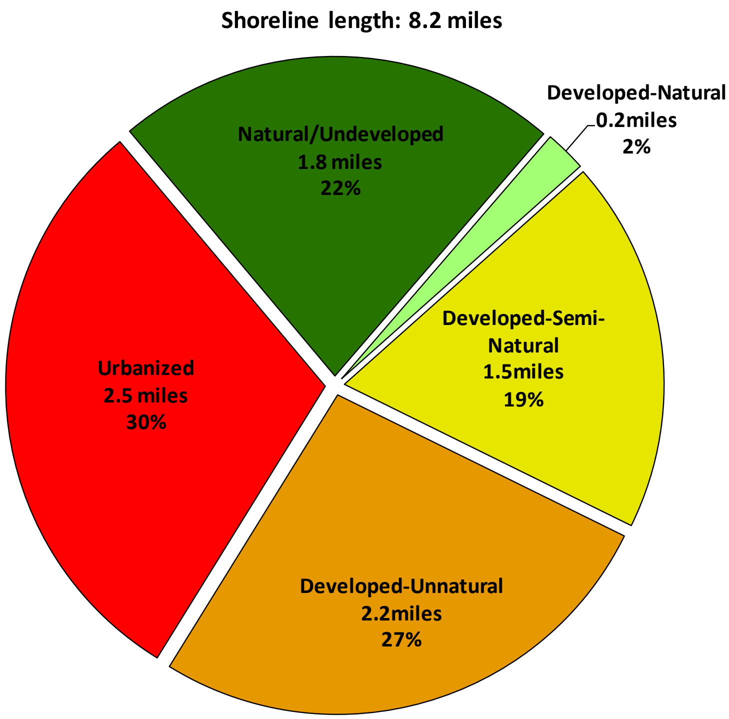



**Figure 3.3-3. Lake Metonga shoreland categories and total lengths.** Based upon a Fall 2018 survey. Locations of these categorized shorelands can be found on Map 3.

While producing a completely natural shoreland is ideal for a lake ecosystem, it is not always practical from a human's perspective. However, riparian property owners can take small steps in ensuring their property's impact upon the lake is minimal. Choosing an appropriate landscape position for lawns is one option to consider. Placing lawns on flat, un-sloped areas or in areas that do not terminate at the lake's edge is one way to reduce the amount of runoff a lake receives from a developed site. And, allowing tree falls and other natural habitat features to remain along a shoreline may result not only in reducing shoreline erosion, but creating wildlife habitat also.

## Coarse Woody Habitat

As part of the shoreland condition assessment, Lake Metonga was also surveyed to determine the extent of its coarse woody habitat. Coarse woody habitat was identified, and classified in three size categories (2-8 inches in diameter, 8+ inches in diameter, or clusters of pieces) as well as four branching categories: no branches, minimal branches, moderate branches, and full canopy. As discussed earlier, research indicates that fish species prefer some branching as opposed to no branching on coarse woody habitat, and increasing complexity is positively correlated with higher fish species richness, diversity and abundance (Newbrey et al. 2005).

During this survey, 35 total pieces of coarse woody habitat were observed along 8.2 miles of shoreline (Map 3), which gives Lake Metonga a coarse woody habitat to shoreline mile ratio of 4:1 (Figure 3.3-4). Only instances where emergent coarse woody habitat extended from shore into the water were recorded during the survey. 29 pieces of 2-8 inches in diameter pieces of coarse woody habitat were found, 6 pieces of 8+ inches in diameter pieces of coarse woody habitat were found, and no instances of clusters of coarse woody habitat were found. It should be noted due to denser areas of emergent in some areas some smaller diameter CWH may have been missed.

To put this into perspective, Wisconsin researchers have found that in completely undeveloped lakes, an average of 345 coarse woody habitat structures may be found per mile (Christensen et al. 1996). Please note the methodologies between the surveys done on Lake Metonga and those cited in this literature comparison are much different, but still provide a valuable insight into what undisturbed shorelines may have in terms of coarse woody habitat.

Onterra has completed coarse woody habitat surveys on 98 lakes throughout Wisconsin since 2012, with the majority occurring in the NLF ecoregion on lakes with public access. The number of coarse woody habitat pieces per shoreline mile in Lake Metonga falls below the 75th percentile of these 98 lakes (Figure 3.3-4).

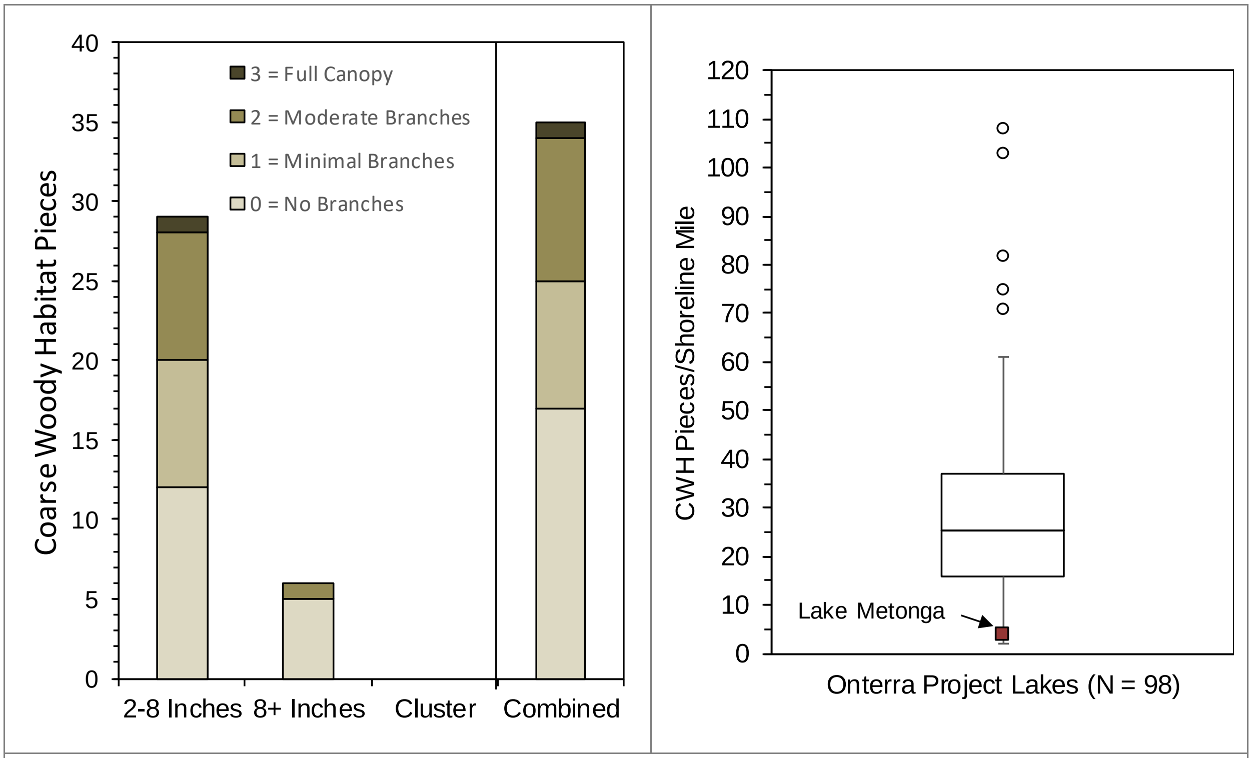



**Figure 3.3-4. Lake Metonga coarse woody habitat survey results.** Based upon a Fall 2018 survey. Locations of the Lake Metonga coarse woody habitat can be found on Map 4.

## 3.4 Aquatic Plants

### *Introduction*

**Photograph 3.4-1. Example of emergent and floating-leaf communities.**

Although the occasional lake user considers aquatic macrophytes to be "weeds" and a nuisance to the recreational use of the lake, the plants are actually an essential element in a healthy and functioning lake ecosystem. It is very important that lake stakeholders understand the importance of lake plants and the many functions they serve in maintaining and protecting a lake ecosystem. With increased understanding and awareness, most lake users will recognize the importance of the aquatic plant community and their potential negative effects on it.

Diverse aquatic vegetation provides habitat and food for many kinds of aquatic life, including fish, insects, amphibians, waterfowl, and even terrestrial wildlife. For instance, wild celery (*Vallisneria americana)* and wild rice (*Zizania aquatica* and *Z. palustris*) both serve as excellent food sources for ducks and geese. Emergent stands of vegetation provide necessary spawning habitat for fish such as northern pike (*Esox lucius*) and yellow perch (*Perca flavescens*). In addition, many of the insects that are eaten by young fish rely heavily on aquatic plants and the periphyton attached to them as their primary food source. The plants also provide cover for feeder fish and zooplankton, stabilizing the predator-prey relationships within the system. Furthermore, rooted aquatic plants prevent shoreland erosion and the resuspension of sediments and nutrients by absorbing wave energy and locking sediments within their root masses. In areas where plants do not exist, waves can resuspend bottom sediments decreasing water clarity and increasing plant nutrient levels that may lead to algae blooms. Lake plants also produce oxygen through photosynthesis and use nutrients that may otherwise be used by phytoplankton, which helps to minimize nuisance algal blooms.

Under certain conditions, a few species may become a problem and require control measures. Excessive plant growth can limit recreational use by deterring navigation, swimming, and fishing activities. It can also lead to changes in fish population structure by providing too much cover for feeder fish resulting in reduced predation by predator fish, which could result in a stunted pan-fish population. Exotic plant species, such as Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*) can also upset the delicate balance of a lake ecosystem by out competing native plants and reducing species diversity. These species will be discussed further in depth in the Aquatic Invasive Species section. These invasive plant species can form dense stands that are a nuisance to humans and provide low-value habitat for fish and other wildlife.

When plant abundance negatively affects the lake ecosystem and limits the use of the resource, plant management and control may be necessary. The management goals should always include the control of invasive species and restoration of native communities through environmentally sensitive and economically feasible methods. No aquatic plant management plan should only contain methods to control plants, they should also contain methods on how to protect and possibly enhance the important plant communities within the lake. Unfortunately, the latter is often neglected and the ecosystem suffers as a result.

## *Aquatic Plant Management and Protection*

Many times, an aquatic plant management plan is aimed at only controlling nuisance plant growth that has limited the recreational use of the lake, usually navigation, fishing, and swimming. It is important to remember the vital benefits that native aquatic plants provide to lake users and the lake ecosystem, as described above. Therefore, all aquatic plant management plans also need to address the enhancement and protection of the aquatic plant community. Below are general descriptions of the many techniques that can be utilized to control and enhance aquatic plants. Each alternative has benefits and limitations that are explained in its description. Please note that only legal and commonly used methods are included. For instance, the herbivorous grass carp (*Ctenopharyngodon idella*) is illegal in Wisconsin and rotovation, a process by which the lake bottom is tilled, is not a commonly accepted practice. Unfortunately, there are no "silver bullets" that can completely cure all aquatic plant problems, which makes planning a crucial step in any aquatic plant management activity. Many of the plant management and protection techniques commonly used in Wisconsin are described below.

**Important Note:**
Even though some of these techniques are not applicable to Lake Metonga, it is still important for lake users to have a basic understanding of all the techniques so they can better understand why particular methods are or are not applicable in their lake**.** The techniques applicable to Lake Metonga are discussed in Summary and Conclusions section and the Implementation Plan found near the end of this document.

### Permits

The signing of the 2001-2003 State Budget enacted many aquatic plant management regulations. The rules for the regulations have been set forth by the WDNR as NR 107 and 109. A major change includes that all forms of aquatic plant management, even those that did not require a permit in the past, require a permit now, including manual and mechanical removal. Manual cutting and raking are exempt from the permit requirement if the area of plant removal is no more than 30 feet wide and any piers, boatlifts, swim rafts, and other recreational and water use devices are located within that 30 feet. This action can be conducted up to 150 feet from shore. Please note that a permit is needed in all instances if wild rice is to be removed. Furthermore, installation of aquatic plants, even natives, requires approval from the WDNR.

Permits are required for chemical and mechanical manipulation of native and non-native plant communities. Large-scale protocols have been established for chemical treatment projects covering >10 acres or areas greater than 10% of the lake littoral zone and more than 150 feet from shore. Different protocols are to be followed for whole-lake scale treatments (≥160 acres or ≥50% of the lake littoral area). Additionally, it is important to note that local permits and U.S. Army Corps of Engineers regulations may also apply. For more information on permit requirements, please contact the WDNR Regional Water Management Specialist or Aquatic Plant Management and Protection Specialist.

## Manual Removal (Hand-Harvesting & DASH)

Manual removal methods include hand-pulling, raking, and hand-cutting. Hand-pulling involves the manual removal of whole plants, including roots, from the area of concern and disposing them out of the waterbody. Raking entails the removal of partial and whole plants from the lake by dragging a rake with a rope tied to it through plant beds. Specially designed rakes are available from commercial sources or an asphalt rake can be used. Hand-cutting differs from the other two manual methods because the entire plant is not removed, rather the plants are cut similar to mowing a lawn; however, Wisconsin law states that all plant fragments must be removed.

**Photograph 3.4-2. Example of aquatic plants that have been removed manually.**

Manual removal or hand-harvesting of aquatic invasive species has gained favor in recent years as an alternative to herbicide control programs. Professional hand-harvesting firms can be contracted for these efforts and can either use basic snorkeling or scuba divers, whereas others might employ the use of a Diver Assisted Suction Harvest (DASH) which involves divers removing plants and feeding them into a suctioned hose for delivery to the deck of the harvesting vessel. The DASH methodology is considered a form of mechanical harvesting and thus requires a WDNR approved permit. DASH is thought to be more efficient in removing target plants than divers alone and is believed to limit fragmentation during the harvesting process.

**Cost**
Contracting aquatic invasive species removal by third-party firm can cost approximately $1,500 per day for traditional hand-harvesting methods whereas the costs can be closer to $2,500 when DASH technology is used. Additional disposal, travel, and permitting fees may also apply.

| *Advantages* | *Disadvantages* |
| --- | --- |
| • Very cost effective for clearing areas around docks, piers, and swimming areas.<br>• Relatively environmentally safe if large-scale efforts are conducted after June 15th.to correspond with fish spawning<br>• Allows for selective removal of undesirable plant species.<br>• Provides immediate relief in localized area.<br>• Plant biomass is removed from waterbody. | • Labor intensive.<br>• Impractical for larger areas or dense plant beds.<br>• Subsequent treatments may be needed as plants recolonize and/or continue to grow.<br>• Uprooting of plants stirs bottom sediments making it difficult to conduct action.<br>• May disturb benthic organisms and fish-spawning areas.<br>• Risk of spreading invasive species if fragments are not removed. |

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## Bottom Screens

Bottom screens are very much like landscaping fabric used to block weed growth in flowerbeds. The gas-permeable screen is placed over the plant bed and anchored to the lake bottom by staking or weights. Only gas-permeable screen can be used or large pockets of gas will form under the mat as the result of plant decomposition. This could lead to portions of the screen becoming detached from the lake bottom, creating a navigational hazard. Normally the screens are removed and cleaned at the end of the growing season and then placed back in the lake the following spring. If they are not removed, sediments may build up on them and allow for plant colonization on top of the screen. Please note that depending on the size of the screen a Wisconsin Department of Natural Resources permit may be required.

*Cost*

Material costs range between $.20 and $1.25 per square-foot. Installation cost can vary largely, but may roughly cost $750 to have 1,000 square feet of bottom screen installed. Maintenance costs can also vary, but an estimate for a waterfront lot is about $120 each year.

| ***Advantages*** | ***Disadvantages*** |
|---|---|
| • Immediate and sustainable control.<br>• Long-term costs are low.<br>• Excellent for small areas and around obstructions.<br>• Materials are reusable.<br>• Prevents fragmentation and subsequent spread of plants to other areas. | • Installation may be difficult over dense plant beds and in deep water.<br>• Not species specific.<br>• Disrupts benthic fauna.<br>• May be navigational hazard in shallow water.<br>• Initial costs are high.<br>• Labor intensive due to the seasonal removal and reinstallation requirements.<br>• Does not remove plant biomass from lake.<br>• Not practical in large-scale situations. |

## Water Level Drawdown

The primary manner of plant control through water level drawdown is the exposure of sediments and plant roots/tubers to desiccation and either heating or freezing depending on the timing of the treatment. Winter drawdowns are more common in temperate climates like that of Wisconsin and usually occur in reservoirs because of the ease of water removal through the outlet structure. An important fact to remember when considering the use of this technique is that only certain species are controlled and that some species may even be enhanced. Furthermore, the process will likely need to be repeated every two or three years to keep target species in check.

*Cost*

The cost of this alternative is highly variable. If an outlet structure exists, the cost of lowering the water level would be minimal; however, if there is not an outlet, the cost of pumping water to the desirable level could be very expensive. If a hydro-electric facility is operating on the system, the costs associated with loss of production during the drawdown also need to be considered, as they are likely cost prohibitive to conducting the management action.

| ***Advantages*** | ***Disadvantages*** |
|---|---|
| • Inexpensive if outlet structure exists.<br>• May control populations of certain species, like Eurasian watermilfoil for a few years.<br>• Allows some loose sediment to consolidate, increasing water depth.<br>• May enhance growth of desirable emergent species.<br>• Other work, like dock and pier repair may be completed more easily and at a lower cost while water levels are down. | • May be cost prohibitive if pumping is required to lower water levels.<br>• Has the potential to upset the lake ecosystem and have significant effects on fish and other aquatic wildlife.<br>• Adjacent wetlands may be altered due to lower water levels.<br>• Disrupts recreational, hydroelectric, irrigation and water supply uses.<br>• May enhance the spread of certain undesirable species, like common reed and reed canary grass.<br>• Permitting process may require an environmental assessment that may take months to prepare.<br>• Non-selective. |

### Mechanical Harvesting

**Photograph 3.4-3. Mechanical harvester.**

Aquatic plant harvesting is frequently used in Wisconsin and involves the cutting and removal of plants much like mowing and bagging a lawn. Harvesters are produced in many sizes that can cut to depths ranging from 3 to 6 feet with cutting widths of 4 to 10 feet. Plant harvesting speeds vary with the size of the harvester, density and types of plants, and the distance to the off-loading area. Equipment requirements do not end with the harvester. In addition to the harvester, a shore-conveyor would be required to transfer plant material from the harvester to a dump truck for transport to a landfill or compost site. Furthermore, if off-loading sites are limited and/or the lake is large, a transport barge may be needed to move the harvested plants from the harvester to the shore in order to cut back on the time that the harvester spends traveling to the shore conveyor. Some lake organizations contract to have nuisance plants harvested, while others choose to purchase their own equipment. If the latter route is chosen, it is especially important for the lake group to be very organized and realize that there is a great deal of work and expense involved with the purchase, operation, maintenance, and storage of an aquatic plant harvester. In either case, planning is very important to minimize environmental effects and maximize benefits.

*Cost*

Equipment costs vary with the size and features of the harvester, but in general, standard harvesters range between $45,000 and $100,000. Larger harvesters or stainless steel models may cost as much as $200,000. Shore conveyors cost approximately $20,000 and trailers range from $7,000 to $20,000. Storage, maintenance, insurance, and operator salaries vary greatly.

| ***Advantages*** | ***Disadvantages*** |
|---|---|
| • Immediate results.<br>• Plant biomass and associated nutrients are removed from the lake.<br>• Select areas can be treated, leaving sensitive areas intact.<br>• Plants are not completely removed and can still provide some habitat benefits.<br>• Opening of cruise lanes can increase predator pressure and reduce stunted fish populations.<br>• Removal of plant biomass can improve the oxygen balance in the littoral zone.<br>• Harvested plant materials produce excellent compost. | • Initial costs and maintenance are high if the lake organization intends to own and operate the equipment.<br>• Multiple treatments are likely required.<br>• Many small fish, amphibians and invertebrates may be harvested along with plants.<br>• There is little or no long-term reduction in plant density with harvesting.<br>• Invasive and exotic species may spread because of plant fragmentation associated with harvester operation.<br>• Bottom sediments may be re-suspended leading to increased turbidity and water column nutrient levels. |

### Herbicide Treatment

The use of herbicides to control aquatic plants and algae is a technique that is widely used by lake managers. Traditionally, herbicides were used to control nuisance levels of aquatic plants and algae that interfere with navigation and recreation. While this practice still takes place in many parts of Wisconsin, the use of herbicides to control aquatic invasive species is becoming more prevalent. Resource managers employ strategic management techniques towards aquatic invasive species, with the objective of reducing the target plant's population over time; and an overarching goal of attaining long-term ecological restoration. For submergent vegetation, this largely consists of implementing control strategies early in the growing season; either as spatially-targeted, small-scale spot treatments or low-dose, large-scale (whole lake) treatments. Treatments occurring roughly each year before June 1 and/or when water temperatures are below 60°F can be less impactful to many native plants, which have not emerged yet at this time of year. Emergent species are targeted with foliar applications at strategic times of the year when the target plant is more likely to absorb the herbicide.

**Photograph 3.4-4. Granular herbicide application.**

While there are approximately 300 herbicides registered for terrestrial use in the United States, only 13 active ingredients can be applied into or near aquatic systems. All aquatic herbicides must be applied in accordance with the product's US Environmental Protection Agency (EPA) approved label. There are numerous formulations and brands of aquatic herbicides and an extensive list can be found in Appendix F of Gettys et al. (2009).

Applying herbicides in the aquatic environment requires special considerations compared with terrestrial applications. WDNR administrative code states that a permit is required if, "you are standing in socks and they get wet." In these situations, the herbicide application needs to be completed by an applicator licensed with the Wisconsin Department of Agriculture, Trade and Consumer Protection. All herbicide applications conducted under the ordinary high water mark require herbicides specifically labeled by the United States Environmental Protection Agency

Aquatic herbicides can be classified in many ways. Organization of this section follows Netherland (2009) in which mode of action (i.e. how the herbicide works) and application techniques (i.e. foliar or submersed treatment) group the aquatic herbicides. The table below provides a general list of commonly used aquatic herbicides in Wisconsin and is synthesized from Netherland (2009).

The arguably clearest division amongst aquatic herbicides is their general mode of action and fall into two basic categories:

1. Contact herbicides act by causing extensive cellular damage, but usually do not affect the areas that were not in contact with the chemical. This allows them to work much faster, but in some plants does not result in a sustained effect because the root crowns, roots, or rhizomes are not killed.
2. Systemic herbicides act slower than contact herbicides, being transported throughout the entire plant and disrupting biochemical pathways which often result in complete mortality.

**Table 3.4-1. Common herbicides used for aquatic plant management.**

| General Mode of Action | | Compound | Specific Mode of Action | Most Common Target Species in Wisconsin |
|---|---|---|---|---|
| Contact | | Copper | plant cell toxicant | Algae, including macro-algae (i.e. muskgrasses & stoneworts) |
| Contact | | Endothall | Inhibits respiration & protein synthesis | Submersed species, largely for curly-leaf pondweed; invasive watermilfoil control when mixed with auxin herbicides |
| Contact | | Diquat | Inhibits photosynthesis & destroys cell membranes | Nusiance species including duckweeds, targeted AIS control when exposure times are low |
| Contact | | Flumioxazin | Inhibits photosynthesis & destroys cell membranes | Nusiance species, targeted AIS control when exposure times are low |
| Systemic | Auxin Mimics | 2,4-D | auxin mimic, plant growth regulator | Submersed species, largely for invasive watermilfoil |
| Systemic | Auxin Mimics | Triclopyr | auxin mimic, plant growth regulator | Submersed species, largely for invasive watermilfoil |
| Systemic | Auxin Mimics | Florpyrauxifen -benzyl | arylpicolinate auxin mimic, growth regulator, different binding afinity than 2,4-D or triclopyr | Submersed species, largely for invasive watermilfoil |
| Systemic | In Water Use Only | Fluridone | Inhibits plant specific enzyme, new growth bleached | Submersed species, largely for invasive watermilfoil |
| Systemic | Enzyme Specific (ALS) | Penoxsulam | Inhibits plant-specific enzyme (ALS), new growth stunted | Emergent species with potential for submergen and floating-leaf species |
| Systemic | Enzyme Specific (ALS) | Imazamox | Inhibits plant-specific enzyme (ALS), new growth stunted | New to WI, potential for submergent and floating leaf species |
| Systemic | Enzyme Specific (foliar use only) | Glyphosate | Inhibits plant-specific enzyme (ALS) | Emergent species, including purple loosestrife |
| Systemic | Enzyme Specific (foliar use only) | Imazapyr | Inhibits plant-specific enzyme (EPSP) | Hardy emergent species, including common reed |

Both types are commonly used throughout Wisconsin with varying degrees of success. The use of herbicides is potentially hazardous to both the applicator and the environment, so all lake organizations should seek consultation and/or services from professional applicators with training and experience in aquatic herbicide use.

Herbicides that target submersed plant species are directly applied to the water, either as a liquid or an encapsulated granular formulation. Factors such as water depth, water flow, treatment area size, and plant density work to reduce herbicide concentration within aquatic systems. Understanding concentration and exposure times are important considerations for aquatic herbicides. Successful control of the target plant is achieved when it is exposed to a lethal concentration of the herbicide for a specific duration of time. Much information has been gathered in recent years, largely as a result of an ongoing cooperative research project between the Wisconsin Department of Natural Resources, US Army Corps of Engineers Research and Development Center, and private consultants (including Onterra). This research couples quantitative aquatic plant monitoring with field-collected herbicide concentration data to evaluate efficacy and selectivity of control strategies implemented on a subset of Wisconsin lakes and flowages. Based on their preliminary findings, lake managers have adopted two main treatment strategies: 1) whole-lake treatments, and 2) spot treatments.

Spot treatments are a type of control strategy where the herbicide is applied to a specific area (treatment site) such that when it dilutes from that area, its concentrations are insufficient to cause significant affects outside of that area. Spot treatments typically rely on a short exposure time (often hours) to cause mortality and therefore are applied at a much higher herbicide concentration than whole-lake treatments. This has been the strategy historically used on most Wisconsin systems.

Whole-lake treatments are those where the herbicide is applied to specific sites, but when the herbicide reaches equilibrium within the entire volume of water (entire lake, lake basin, or within the epilimnion of the lake or lake basin); it is at a concentration that is sufficient to cause mortality to the target plant within that entire lake or basin. The application rate of a whole-lake treatment is dictated by the volume of water in which the herbicide will reach equilibrium. Because exposure time is so much longer, target herbicide levels for whole-lake treatments are significantly less than for spot treatments.

*Cost*

Herbicide application charges vary greatly between $400 and $1,500 per acre depending on the chemical used, who applies it, permitting procedures, and the size/depth of the treatment area.

| ***Advantages*** | ***Disadvantages*** |
|---|---|
| • Herbicides are easily applied in restricted areas, like around docks and boatlifts.<br>• Herbicides can target large areas all at once.<br>• Herbicides can be economical at certain scales compared with other management options.<br>• Herbicide type and application timing can increase selectivity towards target species.<br>• Most herbicides are designed to target plant physiology and in general, have low toxicological effects on non-plant organisms (e.g. mammals, insects) | • All herbicide use carries some degree of human health and ecological risk due to toxicity.<br>• Fast-acting herbicides may cause fish kills due to rapid plant decomposition if not applied correctly.<br>• Many people adamantly object to the use of herbicides in the aquatic environment; therefore, all stakeholders should be included in the decision to use them.<br>• Many aquatic herbicides are nonselective.<br>• Some herbicides have a combination of use restrictions that must be followed after their application.<br>• Overuse of same herbicide may lead to plant resistance to that herbicide. |

## Biological Controls

There are many insects, fish and pathogens within the United States that are used as biological controls for aquatic macrophytes. For instance, the herbivorous grass carp has been used for years in many states to control aquatic plants with some success and some failures. However, it is illegal to possess grass carp within Wisconsin because their use can create problems worse than the plants that they were used to control. Other states have also used insects to battle invasive plants, such as water hyacinth weevils (*Neochetina* spp.) and hydrilla stem weevil (*Bagous* spp.) to control water hyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata),* respectively.

However, Wisconsin, along with many other states, is currently experiencing the expansion of lakes infested with Eurasian watermilfoil and as a result has supported the experimentation and use of the milfoil weevil (*Euhrychiopsis lecontei*) within its lakes. The milfoil weevil is a native weevil that has shown promise in reducing Eurasian watermilfoil stands in Wisconsin, Washington, Vermont, and other states. Research is currently being conducted to discover the best situations for the use of the insect in battling Eurasian watermilfoil. Currently the milfoil weevil is not a WDNR grant-eligible method of controlling Eurasian watermilfoil.

*Cost*

Stocking with adult weevils costs about $1.20/weevil and they are usually stocked in lots of 1000 or more.

| ***Advantages*** | ***Disadvantages*** |
|---|---|
| • Milfoil weevils occur naturally in Wisconsin.<br>• Likely environmentally safe and little risk of unintended consequences. | • Stocking and monitoring costs are high.<br>• This is an unproven and experimental treatment.<br>• There is a chance that a large amount of money could be spent with little or no change in Eurasian watermilfoil density. |

Wisconsin has approved the use of two species of leaf-eating beetles (*Galerucella calmariensis* and *G. pusilla*) to battle purple loosestrife. These beetles were imported from Europe and used as a biological control method for purple loosestrife. Many cooperators, such as county conservation departments or local UW-Extension locations, currently support large beetle rearing operations. Beetles are reared on live purple loosestrife plants growing in kiddy pools surrounded by insect netting. Beetles are collected with aspirators and then released onto the target wild population. For more information on beetle rearing, contact your local UW-Extension location.

In some instances, beetles may be collected from known locations (cella insectaries) or purchased through private sellers. Although no permits are required to purchase or release beetles within Wisconsin, application/authorization and release forms are required by the WDNR for tracking and monitoring purposes.

*Cost*

The cost of beetle release is very inexpensive, and in many cases is free.

| ***Advantages*** | ***Disadvantages*** |
|---|---|
| • Extremely inexpensive control method.<br>• Once released, considerably less effort than other control methods is required.<br>• Augmenting populations many lead to long-term control. | • Although considered “safe,” reservations about introducing one non-native species to control another exist.<br>• Long range studies have not been completed on this technique. |

## Analysis of Current Aquatic Plant Data

Aquatic plants are an important element in every healthy lake. Changes in lake ecosystems are often first seen in the lake's plant community. Whether these changes are positive, such as variable water levels or negative, such as increased shoreland development or the introduction of an exotic species, the plant community will respond. Plant communities respond in a variety of ways. For example, there may be a loss of one or more species. Certain life forms, such as emergent or floating-leaf communities, may disappear from specific areas of the lake. A shift in plant dominance between species may also occur. With periodic monitoring and proper analysis, these changes are relatively easy to detect and provide very useful information for management decisions.

As described in more detail in the methods section, multiple aquatic plant surveys were completed on Lake Metonga; the first looked strictly for the exotic plant, curly-leaf pondweed, while the others that followed assessed both native and non-native species. Combined, these surveys produce a great deal of information about the aquatic vegetation of the lake. These data are analyzed and presented in numerous ways; each is discussed in more detail below.

### Point-intercept Aquatic Plant Survey

The point-intercept method as described by the Wisconsin Department of Natural Resources Bureau of Science Services, PUB-SS-1068 2010 (Hauxwell et al. 2010) was used to complete the whole-lake point-intercept surveys on Lake Metonga in 2005, 2013, and 2018. Based upon guidance from the WDNR, a point spacing (resolution) of 80 meters was used resulting in approximately 1,311 sample locations. At each point-intercept location within the *littoral zone*, information regarding the depth, substrate type (soft sediment, sand, or rock), and the plant species sampled along with their relative abundance on the sampling rake was recorded. A pole-mounted rake was used to collect the plant samples, depth, and sediment information at point locations of 15 feet or less. A rake head tied to a rope (rope rake) was used at sites greater than 15 feet. Depth information was collected using graduated marks on the pole of the rake (at depths < 15 ft) or using an onboard sonar unit (at depths > 15 feet). When a rope rake was used, information regarding substrate type was not collected due to the inability of the sampler to accurately "feel" the bottom with this sampling device.

*Species List*

The species list is simply a list of all of the aquatic plant species, both native and non-native, that were located during the surveys completed in Lake Metonga in 2018. Distinction will be made of those species located during the point-intercept survey and those located during other surveys. The list also contains the growth-form of each plant found (e.g. submergent, emergent, etc.), its scientific name, common name, and its coefficient of conservatism. The latter is discussed in more detail below. Changes in this list over time, whether it is differences in total species present, gains and losses of individual species, or changes in growth forms that are present, can be an early indicator of changes in the ecosystem.

*Frequency of Occurrence*

Frequency of occurrence describes how often a certain aquatic plant species is found within a lake from the point-intercept survey. The occurrence of aquatic plant species is displayed as the *littoral frequency of occurrence*. Littoral frequency of occurrence is used to describe how often each species occurred in the plots that are within the maximum depth of plant growth (littoral zone), and is displayed as a percentage.

*Floristic Quality Assessment*

The floristic quality of a lake's aquatic plant community is calculated using its native *species richness* and their *average conservatism*. Species richness is the number of native aquatic plant species that were physically encountered on the rake during the point-intercept survey. Average conservatism is calculated by taking the sum of the coefficients of conservatism (C-values) of the native species located and dividing it by species richness. Every plant in Wisconsin has been assigned a coefficient of conservatism, ranging from 1-10, which describes the likelihood of that species being found in an undisturbed environment. Species which are more specialized and require undisturbed habitat are given higher coefficients, while species which are more tolerant of environmental disturbance have lower coefficients.

For example, algal-leaf pondweed (*Potamogeton confervoides*) is only found in nutrient-poor, acid lakes in northern Wisconsin and is prone to decline if degradation of these lakes occurs. Because of algal-leaf pondweed's special requirements and sensitivity to disturbance, it has a C-value of 10. In contrast, sago pondweed (*Stuckenia pectinata*) with a C-value of 3, is tolerant of disturbance and is often found in greater abundance in degraded lakes that have higher nutrient concentrations and low water clarity. Higher average conservatism values generally indicate a healthier lake as it is able to support a greater number of environmentally-sensitive aquatic plant species. Low average conservatism values indicate a degraded environment, one that is only able to support disturbance-tolerant species.

On their own, the species richness and average conservatism values for a lake are useful in assessing a lake's plant community; however, the best assessment of the lake's plant community health is determined when the two values are used to calculate the lake's floristic quality. The floristic quality is calculated using the species richness and average conservatism value of the aquatic plant species that were solely encountered on the rake during the point-intercept surveys (equation shown below). This assessment allows the aquatic plant community of Lake Metonga to be compared to other lakes within the region and state.

$$\text{FQI} = \text{Average Coefficient of Conservatism} * \sqrt{\text{Number of Native Species}}$$

*Species Diversity*

Species diversity is often confused with species richness. As defined previously, species richness is simply the number of species found within a given community. While species diversity utilizes species richness, it also takes into account evenness or the variation in abundance of the individual species within the community. For example, a lake with 10 aquatic plant species that had relatively similar abundances within the community would be more diverse than another lake with 10 aquatic plant species were 50% of the community was comprised of just one or two species.

An aquatic system with high species diversity is more stable than a system with a low diversity. This is analogous to a diverse financial portfolio in that a diverse aquatic plant community can withstand environmental fluctuations much like a diverse portfolio can handle economic fluctuations. A lake with a diverse plant community may also better suited to compete against exotic infestations than a lake with a lower diversity. However, in a recent study of 1,100

Minnesota lakes, researchers concluded that more diverse communities were not more resistant or resilient to invaders (Muthukrishnan et al. 2018). The diversity of a lake's aquatic plant community is determined using the Simpson's Diversity Index (1-D):

$$D = \sum (n/N)^2$$

where:

n = the total number of instances of a particular species
N = the total number of instances of all species and
D is a value between 0 and 1

If a lake has a diversity index value of 0.90, it means that if two plants were randomly sampled from the lake there is a 90% probability that the two individuals would be of a different species. The Simpson's Diversity Index value from Lake Metonga is compared to data collected by Onterra and the WDNR Science Services on 212 lakes within the Northern Lakes and Forests ecoregion and on 392 lakes throughout Wisconsin.

### Emergent and Floating-Leaf Community Mapping

While the point-intercept survey is a valuable tool to understand the overall aquatic plant community of a lake, it often underrepresents the floating-leaf and emergent plant communities largely found around the margins of a lake. The emergent and floating-leaf aquatic plant community assessment is a delineation of these plant communities within each lake. This survey creates a snapshot of these important communities within each lake as they existed during the survey and is valuable in the development of the management plan and in comparisons with future surveys. Examples of emergent plants include cattails, rushes, sedges, grasses, bur-reeds, and arrowheads, while examples of floating-leaf species include the water lilies. The emergent and floating-leaf aquatic plant communities in Lake Metonga were mapped using a Trimble Global Positioning System (GPS) with sub-meter accuracy.

## *Lake Metonga Aquatic Plant Survey Results*

Included as a part of this lake management planning project were several surveys with a purpose of assessing the aquatic plant population in Lake Metonga. Table 3.4-2 shows which species were documented from Lake Metonga during point-intercept surveys (X) or during other inventories (I) such as the community mapping survey during 2005, 2013, and 2018. During these surveys, a total of approximately 39 species of plants were located in or along the margins of Lake Metonga (Table 3.4-2). One of these species is not native to the area, Eurasian watermilfoil (EWM). Because of the ecological and sociological significance of EWM, this species and its management in Lake Metonga is discussed in depth in the Non-Native Aquatic Plant Sub-Section.

**Table 3.4-2. Aquatic plant species located on Lake Metonga during 2005, 2013, and 2018.**

| Growth Form | Scientific Name | Common Name | Coefficient of Conservatism (C) | 2005 (Onterra) | 2013 (Onterra) | 2018 (Onterra) |
|---|---|---|---|---|---|---|
| Emergent | *Calla palustris* | Water arum | 9 | | I | |
| | *Carex comosa* | Bristly sedge | 5 | I | I | I |
| | *Carex retrorsa* | Retrorse sedge | 6 | | I | |
| | *Eleocharis palustris* | Creeping spikerush | 6 | | I | I |
| | *Equisetum fluviatile* | Water horsetail | 7 | X | I | |
| | *Sagittaria latifolia* | Common arrowhead | 3 | X | I | I |
| | *Schoenoplectus acutus* | Hardstem bulrush | 5 | X | X | X |
| | *Schoenoplectus tabernaemontani* | Softstem bulrush | 4 | X | I | |
| | *Sparganium emersum* | Short-stemmed bur-reed | 8 | X | | |
| | *Typha* spp. | Cattail species | 1 | X | I | I |
| | *Zizania palustris* | Northern wild rice | 8 | I | I | I |
| FL | *Nuphar variegata* | Spatterdock | 6 | X | X | X |
| | *Nymphaea odorata* | White water lily | 6 | X | X | X |
| Submergent | *Ceratophyllum demersum* | Coontail | 3 | X | X | X |
| | *Bidens beckii* | Water marigold | 8 | X | X | X |
| | *Chara* spp. | Muskgrasses | 7 | X | X | X |
| | *Elodea canadensis* | Common waterweed | 3 | X | X | X |
| | *Heteranthera dubia* | Water stargrass | 6 | X | | I |
| | *Isoetes* sp. | Quillwort species | N/A | X | X | |
| | *Myriophyllum sibiricum* | Northern water milfoil | 7 | X | X | X |
| | *Myriophyllum spicatum* | Eurasian water milfoil | Exotic | X | X | X |
| | *Najas flexilis* | Slender naiad | 6 | X | X | X |
| | *Najas guadalupensis* | Southern naiad | 7 | | | X |
| | *Potamogeton gramineus* | Variable pondweed | 7 | X | X | X |
| | *Potamogeton illinoensis* | Illinois pondweed | 6 | X | X | X |
| | *Potamogeton praelongus* | White-stem pondweed | 8 | X | X | |
| | *Potamogeton pusillus* | Small pondweed | 7 | X | X | |
| | *Potamogeton strictifolius* | Stiff pondweed | 8 | | X | X |
| | *Potamogeton zosteriformis* | Flat-stem pondweed | 6 | X | X | X |
| | *Ranunculus flammula* | Creeping spearwort | 9 | X | X | |
| | *Stuckenia pectinata* | Sago pondweed | 3 | X | X | |
| | *Utricularia vulgaris* | Common bladderwort | 7 | X | X | X |
| | *Vallisneria americana* | Wild celery | 6 | X | X | X |
| S/E | *Eleocharis acicularis* | Needle spikerush | 5 | X | X | |
| | *Juncus pelocarpus* | Brown-fruited rush | 8 | X | X | |
| | *Sagittaria spp.* | Arrowhead species | N/A | X | I | |
| FF | *Lemna trisulca* | Forked duckweed | 6 | X | X | |
| | *Lemna tuionifera* | Lesser duckweed | 5 | X | | |
| | *Spirodela polyrhiza* | Greater duckweed | 5 | | X | |

*FL = Floating Leaf; S/E = Submergent and Emergent; FF = Free Floating*
*X = Located on rake during point-intercept survey; I = Incidental Species*

Lakes in Wisconsin vary in their morphometry, water chemistry, water clarity, substrate composition, management, and recreational use, all factors which influence aquatic plant community composition. Like terrestrial plants, different aquatic plant species are adapted to grow in certain substrate types; some species are only found growing in soft substrates, others only in sandy/rocky areas, and some can be found growing in either. The combination of both soft sediments and areas of harder substrates creates different habitat types for aquatic plants, and generally leads to a higher number of aquatic plant species within the lake.

Data from the point-intercept survey indicate that approximately 69% of the sampling locations located had a sandy substrate, with only 3% containing fine organic sediment (muck) (Figure 3.4-1).

Lake Metonga supports aquatic plant growth out to 18-21 feet (Figure 3.4-2). In 2005, aquatic plant growth was a little more prevalent in waters 2-4 feet deep compared to 2013 and 2018. The data from 2015 also show greater aquatic plant abundance in waters 14-18 feet deep. As discussed in the Water Quality Section (3.1), water clarity has been increasing in Lake Metonga, which should support aquatic plant growing out to increasingly deeper depths.

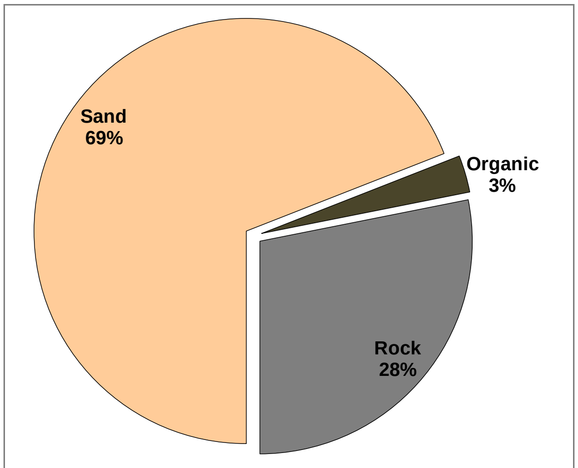



**Figure 3.4-1. Lake Metonga proportion of substrate types within littoral areas sampled with a pole.** Created using data from 2018 aquatic plant point-intercept survey.

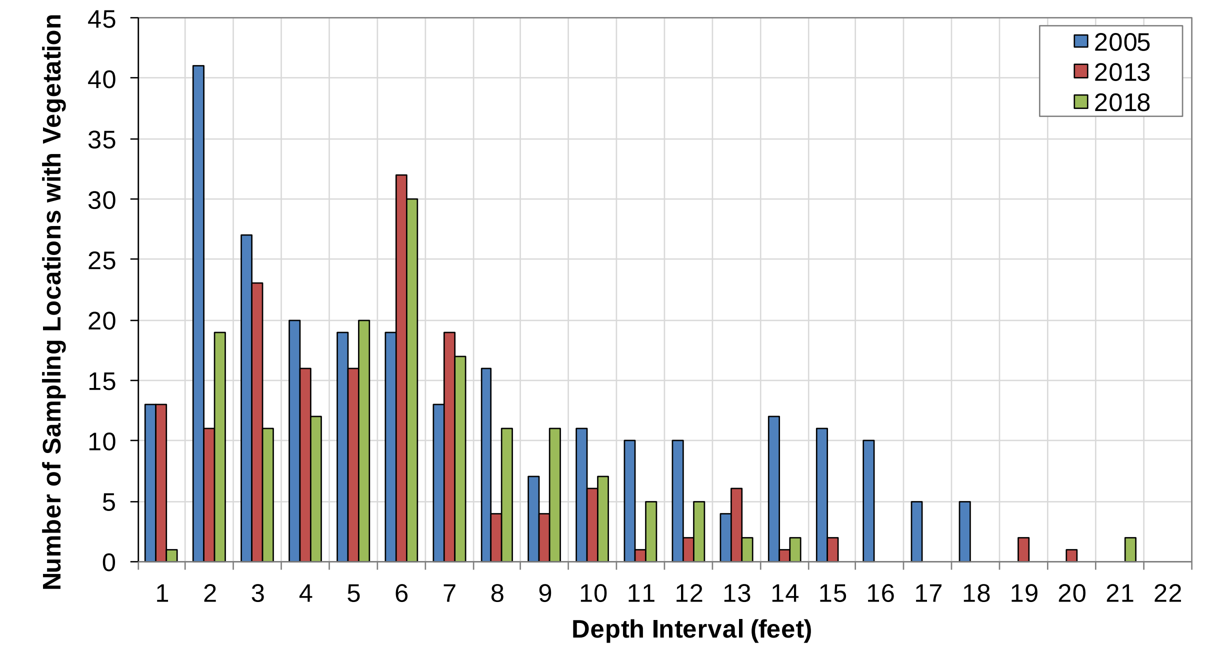



**Figure 3.4-2. Sampling locations containing aquatic vegetation in Lake Metonga.** Created using data from available point-intercept surveys.

Approximately 33% of the point-intercept sampling locations in 2018 that fell within the maximum depth of aquatic plant growth (21 feet), or the littoral zone, contained aquatic vegetation (Figure 3.4-3). The littoral frequency of aquatic vegetation was similar in 2013 (35%), but much greater in 2005 (57%).

Figure 3.4-3 also shows a semi-quantitative analysis of the abundance of aquatic plants through looking at total rake fullness ratings (i.e. how full of plants is the sampling rake at each location). Please note that this type of data was not differentiated during the 2005 survey. Aquatic plant rake-fullness data collected in 2013 and 2018 indicate that where vegetation is present, it is at low densities as most of the sampling locations contained a total rake fullness (TRF) rating of 1.

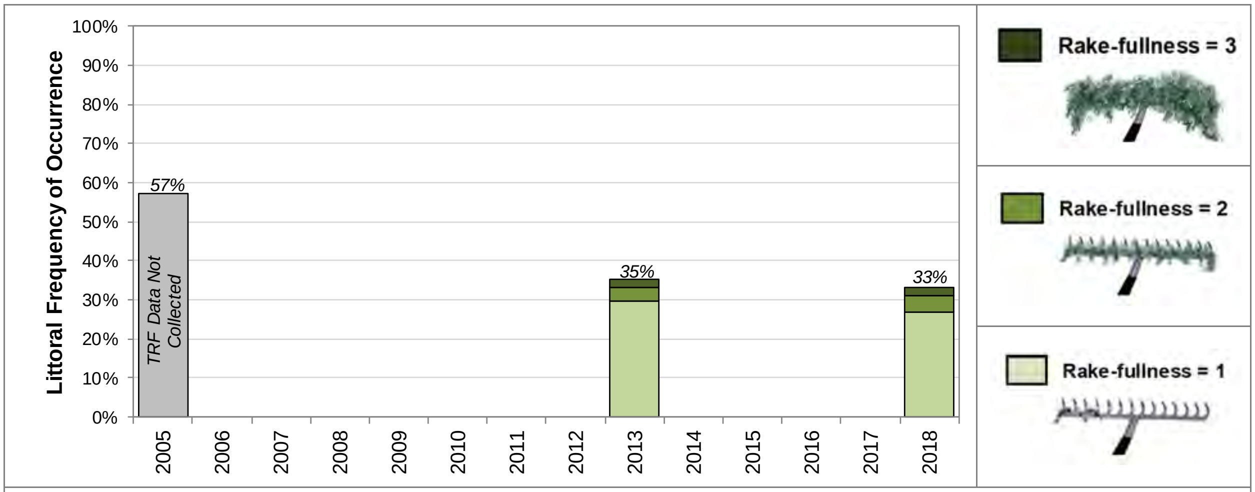



**Figure 3.4-3. Aquatic plant frequency of occurrence and total rake fullness (TRF) ratings in Lake Metonga point-intercept surveys.**

Figure 3.4-4 shows the percent of littoral sampling locations during each of the point-intercept surveys, along with the distribution of what percentage of sites contained either native plants, EWM, or both. These data indicate that the percent of the littoral zone containing native plants declined from 2005 to 2013 and 2013 to 2018.

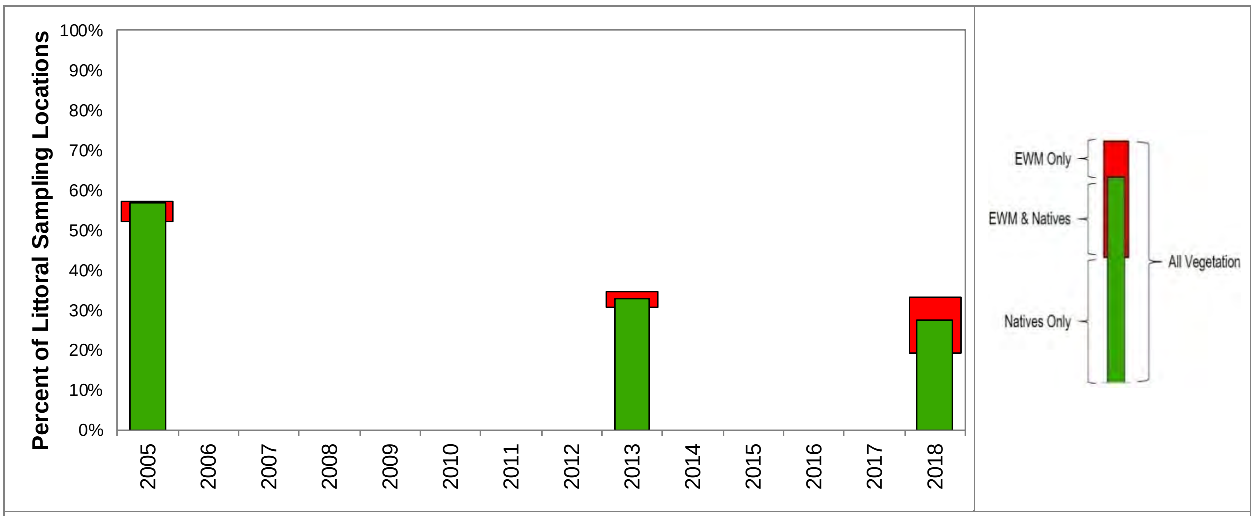



**Figure 3.4-4. Percent of sampling locations that contained either native plants or EWM from available point-intercept surveys.**

Figure 3.4-5 shows the spatial locations of the data presented in Figure 3.4-5. Native vegetation in 2005 was generically more expansive in a few areas of the lake, such as the eastern shore near the carry-in access and the deep shoal in the southwestern part of the lake (out from Farmer's Bay). During the 2018 point-intercept survey, EWM was most prevalent in waters 6-11 feet deep.

Aquatic plant populations are known to fluctuate over time in response to a number of factors including climactic conditions, water clarity, water levels, predation, and aquatic plant management activities (e.g. herbicide treatment). The Water Quality Section (3.1) indicated water clarity has increased over the time period where aquatic plant surveys are available, likely due to the impacts zebra mussels are having on the system. Clearer water typically means that aquatic plants will be able to grow out to deeper depths, which is not currently occurring on Lake Metonga.

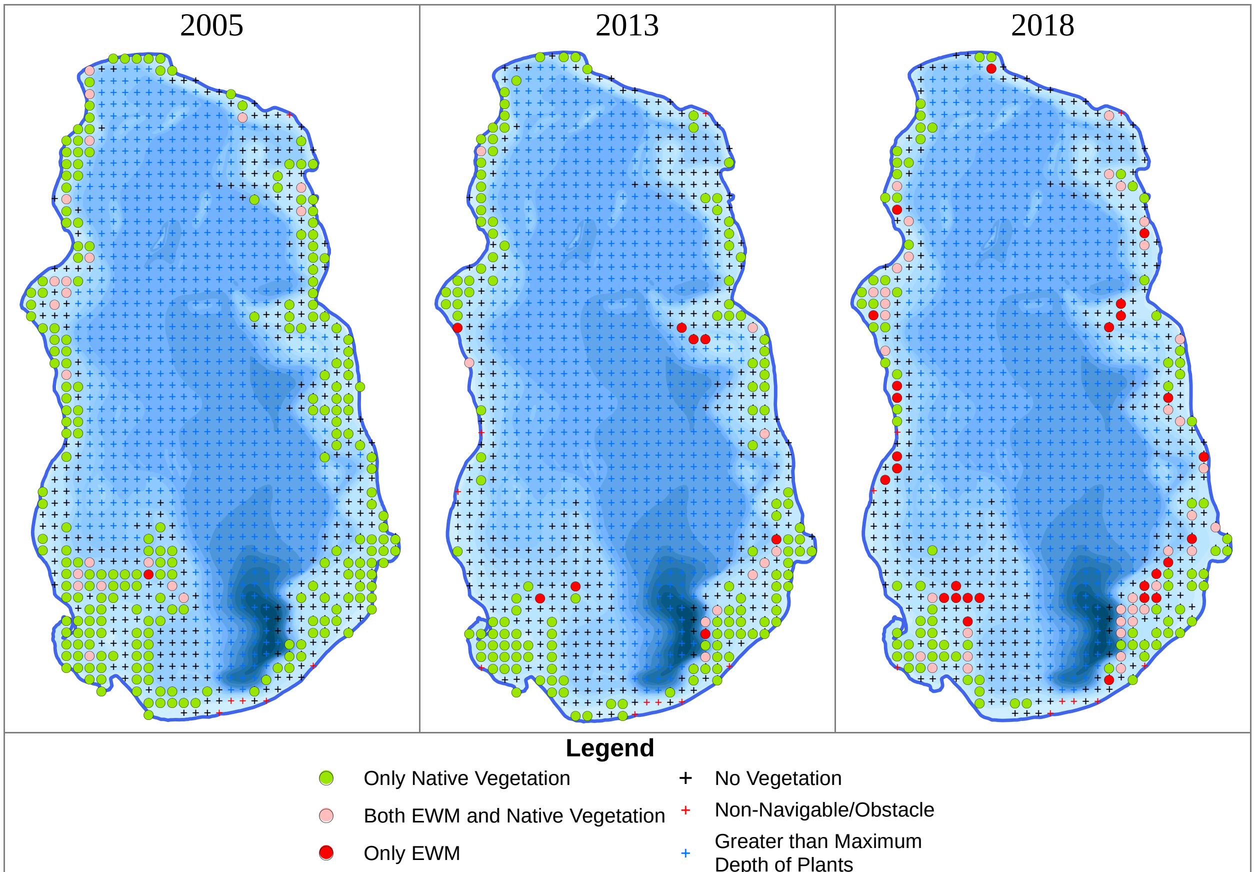



**Figure 3.4-5. Sampling locations that contained either native plants or EWM from available point-intercept surveys.**

Since 2008, the ice-out date on Lake Metonga has been recorded (Figure 3.4-6). As a large lake, the ice often goes off of Lake Metonga later than other area lakes. In years with a cold spring, the ice-out dates have been as late as the second week in May. The length of the growing season, as influenced by the ice-out conditions could impact the aquatic plant growth in the lake.

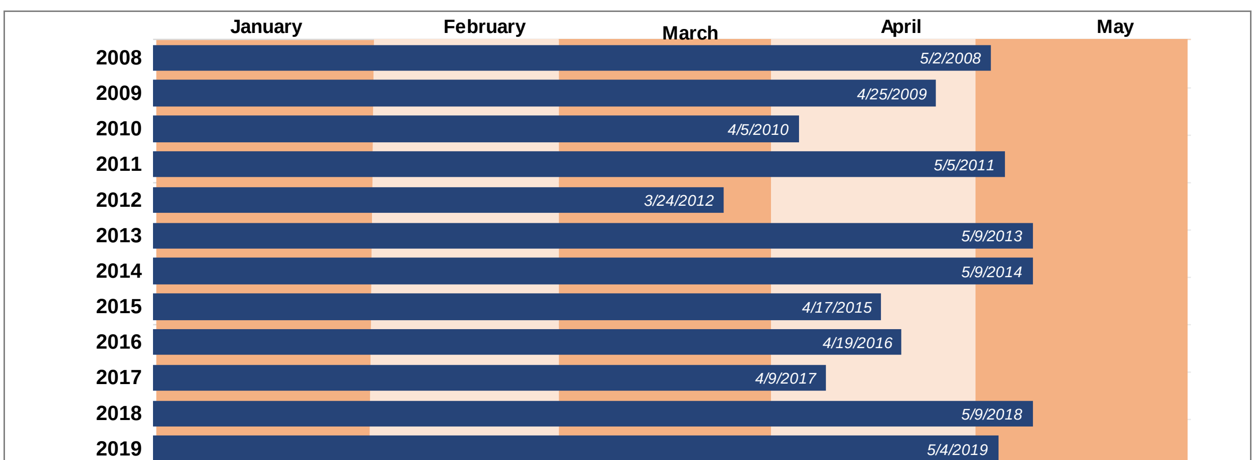



**Figure 3.4-6. Lake Metonga ice-out dates.** Data provided by the LMA.

Rusty crayfish (*Orconectes rusticus*) are originally from the Ohio River basin and are thought to have been transferred to Wisconsin through bait buckets. These crayfish displace native crayfish and reduce aquatic plant abundance and diversity. Rusty crayfish can be identified by their large, smooth claws, varying in color from grayish-green to reddish-brown, and sometimes visible rusty spots on the sides of their shell (Photograph 3.4-5). Because they are more aggressive than native crayfish, some fish that typically eat crayfish do not target rusty crayfish. Rusty crayfish have been present in Lake Metonga since the 1970s, with reports of almost complete decimation of the aquatic plant population in the 1970s and 1980s

Figure 3.4-7 displays the average number of rusty crayfish caught in a trap per day during annual late-summer standardized crayfish surveys on Lake Metonga from 2002-2013 that were provided by the Sokaogon Chippewa Community's fisheries biologist, Michael Preul. As illustrated, the population appeared to decline from 2002-2004 where it remained below 2.0 crayfish per trap per day (CPUE) through 2007. Starting in 2008, rusty crayfish populations increased and remained from 11 to 15 crayfish per trap day CPUE during 2010-2013. It is likely that the rusty crayfish population may have contributed to some level of decline in aquatic vegetation in Lake Metonga from 2005 to 2013. Crayfish populations declined sharply from 2013-2015, then rebounded just as quickly from 2015-2018.

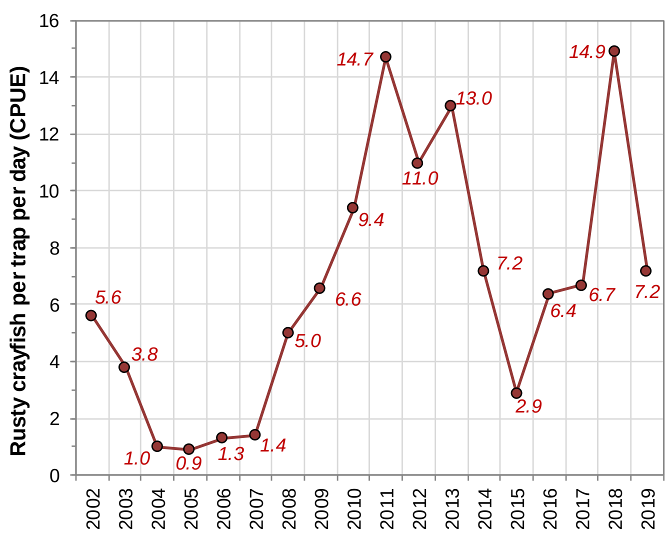



**Figure 3.4-7. Lake Metonga rusty crayfish catch per trap per day from 2002-2019.** Created using data provided by Sokaogon Chippewa Community.

**Photograph 3.4-5. Rusty crayfish.** Photo credit: GLIFWC

Since 2007, varying herbicides and herbicide application strategies have been employed each year on Lake Metonga in an attempt to suppress the EWM population within the lake. While short-term suppression was observed in many of the spot treatment sites over the years, EWM population rebound was observed occurring as soon as one year after treatment. This *seasonal control* did not meet lake managers' expectations and number of different herbicide treatment strategies have been attempted over this time period in an effort to provide longer-term control. Herbicide management activities can have collateral impacts to native plants within the spot treatment application areas, with plants having differing degrees of sensitivity to each herbicide and herbicide use-pattern. More discussions on EWM management will occur within the subsequent subsection.

Of the aquatic plant species located in Lake Metonga in 2018, 16 were encountered directly on the rake during the whole-lake point intercept survey (Figure 3.4-8). Wild celery and EWM were the mostly commonly encountered aquatic plants in Lake Metonga. Coontail, slender naiad, muskgrasses, and Illinois pondweed were the second-tier of most frequent species in the lake. Trend analysis of these native species will be discussed below, with the population of EWM being addressed with the Non-Native Aquatic Plant Sub-Section.

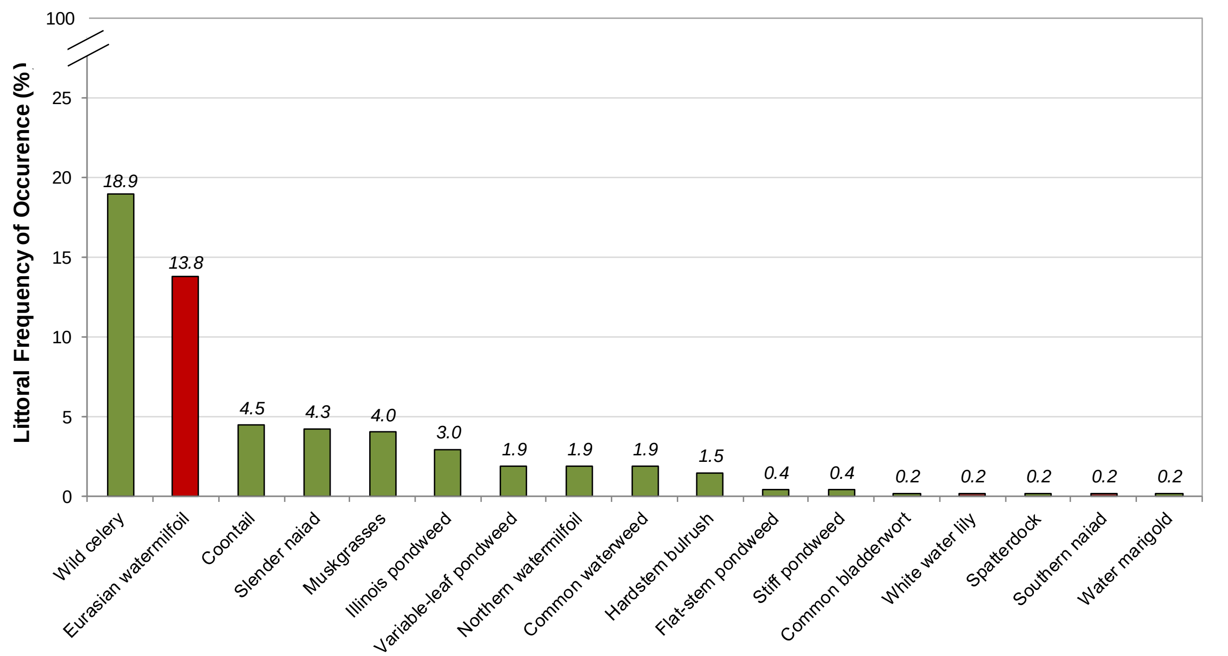



**Figure 3.4-8. Lake Metonga 2018 aquatic plant littoral frequency of occurrence.**

The most common native plant found in Lake Metonga during the 2018 point-intercept survey was wild celery. Wild celery was also the most abundant plant in Lake Metonga during 2013, but the fourth-most abundant plant in 2005. Wild celery produces long, grass-like leaves which extend in a circular fashion from a basal rosette (Photograph 3.4-6). To keep the leaves standing in the water column, lacunar cells in the leaves contain gas making them buoyant. Towards the late-summer when wild celery is at its peak growth stage, it is easily uprooted by wind and wave activity. It can then pile up on shorelines depending on the predominant wind direction. The leaves, fruits, and winter buds of wild celery are food sources for numerous species of waterfowl and other wildlife and are an important component of the Lake Metonga ecosystem. Wild celery has remained relatively stable between 2005 and 2013, but was found to have a statistically valid population increase in 2018 (Figure 3.4-9).

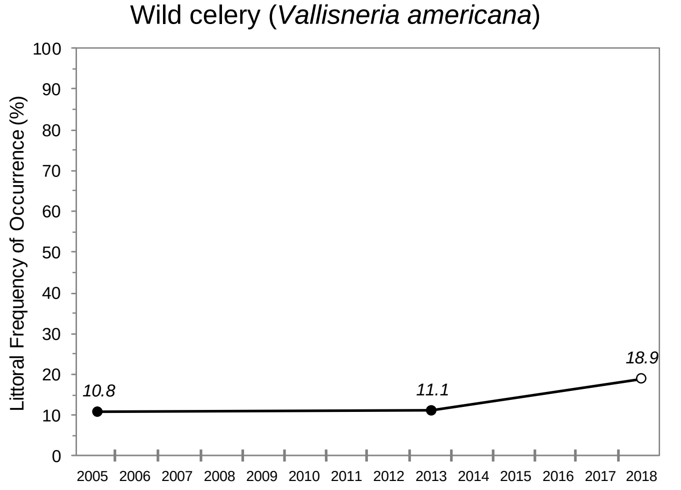



**Figure 3.4-9. Littoral frequency of occurrence of wild celery.** Open circle indicates a statistically valid change in occurrence from the previous survey (Chi-Square α = 0.05).

**Photograph 3.4-6. Wild celery (*Vallisneria americana*).** Photo credit Onterra.

Coontail was the third most common from Lake Metonga in 2018. Unlike most of the submersed plants found in Wisconsin, coontail does not produce true roots and is often found growing entangled amongst other aquatic plants or matted at the surface (Photograph 3.4-7). Because it lacks true roots, coontail derives all of its nutrients directly from the water (Gross et al. 2013). This ability in combination with a tolerance for low-light conditions allows coontail to become more abundant in productive waterbodies with higher nutrients and lower water clarity. Coontail provides many benefits to the aquatic community. Its dense whorls for leaves provide excellent structural habitat for aquatic invertebrates and fish, especially in winter as this plant remains green under the ice. In addition, it competes for nutrients that would otherwise be available for free-floating algae and helps to improve water clarity. Coontail populations in Lake Metonga have had statistically valid declines since 2005 (Figure 3.4-10).

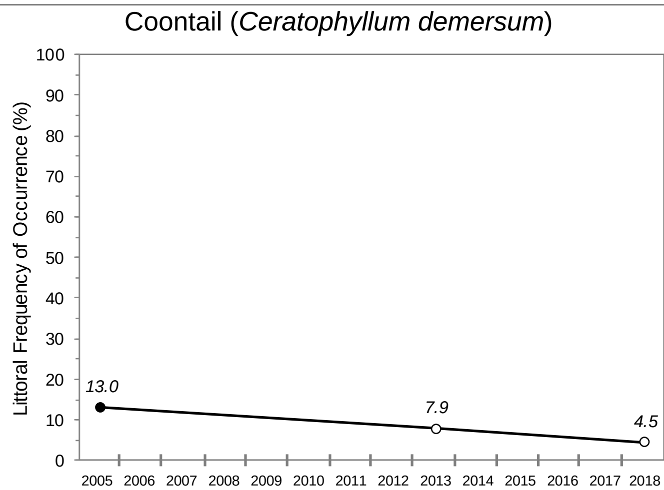



**Figure 3.4-10. Littoral frequency of occurrence of coontail.** Open circle indicates a statistically valid change in occurrence from the previous survey (Chi-Square α = 0.05).

**Photograph 3.4-7. Coontail (*Ceratophyllum demersum*).** Photo credit Onterra.

Like coontail, common waterweed obtains the majority of its nutrients directly from the water (Photograph 3.4-8). While common waterweed can be found growing in many of Wisconsin's waterbodies, excessive growth of common waterweed is often observed in waterbodies with higher nutrients. It can tolerate the low light conditions found in eutrophic systems better than many other aquatic plant species. For these reasons, common waterweed has competitive advantages over other aquatic plant species that favor its growth in productive systems. But on clear-water systems like Lake Metonga, it is unclear what factors drive this species' populations. In 2018, common waterweed was one of the most common aquatic plants in Lake Metonga. In 2018, the population of this species was reduced below 2% of littoral sampling locations (Figure 3.-11).

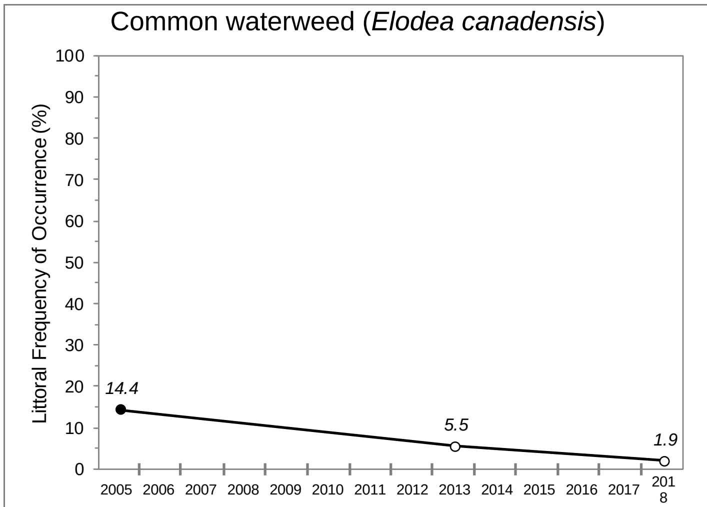



**Figure 3.4-11. Littoral frequency of occurrence of common waterweed.** Open circle indicates a statistically valid change in occurrence from the previous survey (Chi-Square α = 0.05).

**Photograph 3.4-8. Common waterweed (*Elodea canadensis*)** Photo credit: O**nterra**.

During the 2018 point-intercept survey, slender naiad was found at approximately 4.3% of littoral sampling locations and southern naiad was found at 0.2% of littoral sampling locations (Figure 3.4-12). On some lakes, these species can be difficult for some surveyors to differentiate in the field (Photograph 3.4-9). Slender naiad is an annual, reproducing from seed each year, while southern naiad is a perennial, growing out of the previous year's stems. Slender naiad prefers sandy sediments and can tolerate relatively shallow waters. During 2018, slender naiad was most prevalent from 4-7 feet in Lake Metonga. Onterra's experience is that slender naiad is particularly susceptible to whole-lake 2,4-D treatments but less impacted by 2,4-D spot treatments, such as those historically completed on Lake Metonga. Slender naiad populations decreased from 2005 to 2013, with some population rebound occurring in 2018 (Figure 3.4-12)

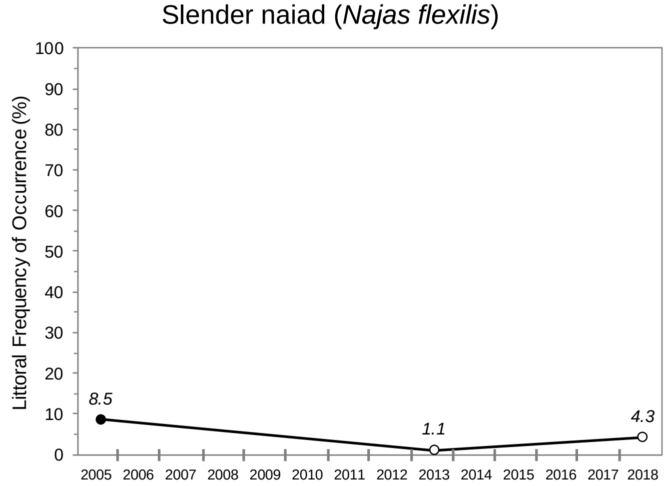



**Figure 3.4-12. Littoral frequency of occurrence of slender naiad.** Open circle represents a statistically valid change in occurrence from previous survey (Chi-square α = 0.05).

**Photograph 3.4-9. Slender naiad (Najas flexilis; left) and southern naiad (N. guadalupensis; right).** Photo credit Onterra.

Charophytes are a group of macro-algae comprised mainly of muskgrasses (Photograph 3.4-10) and stoneworts. Charophytes are almost universally resilient to most herbicide treatments, particularly with systemic herbicides like 2,4-D. As an alga, herbicides are not moved through (translocated) the tissue as the “plant” is made up of colonies of individual cells. Charophytes typically do better in systems with good water clarity. Their large beds help to stabilize bottom sediments. Studies have also shown that muskgrasses sequester phosphorous in the calcium carbonate incrustations which form on these plants, aiding in improving water quality by making the phosphorus unavailable to phytoplankton (Coops 2002). Populations of muskgrasses have declined from 11.7% of the littoral sampling locations in 2005 to 4.0% in 2018 (Figure 3.4-13).

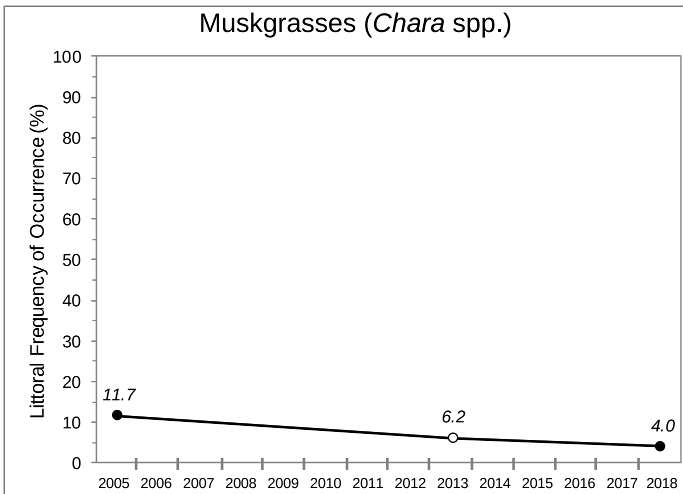



**Figure 3.4-13. Littoral frequency of occurrence of muskgrasses.** Open circle indicates a statistically valid change in occurrence from the previous survey (Chi-Square α = 0.05).

**Photograph 3.4-10. Aquatic macroalgae muskgrasses (*Chara* spp.).** Photo credit: Onterra.

One way to look at the aquatic plant community composition is through the relative frequency of occurrence analysis. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while wild celery had a littoral frequency of occurrence of 18.9% in 2018, its relatively frequency of occurrence was approximately 33% (Figure 3.4-14). Explained another way, if 100 plants were randomly sampled from Lake Metonga in 2018, 33 would be wild celery. Figure 3.4-14 illustrates that wild celery, coontail, and EWM comprised roughly 65% of the 2018 aquatic plant population of Lake Metonga. In 2005, these three species comprised less than 25% of the overall aquatic plant population of Lake Metonga. Less frequently encountered species are pooled under the "other species" category. In 2018, only 6% of the aquatic plant population of Lake Metonga was made up by these species.

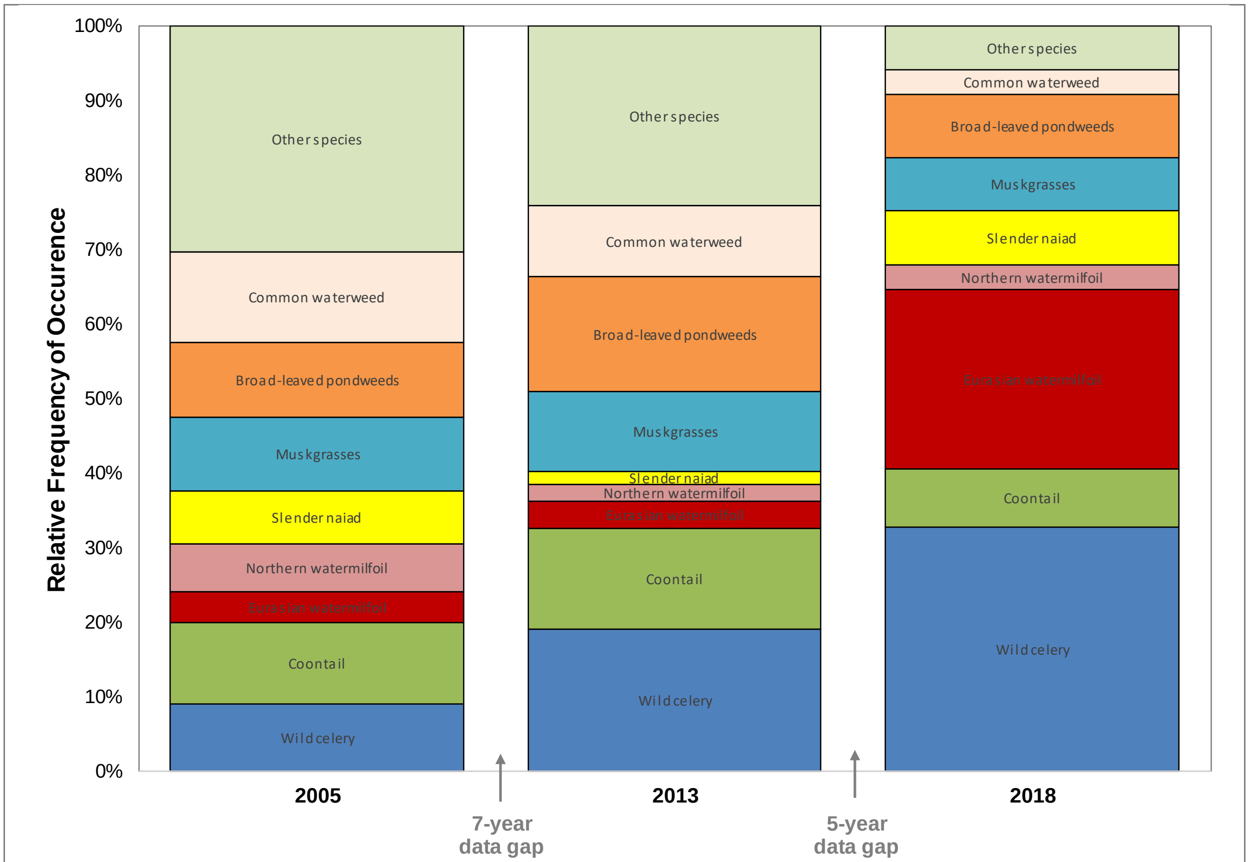



**Figure 3.4-14. Relative frequency of occurrence analysis of Lake Metonga.**

The Simpson's Diversity index is influenced by: 1) the number of species present in the lake and 2) how evenly the plant species are distributed within the community. The diversity metric of Lake Metonga in 2005 was above the upper quartile of other lakes in the Northern Forest Lakes ecoregion, meaning it was within the top 25% of lakes (Figure 3.4-15). As the distribution of aquatic plants became more lopsided and fewer aquatic plants were located in Lake Metonga, the 2018 diversity index has fallen below the 25th percentile of comparative lakes within this region.

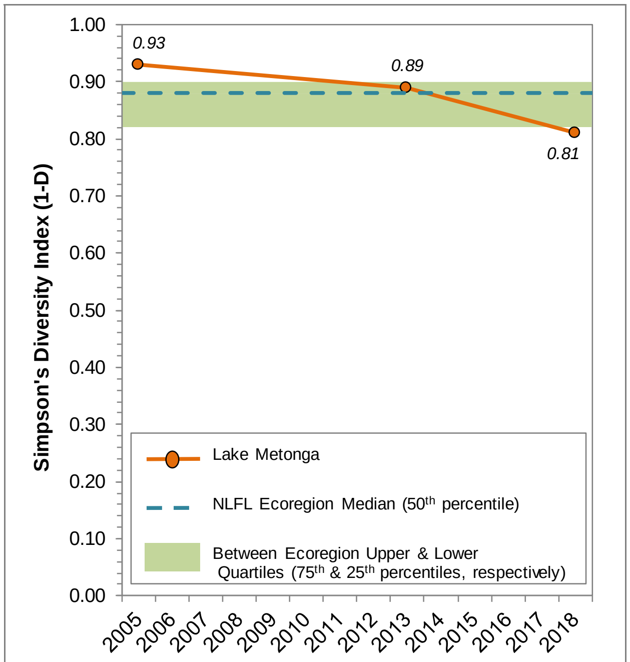



**Figure 3.4-15. Lake Metonga species diversity index.** Ecoregion data provided by WDNR Science Services.

As discussed in the primer section, the calculations used for the Floristic Quality Index (FQI) for a lake's aquatic plant community are based on the aquatic plant species that were encountered on the rake during the point-intercept survey and does not include incidental species. Lake Metonga contained 16 native plant species (richness) during 2008 compared to 28 in 2005. Lake Metonga's native aquatic plant species richness in 2005 and 2013 were above the median value for lakes within the Northern Lake and Forests (NLFL) ecoregion and for lakes throughout Wisconsin, whereas the 2018 richness was below these comparatives (Figure 3.4-16).

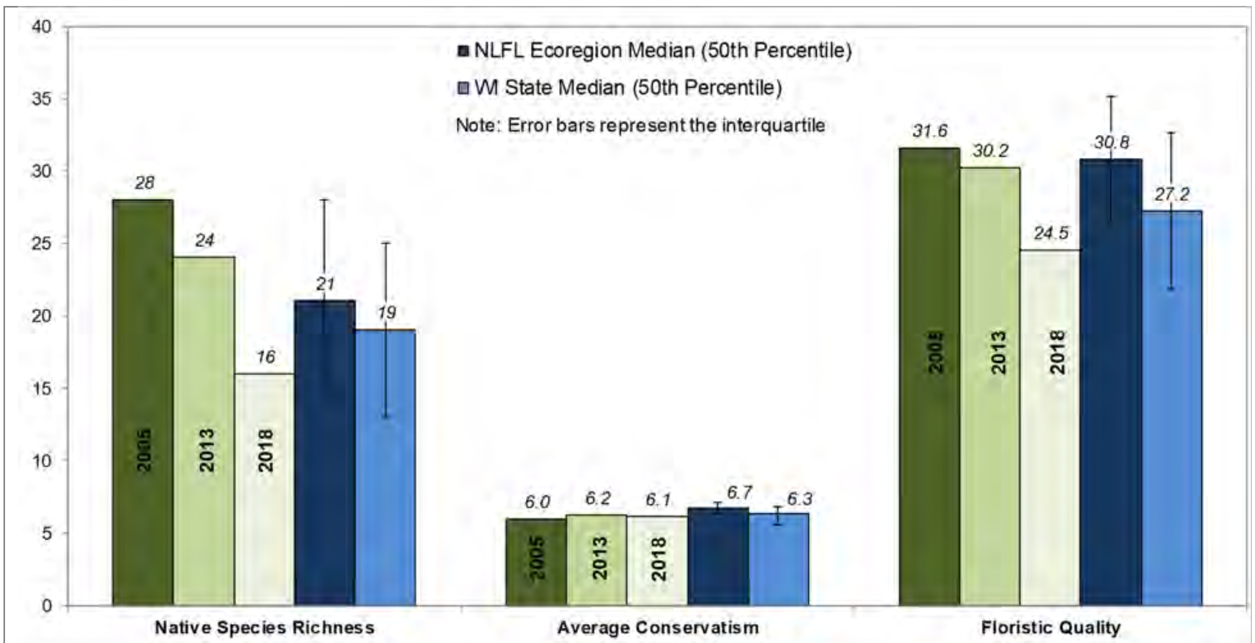



**Figure 3.4-16. Lake Metonga floristic quality analysis.** Created using data from 2005-2018 aquatic plant surveys.

The average conservatism values from the plant species present in Lake Metonga are indicative of species tolerant to disturbance. Plants with higher conservatism values, which are largely absent from Lake Metonga, are those sensitive to disturbance.

A limitation of the point-intercept method is the inability to use this technique to evaluate emergent and/or adjacent wetland areas due to the inability to navigate in these areas. These communities serve as a different, and sometimes preferred, type of habitat within a lake environment for mammals, birds, amphibians and fish. These communities are often impacted by recreational lake use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

The community map represents a 'snapshot' of the important emergent and floating-leaf plant communities, with periodic replication allowing an understanding of the dynamics of these communities within Lake Metonga. Mapping of emergent and floating-leaf communities took place in 2005, 2013, and 2018 by Onterra staff (Figure 3.4-17, Maps 5 & 6). As a whole, these communities remained relatively constant at 55-58 acres over the 13-year time period. A reduction in the colonized areas that contained floating-leaf species (e.g. water lilies) has reduced since 2018.

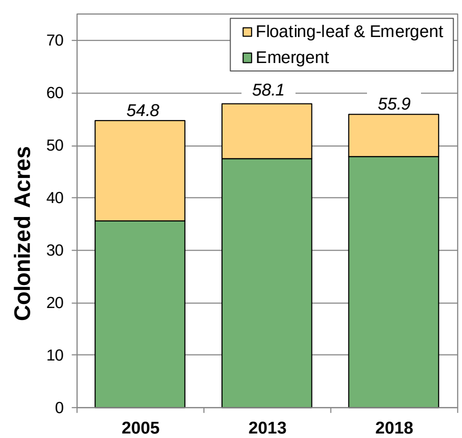



**Figure 3.4-17. Lake Metonga emergent and floating-leaf areal cover.** Created using data from 2005, 2013, and 2018 community mapping surveys.

**Photograph 3.4-11. Hardstem bulrush community on Lake Metonga.** Photo credit: Onterra**.**

Lake Metonga contains numerous hard-stem bulrush colonies (Photograph 3.4-11), which comprise almost the entirety of the colonized emergent vegetation in the lake (Figure 3.4-18). The cylindrical, olive-green stems grow out of rhizomes in firm sediments. Bulrush communities offer important habitat for invertebrates, young fish, nesting birds, and waterfowl. These communities have declined on my lakes and attempts to re-establish them often fail because the inhibiting factors, such as shoreland development, carp activity, competitiveness of invasive species, or high-speed boating continue to impact the area and prevent establishment of the newly installed emergent.

Some Lake Metonga riparians have expressed concerns over encroaching bulrush colonies within their recreational area. Evidence of unregulated herbicide treatment and installation of bottom barriers has been observed on Lake Metonga. Please note that both of these management activities require permitting through the WDNR. Evidence of benthic barriers and illegal herbicide treatments can be reported to the WDNR tip line anonymously at 1-800-847-9367 or reported electronically here: https://dnrx.wisconsin.gov/rav/.

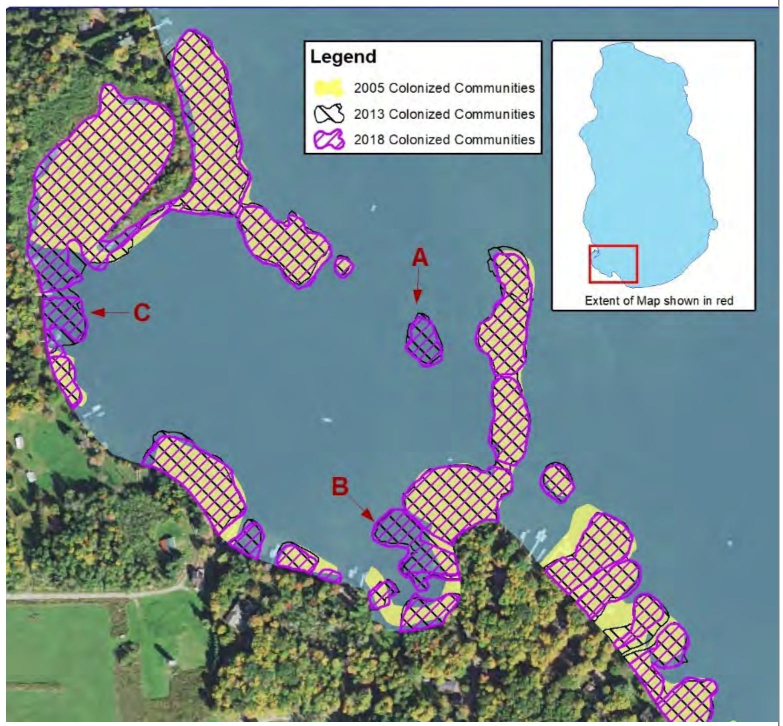



**Figure 3.4-18. Comparison of 2005, 2013, 2018 emergent and floating-leaf plant communities in Farmer's Bay.**

Overlaying the 2005, 2013, and 2018 community mapping surveys, there are no large-scale differences in the floating-leaf and emergent plant communities on Lake Metonga. Small increases in the coverage of emergent plant communities may be occurring in some nearshore areas. Within the southwestern bay, locally known as Farmer's Bay, a few areas of expansion were observed (Figure 3.4-18). Areas labeled A, B, and C did not contain colonized emergent or floating-leaf communities in 2005, but were present in 2013 and 2018.

## *Eurasian Watermilfoil Population in Lake Metonga*

Eurasian watermilfoil is an invasive species, native to Europe, Asia and North Africa, that has spread to most Wisconsin counties. Eurasian watermilfoil is unique in that its primary mode of propagation is not by seed. It actually spreads by shoot fragmentation, which has supported its transport between lakes via boats and other equipment. In addition to its propagation method, EWM has two other competitive advantages over native aquatic plants, 1) it starts growing very early in the spring when water temperatures are too cold for most native plants to grow, and 2) once its stems reach the water surface, it sometimes does not stop growing like most native plants, instead it continues to grow along the surface creating a canopy that blocks light from reaching native plants. Eurasian watermilfoil can create dense stands and dominate submergent communities, reducing important natural habitat for fish and other wildlife, and impeding recreational activities such as swimming, fishing, and boating. However, in some lakes, EWM appears to integrate itself within the community without becoming a nuisance or having a measurable impact to the ecological function of the lake.

*WDNR Long-Term EWM Trends Monitoring Research Project*

Starting in 2005, WDNR Science Services began conducting annual point-intercept aquatic plant surveys on a set of lakes to understand how EWM populations vary over time. This was in response to commonly held beliefs of the time that once EWM becomes established in a lake, its population would continue to increase over time. As outlined in *The Science Behind the "So-Called" Super Weed* (Nault 2016), EWM population dynamics on lakes are not that simplistic. Like other aquatic plants, EWM populations are dynamic and annual changes in EWM frequency of occurrence have been documented in many lakes, including those that are not being actively managed for EWM control (no herbicide treatment or hand-harvesting program). The data are most clear for unmanaged lakes in the Northern Lakes and Forests Ecoregion (Figure 3.4-19). The upper frame of Figure 3.4-19 shows the EWM littoral frequency of occurrence for these unmanaged systems by year, and the lower frame shows the same data based on the number years the survey was conducted following the year of initial detection of EWM listed on the WDNR website. During this study, six of the originally selected "unmanaged lakes" were moved into the "managed" category as the EWM populations were targeted for control by the local lake organization as populations increased.

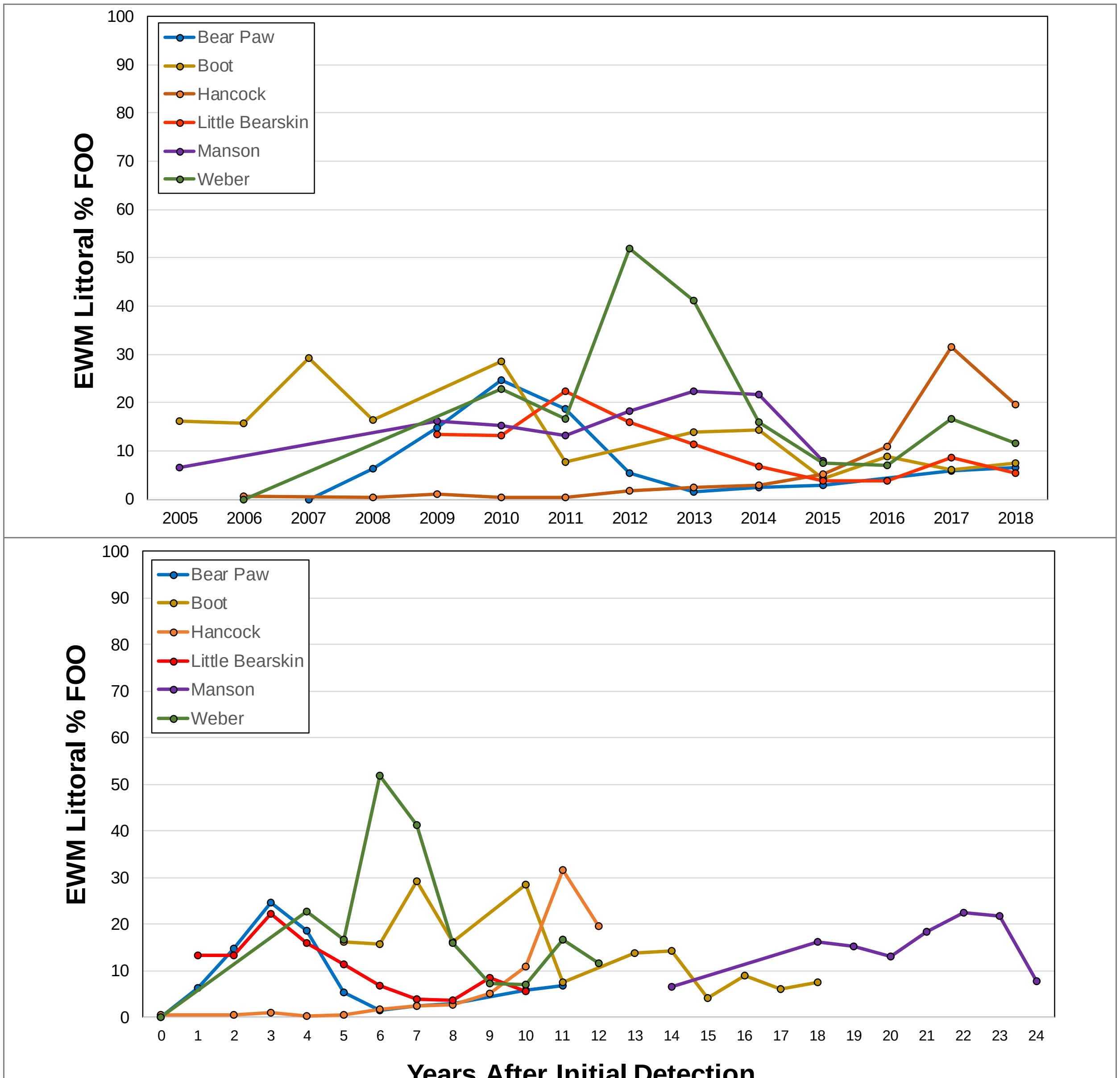



**Figure 3.4-19. Littoral frequency of occurrence of EWM in the Northern Lakes and Forests Ecoregion without management.** Data provided by and used with permission from WDNR.

The results of the study clearly indicate that EWM populations in unmanaged lakes can fluctuate greatly between years. Following initial infestation, EWM expansion was rapid on some lakes, but overall was variable and unpredictable (Nault 2016). On some lakes, the EWM populations reached a relatively stable equilibrium whereas other lakes had more moderate year-to-year variation. Regional climatic factors also seem to be a driver in EWM populations, as many EWM populations declined in 2015 even though the lakes were at vastly different points in time following initial detection within the lake.

### *Lake Metonga Historic EWM Management*

It is important to note that two types of surveys are discussed in the subsequent materials: 1) point-intercept surveys and 2) AIS mapping surveys. As discussed above, the point-intercept survey provides a standardized way to gain quantitative information about a lake's aquatic plant population. The survey methodology allows comparisons to be made over time on Lake Metonga, as shown on Figure 3.4-20. It also allows comparison to be made between lakes, as shown in Figure 3.4-19 when discussing the EWM Long-Term Trends Monitoring Project.

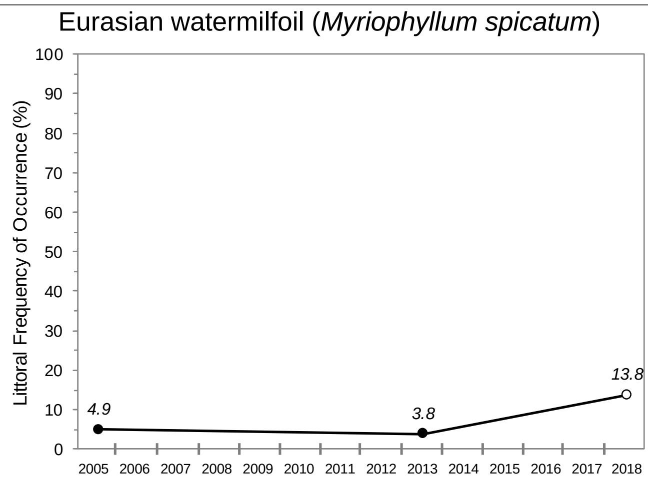



**Figure 3.4-20. Littoral frequency of occurrence of EWM from 2005-2018.** Open circle represents statistically valid change from previous survey.

**Photograph 3.4-12. EWM fragment with adventitious roots.** Photo credit Onterra.

While the point-intercept survey is a valuable tool to understand the overall plant population of a lake, it does not offer a full account (census) of where a particular species exists in the lake. During the AIS mapping surveys, the entire littoral area of the lake was surveyed through visual observations from the boat (Photograph 3.4-13). Field crews supplemented the visual survey by deploying a submersible camera along with periodically doing rake tows. The EWM population is mapped using sub-meter GPS technology by using either 1) point-based or 2) area-based methodologies. Large colonies >40 feet in diameter are mapped using polygons (areas) and were qualitatively attributed a density rating based upon a five-tiered scale from *highly scattered* to *surface matting*. Point-based

**Photograph 3.4-13. EWM mapping survey**. Photo credit Onterra.

techniques were applied to EWM locations that were considered as *small plant colonies* (<40 feet in diameter), *clumps of plants*, or *single or few plants*.

It is important to understand that during the point-intercept survey, the surveyor visits each predefined sampling location and samples the aquatic plants at that location with standardized rake sampler. It is common to see a particularly plant species, such as EWM, very near the sampling location but not yield it on the rake sampler. Particularly in low-density colonies such as those designated by Onterra as *highly scattered* and *scattered* (Map 7, right frame), large gaps between EWM plants may exist resulting in EWM not being present at a particularly pre-determined point-intercept sampling location in that area (Map 7, left frame). For reference, both the point-intercept survey and EWM mapping surveys occurred in 2018 on Lake Metonga and are shown on Map 7. Overall, each survey has its strengths and weaknesses, which is why both are utilized in different ways as part of this project.

Starting in 2007, late-season EWM mapping surveys commenced on Lake Metonga using a consistent density rating system (Figure 3.4-21). Please note that this figure only represents only the acreage of mapped EWM polygons, not EWM mapped within point-based methodologies (*Single or Few Plants, Clumps of Plants,* or *Small Plant Colonies*). Said another way, EWM marked with point-based mapping methods do not contribute to colonized acreage as shown on Figure 3.4-21.

First officially documented within the system in 1994, Eurasian water milfoil (EWM) has been actively managed by the Lake Metonga Association (LMA) to reduce its amount and density through 2,4-D chemical applications and biological control introductions since 1998.

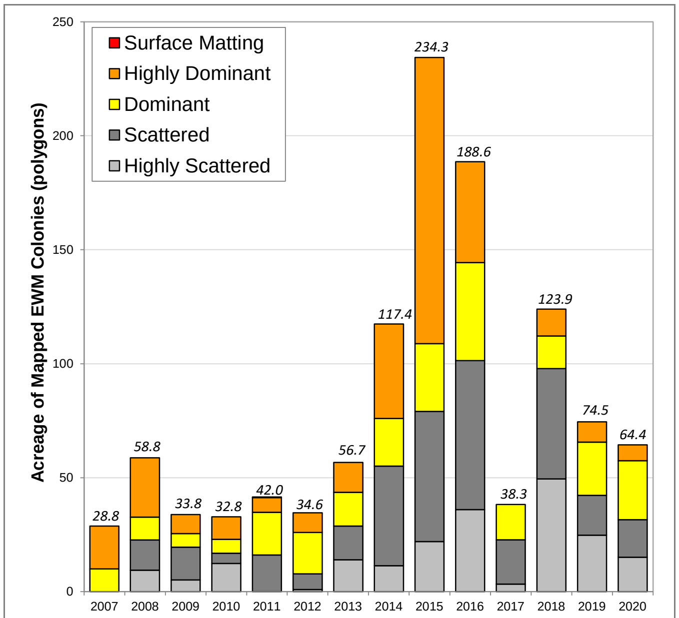



**Figure 3.4-21. Acreage of mapped EWM colonies on Lake Metonga from 2007 to 2020.** Data from Onterra Late-summer EWM mapping surveys.

The LMA attempted a biological control activity towards EWM in 2002 within Strawberry Bay by augmenting the native weevil populations (added 8,000) that preferentially feed on EWM plants. The LMA concluded that there was no documentation of EWM control on a site-wide basis. Furthermore, anecdotal reports from Les Schramm and members of the LMA state that there was no control of Eurasian water milfoil by the weevils. Recent research from the University of Wisconsin – Trout Lake Station on milfoil weevils has indicated that background populations of these native weevils in most lakes is quite high, with stocking efforts having an insignificant impact on fostering a population sufficient to impact EWM. Due to the lack of success of weevil stocking on this system, the program was discontinued.

The term *Best Management Practice (BMP)* is often used in environmental management fields to represent the management option that is currently supported by that latest science and policy. When used in an action plan, the term can be thought of as a placeholder with anticipation of having an evolving definition over time. During 2007 to 2013, the BMP for managing EWM was through 2,4-D spot treatments. Spot treatments are a type of control strategy where the herbicide is applied to a specific area (treatment site) such that when it dilutes from that area, its concentrations are insufficient to cause significant affects outside of that area. Spot treatments typically rely on a short exposure time to cause mortality as the herbicide dissipates out of the spots rapidly. Due to the size and shape of Lake Metonga, all previous herbicide applications have been spot treatments.

At the start of the timeframe, the LMA initiated granular 2,4-D spot treatments (Figure 3.4-22). Emerging research demonstrated that liquid treatments provided more consistent results at a fraction of the cost of granular products, which prompted the LMA to move towards liquid herbicides starting in 2010. However, some LMA members believed that the granular herbicides were more effective than the 2011-2012. This included granular treatment within Strawberry Bay, which provided multiple years of reduced EWM. With today's understanding, it is likely that this semi-protected bay held concentrations longer than exposed parts of the system which lead to more efficacious treatments.

A trial set of sites was targeted in spring 2013 with a granular combination of 2,4-D and triclopyr. EWM had rebounded to *highly dominant* densities within this site by the late-summer of 2013, falling well short of expectations.

From 2007 to 2013, EWM colonized acreage in Lake Metonga was between 30 acres and 60 acres. As discussed in the *Lake Metonga EWM Control & Prevention Project Final Report* (Jan 2014), "the EWM population of Lake Metonga is not being reduced over time." While short-term control was observed in many of the spot treatment sites over the years, EWM population rebound was observed occurring as soon as one year after treatment. This *seasonal control* did not meet lake managers' expectations and number of different herbicide treatment strategies have been attempted since 2007 in an effort to provide longer-term control (Figure 3.4-22).

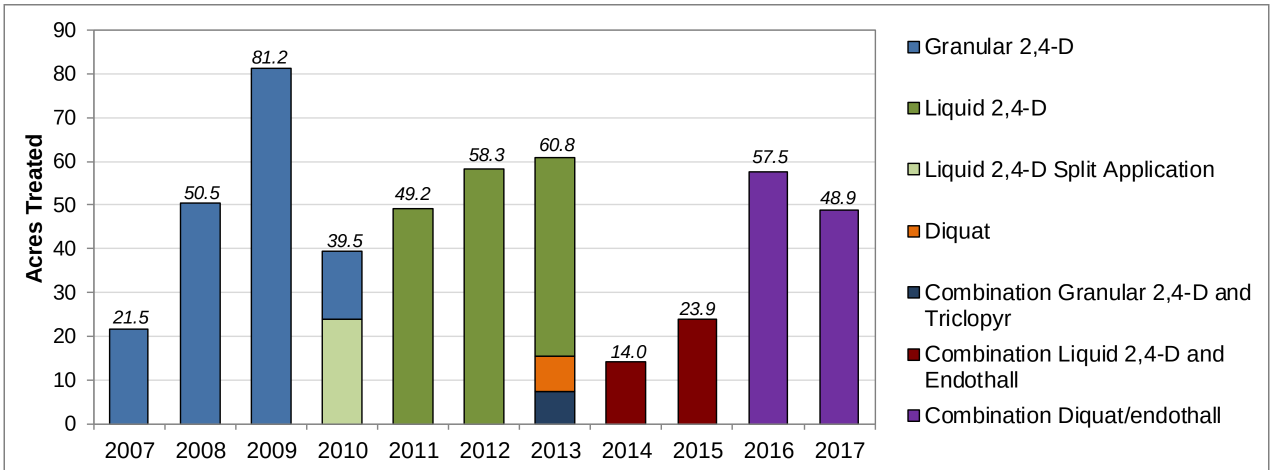



**Figure 3.4-22. Lake Metonga treatment history.** No herbicide treatments were conducted in 2018-2020

After numerous years of not achieving greater than season control on an EWM population in relatively deep water (10-15 ft) lakeward from Farmer's Bay, a strategy involving an herbicide with a shorter exposure time requirement, diquat, was used. Traditionally, the BMPs involved using a systemic herbicide such as 2,4-D. Based upon the published literature, spot treatments using 2,4-D need to sustain exposure for 24 hours. Diquat was suspected as only needing 4-6 hours of exposure time. During 2013 as part of the joint WDNR/USACE research project, this 8-acre spot treatment was monitored through the aid of a specialized dye (rhodamine WT) that was mixed with the herbicide and applied to the site. Two data collectors were placed within this treatment site and monitored the amount of dye that was present in the water at 10-minute increments. As shown in Figure 3.4-23, the dye was present at sufficient concentrations for 1-2 hours. This confirms that if 2,4-D or another weak acid auxin hormone was used on this site, the exposure time is far too short to kill the EWM plants. The EWM may be impacted in this area and hard to detect by the common lake user, but will simply grow back by the end of the season. Even a short-exposure herbicide such as diquat is suspected as requiring a longer exposure time than was achieved in this instance.

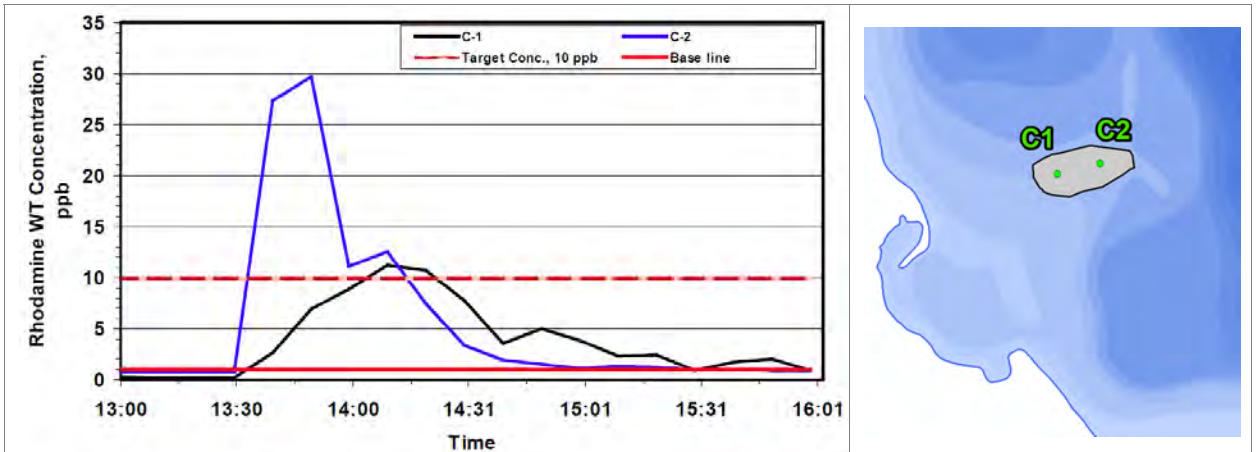



**Figure 3.4-23. 2013 Dye Treatment Results.**

A set of unsuccessful trial treatments occurred in 2013, followed by a lapse of funding in 2014 when a WDNR AIS-EPC Grant application was unsuccessful. Without state assistance, the LMA funded another trial treatment in 2014 using a combination of liquid 2,4-D and endothall. This treatment met short-term control goals but rebound occurred during the year following treatment. Additional combination 2,4-D/endothall herbicide treatments occurred on Lake Metonga in 2015, but also fell short of meeting expectations for longer-term control.

Numerous meetings, teleconferences, and email exchanges occurred between the LMA, Onterra, the WDNR Lakes Coordinator, the WDNR Fisheries Manager, and the Sokaogon Chippewa Community's fisheries biologist during the winter of 2015-2016. All entities understand the difficulties of conducting successful EWM management on Lake Metonga. The WDNR indicated their preference for a *Nuisance Control and Containment Strategy*, which would target EWM near the lake's public access and high-use areas with an herbicide strategy, but refrain from herbicide management in other areas of the lake. The LMA reluctantly agreed to implementing this strategy in 2016.

The 2016 strategy resulted in season EWM population suppression, with EWM being largely absent from these areas for much of the recreation season. However, EWM rebound occurred by the end of the season. The left frames of Figure 3.4-24 show the Late-season 2016 EWM within two areas that were targeted earlier that summer. The same herbicide strategy was implemented on these areas in spring of 2017, with additional attention paid to implementing the treatment when winds were as low as possible. Again, EWM was absent from the treatment areas during the recreational season following the treatment. For B-17 near the southern boat landing and County Park, multi-year EWM population suppression was achieved, with only low-density occurrences being observed in 2018 and 2019. Similar results were observed near the north boat landing and City Park, with population rebound only occurring in site E-17. Lake-wide EWM population reductions were observed from 2018 to 2019, which was also reflected in E-17 as EWM densities reduced during a period of no management.

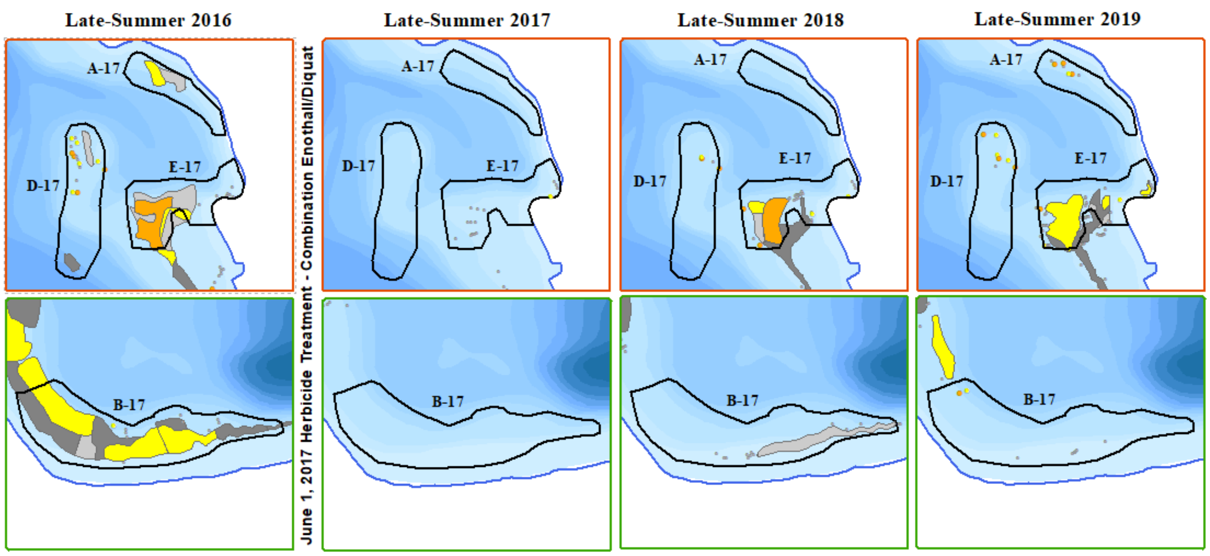



**Figure 3.4-24. 2017 Herbicide Treatment Results.** Late-Summer 2016 is pretreatment for June 2017 treatment. No additional herbicide management took place during this time period. See Map 7 for legend.

Large EWM population changes have been observed on Lake Metonga from 2016 to 2020, a period with only a limited herbicide treatment occurring in spring 2017. The EWM population in 2017 was near its lowest levels during this decade (Map 8). EWM population increases were observed in 2018, with decline again occurring in 2019. The EWM footprint has remained largely the same from 2019-2020 (Map 9), but the density reduced by a small amount. As discussed above, the WDNR Long-Term EWM Trends Monitoring Research Project revealed that EWM population fluctuations, and even reductions, have been documented on lakes that have not undergone active management (Figure 3.4-19).

### *Lake Metonga Future EWM Management Discussions*

During the Planning Committee meetings, Onterra outlined three broad EWM population management perspectives for consideration including a generic potential action plan for each (Figure 3.4-25). The LMA reviewed these potential EWM management goals, including the associated potential action plans for applicability on Lake Metonga. The following paragraphs provide brief overview of these extensive conversations. During these discussions, conversation regarding risk assessment of the various management actions were prominent. Onterra provided extracted relevant chapters from the WDNR's *APM Strategic Analysis Document* to serve as an objective baseline for the LMA to weigh the benefits of the management strategy with the collateral impacts each management action may have on the Lake Metonga ecosystem. These chapters are included as Appendix E. The LMA Planning Committee also reviewed these management perspectives in the context of perceived riparian stakeholder support, which is discussed in the subsequent sub-section.

1. **No Coordinated Active Management**
   **(Let Nature Take its Course)**
   - Focus on education of manual removal by property owners
2. **Reduce EWM Population on a lake-wide level**
   **(Lake-Wide Population Management)**
   - Would likely rely on herbicide treatment strategies (risk assessment)
   - Will not "eradicate" EWM
   - Set triggers (thresholds) of implementation and tolerance
3. **Minimize navigation and recreation impediment**
   **(Nuisance Control)**
   - May be accomplished through professional hand-harvesting of areas or lanes
   - Hand-harvesting may not be able to accomplish this goal and herbicides or a mechanical harvester may be required

**Figure 3.4-25. Potential EWM Management Perspectives**

**Let Nature Take its Course:** In some instances, the EWM population of a lake may plateau or reduce without conducting active management (Figure 3.4-19). Some lake groups decide to periodically monitor the EWM population, typically through a semi-annual point-intercept survey, but do not coordinate active management (e.g. hand-harvesting or herbicide treatments). This requires that the riparians tolerate the conditions caused by the EWM, acknowledging that some years may be problematic to recreation, navigation, and aesthetics. Individual riparians may choose to hand-remove the EWM within their recreational footprint, but the lake group would not assist financially or assist with securing permits. In some instances, the lake group may select this management goal, but also set an EWM population threshold or "trigger" where they would revisit their management strategy if the population reached that level.

**Lake-Wide Population Management:** Some believe that there is an intrinsic responsibility to correct for changes in the environment that are caused by humans. For lakes with EWM populations, that may be to manage the EWM population at a reduced level with the perceived goal to allow the lake to function as it had prior to EWM establishment. It must also be acknowledged that some lake managers and natural resource regulators question whether that is an achievable goal.

In early EWM populations, the entire population may be targeted through hand-harvesting or spot treatments. This is the strategy the LMA employed up until roughly 2012, when the lack of long-term control coupled with EWM population increases prompted the group to conduct some experimental trial treatments.

On more advanced or established populations, this may be accomplished through large-scale control efforts such as water-level drawdowns or whole-lake herbicide treatment strategies. If conducted properly, large-scale management can reduce EWM populations for several years, but will not eradicate it from the lake. Subsequent smaller scale management (e.g. hand-harvesting or spot treatments) is typically employed to slow the rebound of the population until another large-scale effort is likely required again. Typically, complete rebound of an EWM population following a large-scale control action is 4-6 years, with quicker rebound on some lakes and longer control observed on others. Large-scale control efforts, especially using herbicide treatments, can be impactful of some native plant species as well as carry a risk of environmental toxicity. Some argue that the impacts of the control actions may have greater negative impacts to the ecology of the system than if the EWM population was not managed.

Implementing whole-lake treatments on lakes that have similar morphology to Lake Metonga have proven difficult, with an increased risk of incorrect dosing. Therefore, this type of management many not be appropriate for Lake Metonga.

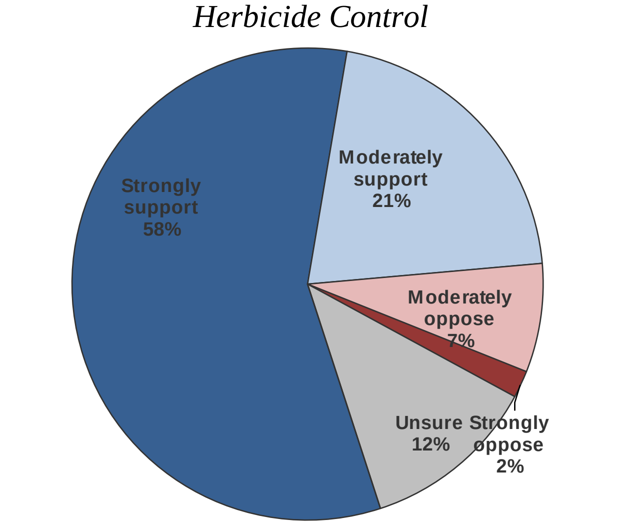
**Nuisance Control:** The concept of ecosystem services is that the natural world provides a multitude of services to humans, such as the production of food and water (provisioning), control of climate and disease (regulating), nutrient cycles and pollination (supporting), and spiritual and recreational benefits (cultural). Some lake groups acknowledge that the most pressing issues with the EWM population on their lake is the reduced recreation, navigation, and aesthetics compared to before EWM became established in their lake. Particularly on lakes with large EWM populations that may be impractical or unpopular to target on a lake-wide basis, the lake group would coordinate (secure permits and financially support the effort) a strategy to improve these cultural ecosystem services.

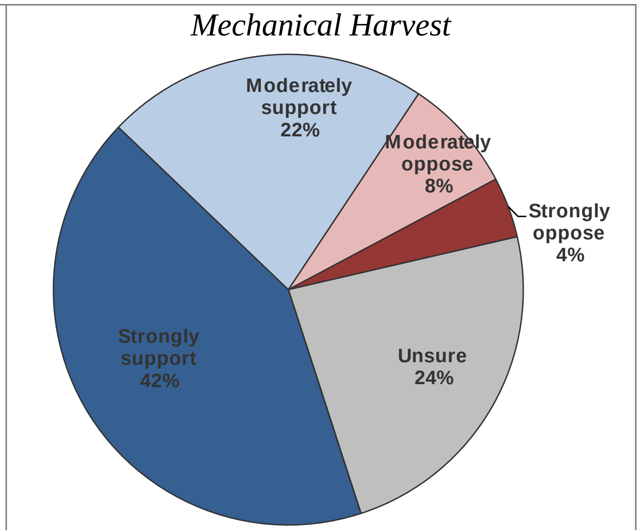
In order to reach this goal, a strategic network of common use lanes and riparian spokes through EWM colonies are maintained by either professional hand-harvesting or mechanical harvesting (i.e. weed cutting machine). On lakes with surface matted or near surface matted EWM in high navigation corridors, mechanical harvesting may be able to temporarily remove the top few feet of EWM of select areas whereas herbicide spot treatments may provide an entire season of nuisance relief. The *Nuisance Control and Containment Strategy* implemented in 2016 and 2017 fit this category of EWM management.

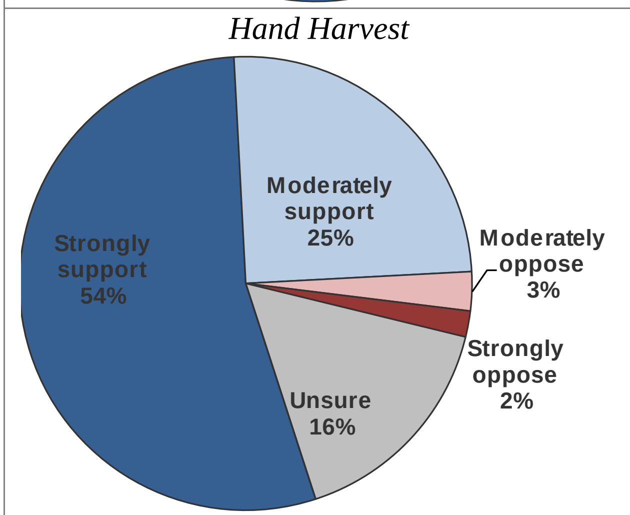
*Stakeholder Survey Responses to Aquatic Vegetation in Lake Metonga*

As discussed in section 2.0, the stakeholder survey asks many questions pertaining to perception of the lake and how it may have changed over the years. The return rate of the survey was 69%. In instances where stakeholder survey response rates are 60% or above, the results can be interpreted as being a statistical representation of the population. Therefore, the results of the stakeholder survey are reflective of the sentiments of the LMA members and Lake Metonga riparian property owners.

The planning committee wanted to understand the stakeholders' perceptions on the use of various active management techniques, therefore a series of questions were included within the stakeholder survey asking riparians *What is your level of support or opposition for future: herbicide use (#31), hand-harvesting by hired professionals (#32), mechanical harvesting (#33) to target EWM in Lake Metonga.* Figure 3.4-26 displays the results of this series of questions. Hand-harvesting and herbicide use had the highest level of support, with lower opposition to hand-harvesting compared to herbicide use. Mechanical harvesting had lower support, but still almost two-thirds of respondents being favorable to this management technique.




| | Herbicide Use | Mechanical Harvest | Hand Harvest |
|---|---|---|---|
| **Support** | 79% | 64% | 79% |
| **Oppose** | 9% | 12% | 5% |
| **Unsure** | 12% | 24% | 16% |

**Figure 3.4-26. Stakeholder survey response Question #31-33.** What is your level of support for the responsible use of the following techniques? Table pools *highly supportive and moderately supportive responses* for support and *not supportive and moderately un-supportive* for oppose.

As previously discussed, all management techniques carry risks which need to be discussed when determining a management strategy. Figure 3.4-27 captures the Lake Metonga stakeholder concerns of the three potential management actions. Stakeholders had the highest concern of herbicidal impacts including unknown impacts and impacts to plants, animals, and humans. Stakeholders had the least concern that herbicide use was too costly or ineffective.

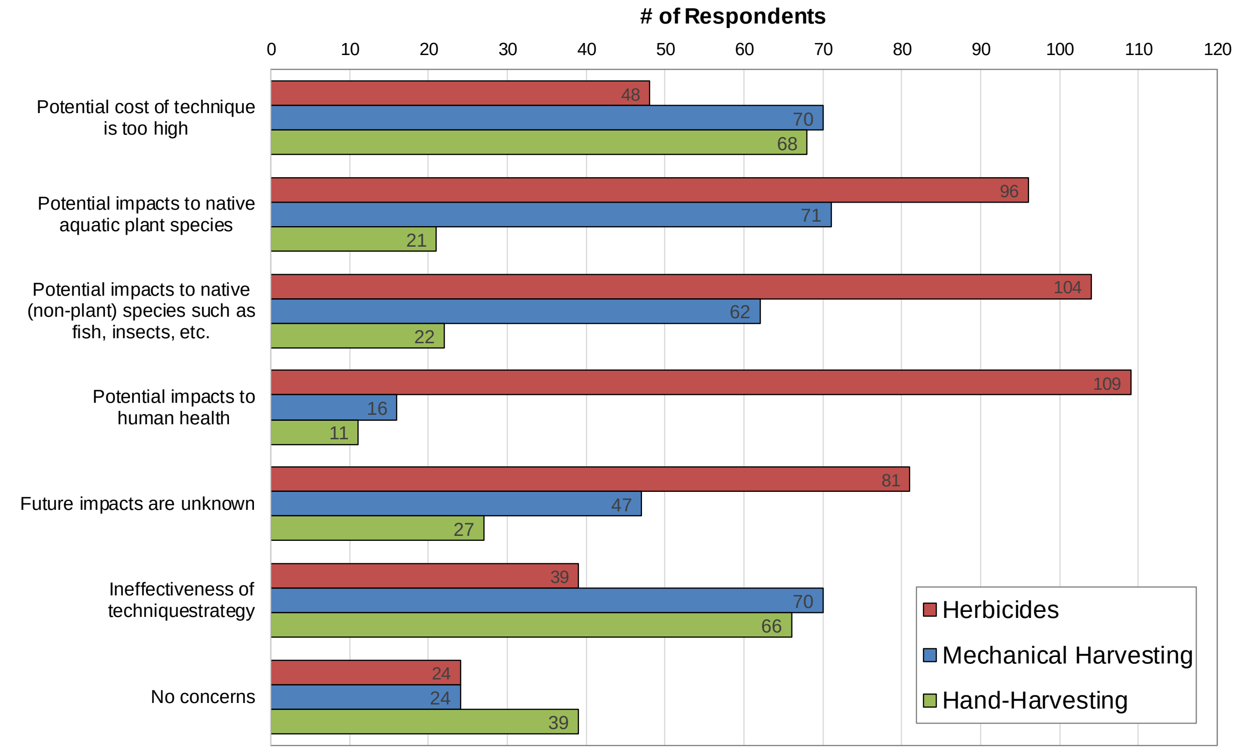



**Figure 3.4-27. Stakeholder survey response Question #34.** What concerns, if any, do you have for the future use of the following techniques?

## 3.5 Aquatic Invasive Species in Lake Metonga

As is discussed in section 2.0 Stakeholder Participation, the lake stakeholders were asked about aquatic invasive species (AIS) and their presence in Lake Metonga within the anonymous stakeholder survey. Onterra and the WDNR have confirmed that there are four AIS present (Table 3.5-1).

**Table 3.5-1. AIS present within Lake Metonga**

| Type | Common name | Scientific name | Location within the report |
|---|---|---|---|
| Plants | Eurasian watermilfoil | *Myriophyllum spicatum* | Section 3.4 – Aquatic Plants |
| Invertebrates | Zebra mussel | *Dreissena polymorpha* | Section 3.1 – Water Quality |
| | Rusty crayfish | *Orconectes rusticus* | Section 3.4 – Aquatic Plants |

Figure 3.5-1 displays the seven aquatic invasive species that Lake Metonga stakeholders believe are in Lake Metonga. Only the species present in Lake Metonga are discussed below or within their respective locations listed in Table 3.5-1. While it is important to recognize which species stakeholders believe to present within their lake, it is more important to share information on the species present and possible management options. More information on these invasive species or any other AIS can be found at the following links:

- http://dnr.wi.gov/topic/invasives/
- https://nas.er.usgs.gov/default.aspx
- https://www.epa.gov/greatlakes/invasive-species

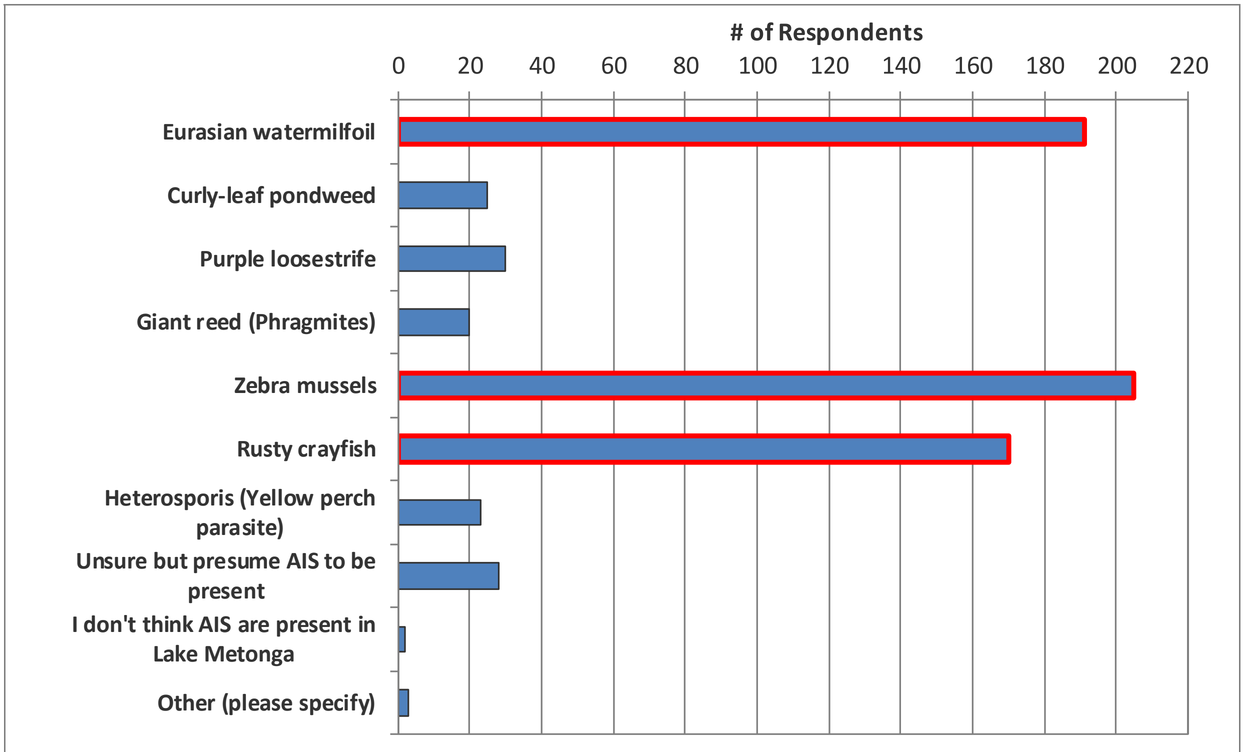



**Figure 3.5-1. Stakeholder survey response Question #28.** Which aquatic invasive species do you suspect are in Lake Metonga? Invasive species located in Lake Metonga are outlined in red.

## 3.6 Fisheries Data Integration

Fishery management is an important aspect in the comprehensive management of a lake ecosystem; therefore, a brief summary of available data is included here as a reference. The following section is not intended to be a comprehensive plan for the lake's fishery, as those aspects are currently being conducted by the fisheries biologists overseeing Lake Metonga. The goal of this section is to provide an overview of some of the data that exists. Although current fish data were not collected as a part of this project, the following information was compiled based upon data available from the Wisconsin Department of Natural Resources (WDNR) the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and personal communications with DNR Fisheries Biologist Greg Matzke (WDNR 2019 & GLIFWC 2018).

### *Lake Metonga Fishery*

#### Energy Flow of a Fishery

When examining the fishery of a lake, it is important to remember what drives that fishery, or what is responsible for determining its mass and composition. The gamefish in Lake Metonga are supported by an underlying food chain. At the bottom of this food chain are the elements that fuel algae and plant growth – nutrients such as phosphorus and nitrogen, and sunlight. The next tier in the food chain belongs to zooplankton, which are tiny crustaceans that feed upon algae and plants, and insects. Smaller fish called planktivores feed upon zooplankton and insects, and in turn become food for larger fish species. The species at the top of the food chain are called piscivores, and are the larger gamefish that are often sought after by anglers, such as bass and walleye.

A concept called energy flow describes how the biomass of piscivores is determined within a lake. Because algae and plant matter are generally small in energy content, it takes an incredible amount of this food type to support a sufficient biomass of zooplankton and insects. In turn, it takes a large biomass of zooplankton and insects to support planktivorous fish species. And finally, there must be a large planktivorous fish community to support a modest piscivorous fish community. Studies have shown that in natural ecosystems, it is largely the amount of primary productivity (algae and plant matter) that drives the rest of the producers and consumers in the aquatic food chain. This relationship is illustrated in Figure 3.6-1.

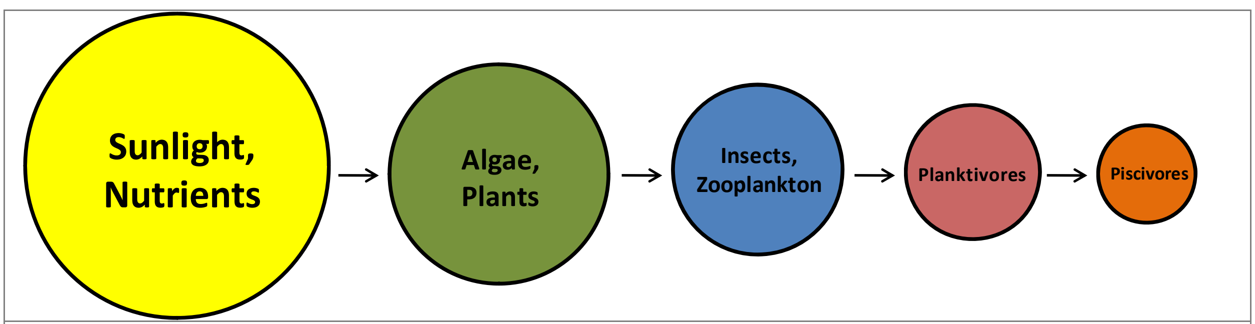



**Figure 3.6-1. Aquatic food chain.** Adapted from Carpenter et. al 1985.

As discussed in the Water Quality section, Lake Metonga is a mesotrophic system, meaning it has a moderate amount of nutrients and thus a moderate amount of primary productivity. This is relative to an oligotrophic system, which contains fewer nutrients (less productive) and a eutrophic system, which contains more nutrients (more productive). Simply put, this means Lake Metonga should be able to support an appropriately sized population of predatory fish (piscivores) when compared to eutrophic or oligotrophic systems. Table 3.6-1 shows the popular game fish present in the system. Although not an exhaustive list of fish species in the lake, additional species documented in past surveys of Lake Metonga include white sucker (*Catostomus commersonii*) and the golden shiner (*Notemigonus crysoleucas*).

**Table 3.6-1. Gamefish present in Lake Metonga with corresponding biological information.** (Becker, 1983).

| Common Name (*Scientific Name*) | Max Age (yrs) | Spawning Period | Spawning Habitat | Food Source |
|---|---|---|---|---|
| Black Bullhead (*Ameiurus melas*) | 5 | April - June | Matted vegetation, woody debris, overhanging banks | Amphipods, insect larvae and adults, fish, detritus, algae |
| Black Crappie (*Pomoxis nigromaculatus*) | 7 | May - June | Near *Chara* or other vegetation, over sand or fine gravel | Fish, cladocera, insect larvae, other invertebrates |
| Bluegill (*Lepomis macrochirus*) | 11 | Late May - Early August | Shallow water with sand or gravel bottom | Fish, crayfish, aquatic insects and other invertebrates |
| Brook Trout (*Salvelinus fontinalis*) | 6 | October - December | Streams or spring-fed tributaries, gravel bottom | Aquatic insects, terrestrial insects, crustaceans, fish and |
| Largemouth Bass (*Micropterus salmoides*) | 13 | Late April - Early July | Shallow, quiet bays with emergent vegetation | Fish, amphipods, algae, crayfish and other invertebrates |
| Northern Pike (*Esox lucius*) | 25 | Late March - Early April | Shallow, flooded marshes with emergent vegetation with fine leaves | Fish including other pike, crayfish, small mammals, water fowl, frogs |
| Pumpkinseed (*Lepomis gibbosus*) | 12 | Early May - August | Shallow warm bays 0.3 - 0.8 m, with sand or gravel bottom | Crustaceans, rotifers, mollusks, flatworms, insect larvae (terrestrial and aquatic) |
| Rock Bass (*Ambloplites rupestris*) | 13 | Late May - Early June | Bottom of course sand or gravel, 1 cm - 1 m deep | Crustaceans, insect larvae, and other invertebrates |
| Smallmouth Bass (*Micropterus dolomieu*) | 13 | Mid May - June | Nests more common on north and west shorelines over gravel | Small fish including other bass, crayfish, insects (aquatic and terrestrial) |
| Walleye (*Sander vitreus*) | 18 | Mid April - Early May | Rocky, wavewashed shallows, inlet streams on gravel bottoms | Fish, fly and other insect larvae, crayfish |
| Yellow Bullhead (*Ameiurus natalis*) | 7 | May - July | Heavy weeded banks, beneath logs or tree roots | Crustaceans, insect larvae, small fish, some algae |
| Yellow Perch (*Perca flavescens*) | 13 | April - Early May | Sheltered areas, emergent and submergent veg | Small fish, aquatic invertebrates |

## Survey Methods

In order to keep the fishery of a lake healthy and stable, fisheries biologists must assess the current fish populations and trends. To begin this process, the correct sampling technique(s) must be selected to efficiently capture the desired fish species. A commonly used passive trap is a fyke net (Photograph 3.6-1). Fish swimming towards this net along the shore or bottom will encounter the lead of the net, be diverted into the trap and through a series of funnels which direct the fish further into the net. Once reaching the end, the fisheries technicians can open the net, record biological characteristics, mark (usually with a fin clip), and then release the captured fish.

The other commonly used sampling method is electrofishing (Photograph 3.6-1). This is done, often at night, by using a specialized boat fit with a generator and two electrodes installed on the front touching the water. Once a fish comes in contact with the electrical current produced, the fish involuntarily swims toward the electrodes. When the fish is in the vicinity of the electrodes, they become stunned making them easier to net and place into a livewell to recover. Contrary to what some may believe, electrofishing does not kill the fish and after being placed in the livewell fish generally recover within minutes. As with a fyke net survey, biological characteristics are recorded and any fish that has a mark (considered a recapture from the earlier fyke net survey) are also documented before the fish is released.

The mark-recapture data collected between these two surveys is placed into a statistical model to calculate the population estimate of a fish species. Fisheries biologists can then use this data to make recommendations and informed decisions on managing the future of the fishery.

**Photograph 3.6-1. Fyke net positioned in the littoral zone of a Wisconsin Lake (left) and an electroshocking boat (right).**

## Fish Stocking

**Photograph 3.6-2. Fingerling Walleye.**

To assist in meeting fisheries management goals, the WDNR may permit the stocking of fingerling or adult fish in a waterbody that were raised in permitted hatcheries (Photograph 3.6-2). Stocking a lake may be done to assist the population of a species due to a lack of natural reproduction in the system, or to otherwise enhance angling opportunities. Lake Metonga was historically stocked as early as 1937 with black crappie, bluegill, largemouth bass, pumpkinseed, walleye, northern pike and yellow perch. Recently (1991 to 2012) Lake Metonga has been stocked with walleye (Table 3.6-2). Stocking efforts by the WDNR discontinued after 2012 because natural reproduction was occurring at high enough levels after the bullhead harvesting. Future WDNR surveys will evaluate if natural reproduction is still providing a sufficient population.

**Table 3.6-2. Stocking data available for walleye in Lake Metonga (1991-2012).** Lake Metonga Association/Mole Lake Tribe (LMA/MLT)

| Year | Species | Age Class | Organization | # Fish Stocked | Avg Fish Length (in) |
|---|---|---|---|---|---|
| 1991 | Walleye | Fingerling | WDNR | 55,135 | 2.85 |
| 1992 | Walleye | Fingerling | WDNR | 55,448 | 2 |
| 1994 | Walleye | Fingerling | WDNR | 105,098 | 2 |
| 1997 | Walleye | Small Fingerling | WDNR | 100,000 | 1.7 |
| 2000 | Walleye | Small Fingerling | WDNR | 198,447 | 2.15 |
| 2002 | Walleye | Small Fingerling | WDNR | 107,850 | 1.3 |
| 2004 | Walleye | Small Fingerling | WDNR | 107,850 | 1.45 |
| 2006 | Walleye | Small Fingerling | WDNR | 44,565 | 1.45 |
| 2007 | Walleye | Fingerling | LMA/MLT | 10,000 | - |
| 2008 | Walleye | Small Fingerling | WDNR | 78,988 | 1.6 |
| 2008 | Walleye | Fingerling | LMA/MLT | 10,000 | - |
| 2009, 2010, 2012 | Walleye | Fry | LMA/MLT | 8.5 million | - |
| 2010 | Walleye | Small Fingerling | WDNR | 75,495 | 1.4 |
| 2012 | Walleye | Small Fingerling | WDNR | 75,495 | 1.6 |

## Fishing Activity

Based on data collected from the stakeholder survey (Appendix B), fishing was the second important reason for owning property on or near Lake Metonga (Question #10), relaxing/entertaining was the first most important reason. Figure 3.6-2 displays the fish that Lake Metonga stakeholders enjoy catching the most, with yellow perch and walleye being the most popular. Approximately 80% of these same respondents believed that the quality of fishing on the lake was either good or fair (Figure 3.6-3). Approximately 70% of landowners who fish Lake Metonga believe the quality of fishing has remained the same or gotten worse (Figure 3.6-4).

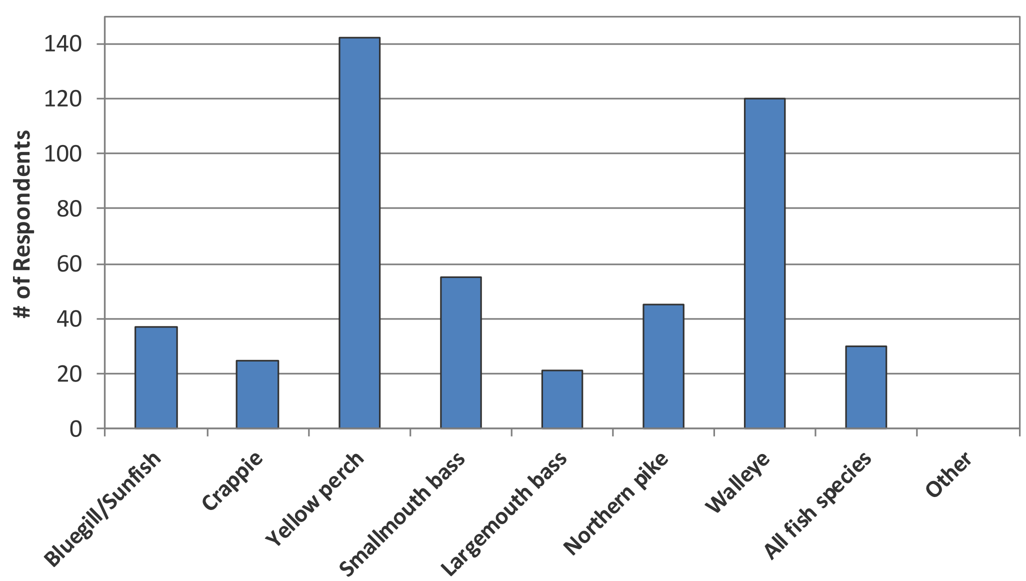



**Figure 3.6-2. Stakeholder survey response Question #12.** What species of fish do you like to catch on Lake Metonga?

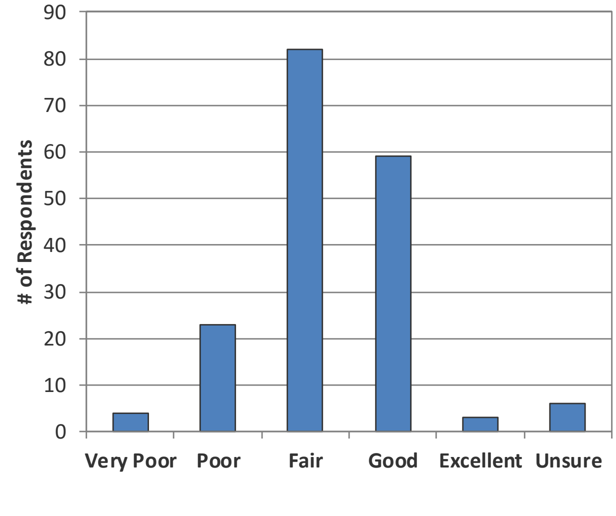



**Figure 3.6-3. Stakeholder survey response Question #13.** How would you describe the current quality of fishing on Lake Metonga?

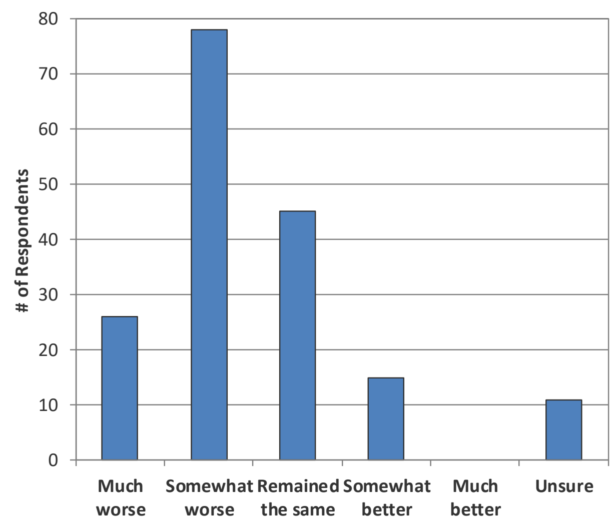



**Figure 3.6-4. Stakeholder survey response Question #14.** How has the quality of fishing changed on Lake Metonga since you started fishing the lake?

The WDNR measures sport fishing harvest by conducting creel surveys. A Creel Survey Clerk will count the number of anglers present on a lake and interview anglers who have completed fishing for the day. Data collected from the interviews include targeted fish species, harvest, lengths of harvested fish and hours of fishing effort. Creel clerks will work on randomly-selected days and shifts to achieve a randomized census of the fish being harvested. A creel survey was completed on Lake Metonga during the 2004-05, 2007-08, 2010-11, 2013-14 and 2016-17 fishing seasons (Table 3.6-3).

Total angler directed effort was highest in 2010-11 (37 hours/acre). Anglers directed the largest amount of effort towards yellow perch and walleye during all seasons (Table 3.6-3).

**Table 3.6-3. Creel Survey from 2004-05, 2007-08, 2010-11, 2013-14, and 2016-17 fishing seasons.**

| Species | Year | Directed Effort (Hours) | Percent of Total | Total Catch | Specific catch rate (Hours/Fish)* | Total Harvest | Specific harvest Rate (Hours/Fish)* | Mean length of harvested fish |
|---|---|---|---|---|---|---|---|---|
| Walleye | 2016-17 | 10389 | 20.9% | 2284 | 5 | 678 | 15.8 | 18.3 |
| | 2013-14 | 5715 | 17.5% | 3228 | 4.4 | 231 | 26.7 | 19.5 |
| | 2010-11 | 10172 | 13.3% | 3894 | 4.4 | 647 | 16.6 | 18.4 |
| | 2007-08 | 13816 | 24.2% | 1615 | 8.9 | 444 | 31.3 | 17.0 |
| | 2004-05 | 14388 | 32.6% | 2792 | 6.3 | 370 | 41.7 | 17.6 |
| Yellow Perch | 2016-17 | 28863 | 58.1% | 48498 | 0.6 | 18556 | 1.6 | 9.1 |
| | 2013-14 | 22344 | 68.3% | 45302 | 0.5 | 14306 | 1.6 | 9.5 |
| | 2010-11 | 58445 | 76.3% | 128145 | 0.5 | 76522 | 0.8 | 8.6 |
| | 2007-08 | 27545 | 48.3% | 73109 | 0.4 | 28716 | 1 | 8.1 |
| | 2004-05 | 16610 | 37.7% | 23480 | 0.7 | 8656 | 2 | 8.8 |
| Northern Pike | 2016-17 | 2505 | 5.0% | 844 | 8 | 226 | 23.3 | 26.6 |
| | 2013-14 | 249 | 0.8% | 126 | 9.4 | 37 | 9.4 | 26.1 |
| | 2010-11 | 1305 | 1.7% | 444 | 8.5 | 142 | 15 | 25.7 |
| | 2007-08 | 5639 | 9.9% | 1099 | 9.5 | 444 | 17.5 | 24.8 |
| | 2004-05 | 3284 | 7.5% | 1319 | 14.4 | 159 | 40.8 | 24.0 |
| Smallmouth Bass | 2016-17 | 5297 | 10.7% | 6270 | 1.5 | 57 | 322.6 | 17.9 |
| | 2013-14 | 3934 | 12.0% | 3083 | 2.1 | 83 | 62.1 | 17.2 |
| | 2010-11 | 5197 | 6.8% | 10465 | 1.4 | 255 | 28.9 | 16.9 |
| | 2007-08 | 6628 | 11.6% | 6451 | 1.7 | 270 | 28.7 | 16.9 |
| | 2004-05 | 7371 | 16.7% | 5006 | 2.1 | 407 | 23 | 16.5 |
| Largemouth Bass | 2016-17 | 406 | 0.8% | 300 | 9.3 | 4 | - | 16.4 |
| | 2013-14 | 134 | 0.4% | 31 | 19 | 0 | - | - |
| | 2010-11 | 706 | 0.9% | 91 | 10.9 | 0 | - | - |
| | 2007-08 | 2321 | 4.1% | 102 | 75.2 | 0 | - | - |
| | 2004-05 | 447 | 1.0% | 124 | 7.1 | 0 | - | - |

*A cell with a "–" indicates no fish of a given species were caught/harvested by anglers who specifically targeted that species.*

## *Fish Populations and Trends*

Utilizing the above-mentioned fish sampling techniques and specialized formulas, WDNR fisheries biologists can estimate populations and determine trends of captured fish species. These numbers provide a standardized way to compare fish caught in different sampling years depending on gear used (fyke net or electrofishing). Data is analyzed by fisheries biologists to better understand the fishery and how it should be managed.

### Gamefish

The gamefish present on Lake Metonga represent different population dynamics depending on the species. The results for the stakeholder survey show landowners prefer to catch walleye on Lake Metonga (Figure 3.6-2). Brief summaries of popular gamefish present in Lake Metonga are provided based off of the report submitted by WDNR fisheries biologist Greg Matzke and Lawrence Eslinger following the fisheries survey completed in 2016 and personal communications with Greg Matzke in 2019.

**Walleye** are a valued sportfish in Wisconsin. Historically walleye were stocked every other year to maintain a desirable fishing population in Lake Metonga (Table 3.6-2). Bullhead harvesting began in 2008 by the Mole Lake Community and since Lake Metonga has been able to support a sizeable population of walleye with natural reproduction occurring. Non-stocked age-0 walleye have shown improvement over the last 20 years with the assistance of bullhead removal (Figure 3.6-5). A walleye population survey was conducted during the spring of 2019, this survey estimated the adult walleye population to be approximately 3.8 adults per acre. This is population meets the WDNR's goal for natural reproducing waters which is 3 adults per acre. The WDNR recommends continuing the bullhead removal in order to maintain the high walleye reproduction.

**Smallmouth bass** are considered to be of low-to-moderate abundance in Lake Metonga and the second most abundant gamefish species. During the 2013 survey a population estimate of 1.4 fish per acre was determined with the majority of fish between 14 to 19.9 inches.

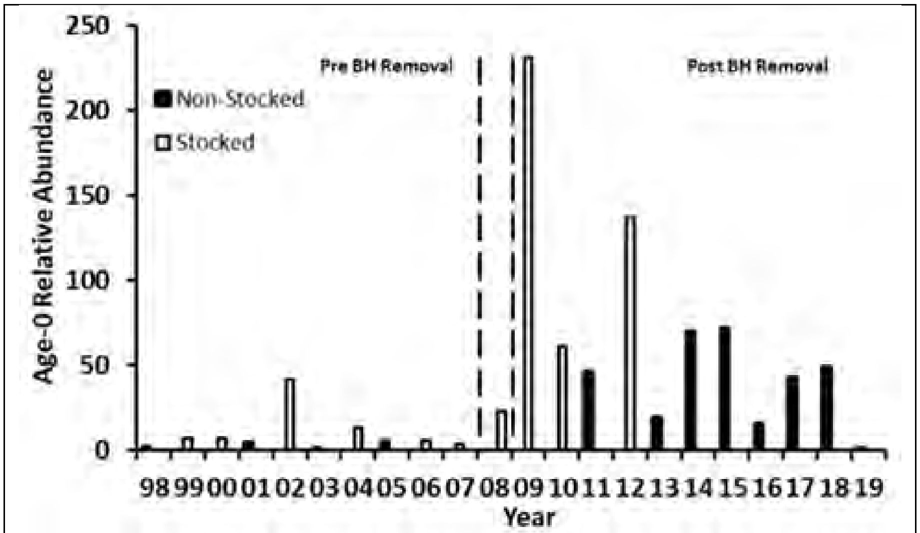



**Figure 3.6-5 Catch per mile of age-0 walleye during fall electrofishing surveys, 1998-2019.**

**Largemouth bass** are present in Lake Metonga in low abundance but have excellent size structure. When compared to other lakes within Forest and Florence Counties.

## Panfish

**Yellow perch** were captured at a rate of 109.8 fish per net-night during the spring survey in 2019, and are considered abundant in Lake Metonga. Observations of high yellow perch abundance during DNR surveys, and creel survey data, suggest that Lake Metonga has consistently had a high abundance of yellow perch. During the 2013 survey extra effort was put toward assessing the yellow perch population, that survey showed the Lake Metonga population had the highest size structure for yellow perch populations in the area.

Past surveys of Lake Metonga measured a much lower relative abundance of yellow perch, however, these surveys are conducted primarily for walleye and may not be a true reflection of the yellow perch population. This is most likely due to the WDNR surveys primarily targeting walleye spawning habitat for a walleye population estimate. During these surveys, observations of large yellow perch populations were made and with these observations, along with creel harvest data, it should be assumed Lake Metonga harbors an abundant yellow perch population. Size structures were also collected during the 2013 survey which show Lake Metonga has the highest yellow perch size structure of all lakes in the region (Matzke 2015). Lake Metonga also exhibits exceptional growth rates for yellow perch. According to the 2013 survey yellow perch achieve a length of 8 inches in just over 3 years, which is about 3 years faster than the average lake located in the Northern Region of Wisconsin. The northern region of Wisconsin includes lakes located in Ashland, Barron, Bayfield, Burnett, Douglas, Iron, Polk, Price, Rusk, Sawyer, Taylor, Washburn, Florence, Langlade, Lincoln, Oneida and Forest Counties.

### Bullhead Removal

Bullhead have been removed by the Mole Lake Community with some financial assistance from the Lake Metonga Association from 2008 to 2017. Since removal began WDNR staff have seen an increase in walleye recruitment and adult populations higher than they have ever been in Lake Metonga (Matzke 2019). As of May 2019, over 30,000 bullheads have been removed from Lake Metonga (Figure 3.6-5). To maintain a suitable walleye population bullhead removal is recommended to continue (WDNR 2019). Of the 205 stakeholders who were aware of the bullhead removal efforts, 89% recommended the harvesting to continue (Figure 3.6-6).

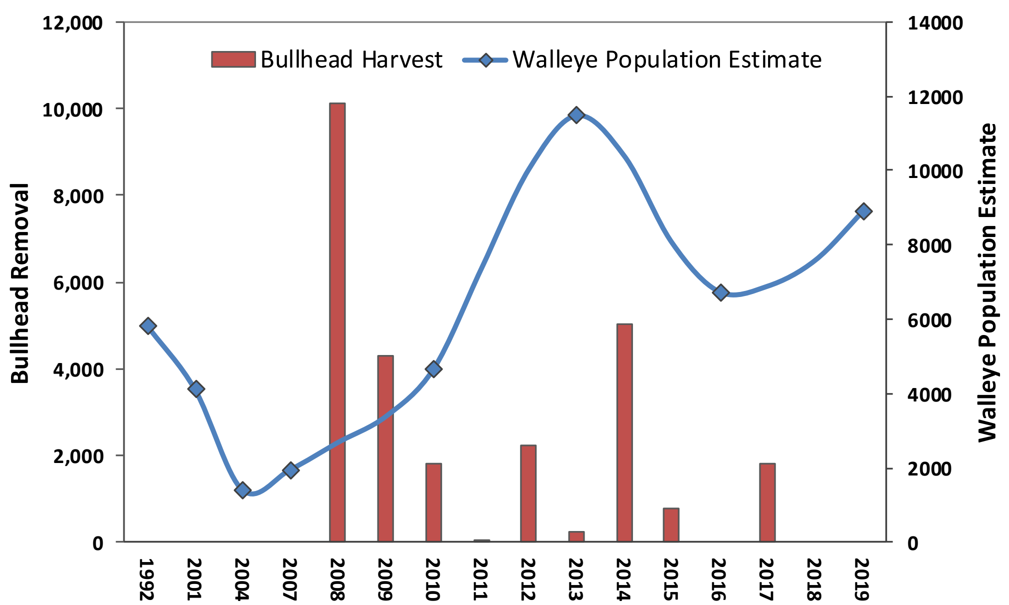



**Figure 3.6-5. Bullhead harvest and walleye population estimates** (WDNR 2019 and personal communications with Greg Matzke).

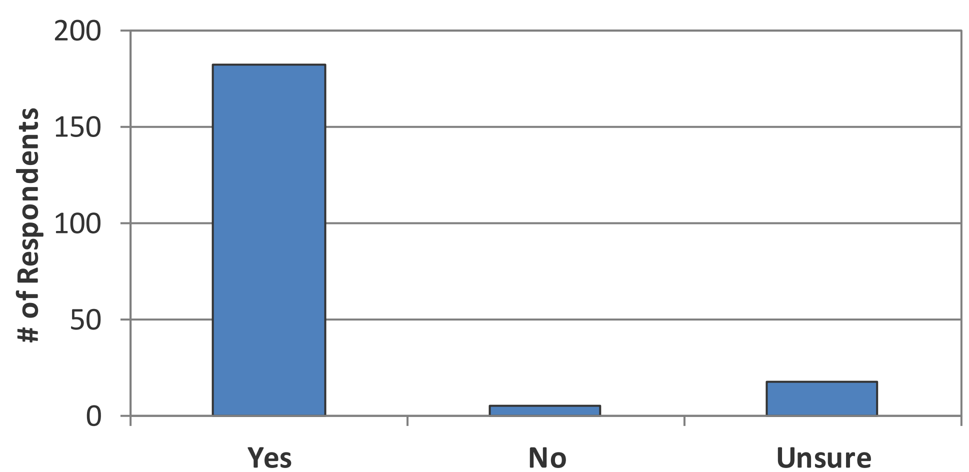



**Figure 3.6-6. Stakeholder survey response Question #20.** Do you favor the LMA continuing to work with the Mole Lake Sokaogon Chippewa Tribe to remove bullhead?

### *Lake Metonga Spear Harvest Records*

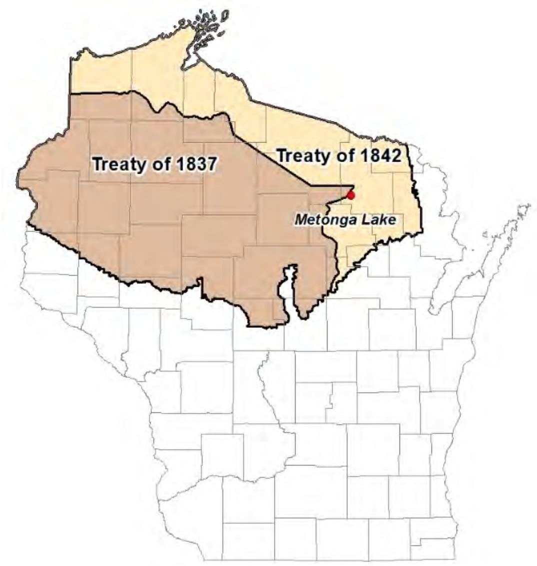



**Figure 3.6-7. Location of Lake Metonga within the Native American Ceded Territory (GLIFWC 2017).** This map was digitized by Onterra; therefore, it is a representation and not legally binding.

Approximately 22,400 square miles of northern Wisconsin was ceded to the United States by the Lake Superior Chippewa tribes in 1837 and 1842 (Figure 3.6-7). Lake Metonga falls within the ceded territory based on the Treaty of 1842. This allows for a regulated open water spear fishery by Native Americans on lakes located within the Ceded Territory. Determining how many fish are able to be taken from a lake, either by spear harvest or angler harvest, is a highly regimented and dictated process. This highly structured procedure begins with bi-annual meetings between tribal and state management authorities. Reviews of population estimates are made for ceded territory lakes, and then a "total allowable catch" (TAC) is established, based upon estimates of a sustainable harvest of the fishing stock. The TAC is the number of adult walleye or muskellunge that can be harvested from a lake by tribal and recreational anglers without endangering the population. A "safe harvest" value is calculated as a percentage of the TAC each year for all walleye lakes in the ceded territory. The safe harvest is a conservative estimate of the number of fish that can be harvested by a combination of tribal spearing and state-licensed anglers. The safe harvest limits are set through either recent population estimates or a statistical model that ensure there is less than a 1 in 40 chance that more than 35% of the adult walleye population will be harvested in a lake through tribal or recreational harvesting means. By March 15$^{th}$ of each year the relevant Indian communities may declare a proportion of the total Safe Harvest on each lake; this declaration represents the maximum number of fish that can be taken by tribal spearers or netters annually. Prior to 2015, annual walleye bag limits for anglers were adjusted in all Ceded Territory lakes based upon the percent of the safe harvest levels determined for the Native American spearfishing season. Beginning in 2015, new regulations for walleye were created to stabilize regional walleye angler bag limits. The daily bag limits for walleye in lakes located partially or wholly within the ceded territory is three. The state-wide bag limit for walleye is five. Anglers may only remove three walleye from any individual lake in the ceded territory but may fish other waters to full-fill the state bag limit (WDNR 2017).

Spearers are able to harvest muskellunge, walleye, northern pike, and bass during the open water season; however, in practice walleye and muskellunge are the only species harvested in significant numbers, so conservative quotas are set for other species. The spear harvest is monitored through a nightly permit system and a complete monitoring of the harvest (GLIFWC 2016). Creel clerks and tribal wardens are assigned to each lake at the designated boat landing. A catch report is completed for each boating party upon return to the boat landing. In addition to counting every fish harvested, the first 100 walleye (plus all those in the last boat) are measured and sexed. Tribal spearers may only take two walleyes over twenty inches per nightly permit; one between 20 and 24 inches and one of any size over 20 inches (GLIWC 2016). This regulation limits the harvest of the larger, spawning female walleye. An updated nightly declaration is determined each morning by 9 a.m. based on the data collected from the successful spearers. Harvest of a particular species ends once the declaration is met. In 2011, a new reporting requirement went into effect on lakes with smaller declarations.

Walleye open water spear harvest records are provided in Figure 3.6-8 from 1999 to 2019. As many as 1,086 walleye have been harvested from the lake in the past (2014), but the average harvest is roughly 314 fish in a given year. Spear harvesters on average have taken 83% of the declared quota.

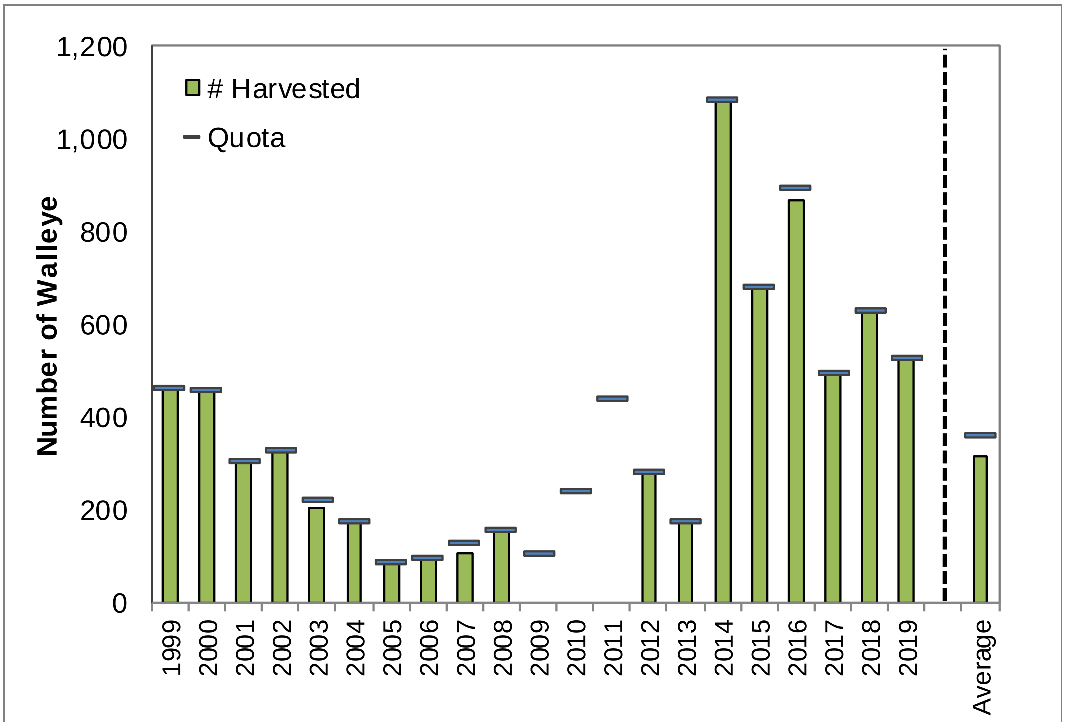



**Figure 3.6-8. Lake Metonga walleye spear harvest data.** (GLIFWC 1999-2019).

Lake Metonga does not harbor a population of Muskellunge, as such there have been no safe harvests or quotas set for the species. The WDNR made a proposal in 2016 to introduce muskellunge into Lake Metonga and maintain a low-density musky population through stocking. This introduced population would likely utilize the abundant white sucker population, see positive impacts on bullhead control, stabilize the walleye population, and create a highly desirable musky fishery. The proposal was not voted in favor by the public, however, mainly due to concerns muskellunge would reduce yellow perch and walleye populations. The WNDR retracted the proposal and has no plans to advise again in the future.

## *Lake Metonga Fish Habitat*

### Substrate Composition

Just as forest wildlife require proper trees and understory growth to flourish, fish require certain substrates and habitat types to nest, spawn, escape predators, and search for prey. Lakes with primarily a silty/soft substrate, many aquatic plants, and coarse woody debris may produce a completely different fishery than lakes that are largely sandy/rocky, and contain few aquatic plant species or coarse woody habitat.

Substrate and habitat are critical to fish species that do not provide parental care to their eggs. Northern pike is one species that does not provide parental care to its eggs (Becker 1983). Northern pike broadcast their eggs over woody debris and detritus, which can be found above sand or muck. This organic material suspends the eggs above the substrate, so the eggs are not buried in sediment and suffocate as a result. Walleye are another species that does not provide parental care to its eggs. Walleye preferentially spawn in areas with gravel or rock in places with moving water or wave action, which oxygenates the eggs and prevents them from getting buried in sediment. Fish that provide parental care are less selective of spawning substrates. Species such as bluegill tend to prefer a harder substrate such as rock, gravel or sandy areas if available, but have been found to spawn and care for their eggs in muck as well.

According to the point-intercept survey conducted by Onterra in 2018, 69% of the substrate sampled in the littoral zone of Lake Metonga were sand sediments, 28% was composed of rock and 3% were composed of soft sediments.

## Woody Habitat

As discussed in the Shoreland Condition Section, the presence of coarse woody habitat is important for many stages of a fish's life cycle, including nesting or spawning, escaping predation as a juvenile, and hunting insects or smaller fish as an adult. Unfortunately, as development has increased on Wisconsin lake shorelines in the past century, this beneficial habitat has often been the first to be removed from the natural shoreland zone. Leaving these shoreland zones barren of coarse woody habitat can lead to decreased abundances and slower growth rates in fish (Sass 2006). A fall 2018 survey documented 35 pieces of coarse woody along the shores of Lake Metonga, resulting in a ratio of approximately 4 pieces per mile of shoreline. Fisheries Biologists do not suggest a specific number of fish sticks for a lake but rather highly encourage their installation wherever possible. To learn how Lake Metonga's coarse woody habitat is compared to other lakes in its region please refer to section 3.3.

**Photograph 3.6-3. Fish Stick Example.** (Photo courtesy of WDNR 2013).

## Fish Habitat Structures

Some fisheries managers may look to incorporate fish habitat structures on the lakebed or littoral areas extending to shore for the purpose of improving fish habitats and spawning areas. These projects are typically conducted on lakes lacking significant coarse woody habitat in the shoreland zone. The "Fish sticks" program, outlined in the WDNR best practices manual, adds trees to the shoreland zone restoring fish habitat to critical near shore areas. Typically, every site has 3 – 5 trees which are partially or fully submerged in the water and anchored to shore (Photograph 3.6-3). The WDNR recommends placement of the fish sticks during the winter on ice when possible to prevent adverse impacts on fish spawning or egg incubation periods. The program requires a

WDNR permit and can be funded through many different sources including the WDNR, County Land & Water Conservation Departments or partner contributions.

**Photograph 3.6-4. Examples of fish sticks (left) and half-log habitat structures.** (Photos by WDNR)

Fish cribs are a type of fish habitat structure placed on the lakebed. These structures are more commonly utilized when there is not a suitable shoreline location for fish sticks. Installing fish cribs may also be cheaper than fish sticks; however, some concern exists that fish cribs can concentrate fish, which in turn leads to increased predation and angler pressure. Having multiple locations of fish cribs can help mitigate that issue. Aquatic plant abundance declined following the invasive rusty crayfish introduction in 1977. Since the rusty crayfish introduction, the Lake Metonga Association has placed cribs throughout the lake to improve fish structure and habitat.

Half-logs are another form of fish spawning habitat placed on the bottom of the lakebed (Photograph 3.6-3). Smallmouth bass specifically have shown an affinity for overhead cover when creating spawning nests, which half-logs provide (Wills 2004). If the waterbody is exempt from a permit or a permit has been received, information related to the construction, placement and maintenance of half-log structures are available online.

An additional form of fish habitat structure is spawning reefs. Spawning reefs typically consist of small rubble in a shallow area near the shoreline for mainly walleye habitat. Rock reefs are sometimes utilized by fisheries managers when attempting to enhance spawning habitats for some fish species. However, a 2004 WDNR study of rock habitat projects on 20 northern Wisconsin lakes offers little hope the addition of rock substrate will improve walleye reproduction (WDNR 2004).

If interested, the Lake Metonga Association Inc., may work with the local WDNR fisheries biologist to determine if the installation of fish habitat structures should be considered in aiding fisheries management goals for Lake Metonga.

## *Regulations*

Regulations for Lake Metonga gamefish species as of May 2019 are displayed in Table 3.6-4. Additionally, motor trolling is allowed with up to three hooks, baits, or lures, per angler. For specific fishing regulations on all fish species, anglers should visit the WDNR website (*www.http://dnr.wi.gov/topic/fishing/regulations/hookline.html)* or visit their local bait and tackle shop to receive a free fishing pamphlet that contains this information.

**Table 3.6-4. WDNR fishing regulations for Lake Metonga (As of May 2019).**

| Species | Daily bag limit | Length Restrictions | Season |
|---|---|---|---|
| Panfish (bluegill, pumpkinseed, sunfish, crappie and yellow perch) | 25 | None | Open All Year |
| Smallmouth bass and largemouth bass | 5 | 14" | June 15, 2019 to March 1, 2020 |
| Smallmouth bass | Catch and release only | None | May 4, 2019 to June 14, 2019 |
| Largemouth bass | 5 | 14" | May 4, 2019 to June 14, 2019 |
| Muskellunge and hybrids | 1 | 40" | May 25, 2019 to November 30, 2019 |
| Northern pike | 5 | None | May 4, 2019 to March 1, 2020 |
| Walleye, sauger, and hybrids | 3 | The minimum length is 15", but walleye, sauger, and hybrids from 20" to 24" may not be kept, and only 1 fish over 24" is allowed. | May 4, 2019 to March 1, 2020 |
| Bullheads | Unlimited | None | Open All Year |
| Cisco and whitefish | 25 pounds plus one more fish of either species in total | None | Open All Year |

**General Waterbody Restrictions:** Motor Trolling is allowed with 1 hook, bait, or lure per angler, and 2 hooks, baits, or lures maximum per boat.

## Mercury Contamination and Fish Consumption Advisories

Freshwater fish are amongst the healthiest of choices you can make for a home-cooked meal. Unfortunately, fish in some regions of Wisconsin are known to hold levels of contaminants that are harmful to human health when consumed in great abundance. The two most common contaminants are polychlorinated biphenyls (PCBs) and mercury. These contaminants may be found in very small amounts within a single fish, but their concentration may build up in your body over time if you consume many fish. Health concerns linked to these contaminants range from poor balance and problems with memory to more serious conditions such as diabetes or cancer. These contaminants, particularly mercury, may be found naturally to some degree. However, the majority of fish contamination has come from industrial practices such as coal-burning facilities, waste incinerators, paper industry effluent and others. Though environmental regulations have reduced emissions over the past few decades, these contaminants are greatly resistant to breakdown and may persist in the environment for a long time. Fortunately, the human body is able to eliminate contaminants that are consumed however this can take a long time depending upon the type of contaminant, rate of consumption, and overall diet. Therefore, guidelines are set upon the consumption of fish as a means of regulating how much contaminant could be consumed over time.

General fish consumption guidelines for Wisconsin inland waterways are presented in Figure 3.6-9. There is an elevated risk for children as they are in a stage of life where cognitive development is rapidly occurring. As mercury and PCB both locate to and impact the brain, there are greater restrictions on women who may have children or are nursing children, and also for children under 15.

| Fish Consumption Guidelines for Most Wisconsin Inland Waterways | | |
|---|---|---|
| | **Women of childbearing age, nursing mothers and all children under 15** | **Women beyond their childbearing years and men** |
| ***Unrestricted**** | - | Bluegill, crappies, yellow perch, sunfish, bullhead and inland trout |
| ***1 meal per week*** | Bluegill, crappies, yellow perch, sunfish, bullhead and inland trout | Walleye, pike, bass, catfish and all other species |
| ***1 meal per month*** | Walleye, pike, bass, catfish and all other species | Muskellunge |
| ***Do not eat*** | Muskellunge | - |

**Doctors suggest that eating 1-2 servings per week of low-contaminant fish or shellfish can benefit your health. Little additional benefit is obtained by consuming more than that amount, and you should rarely eat more than 4 servings of fish within a week.*

**Figure 3.6-9. Wisconsin statewide safe fish consumption guidelines.** Graphic displays consumption guidance for most Wisconsin waterways. Figure adapted from WDNR website graphic (http://dnr.wi.gov/topic/fishing/consumption/)

## *Fishery Management & Conclusions*

Lake Metonga harbors an abundant and sizeable yellow perch population with few other panfish species found. There are no management recommendations for the less common panfish species. High angler harvest does have an impact on the yellow perch population, however, the WDNR does not see the harvest as a major biological impact so no changes to yellow perch regulations are recommended at this time. If future surveys detect negative impacts are occurring to yellow perch or other gamefish populations who utilize this panfish species then a more restrictive regulation may be considered (Matzke 2015). A creel survey will be completed during the 2019-2020 fishing season to estimate angler effort, catch and harvest (Matzke 2019).

# 4.0 SUMMARY AND CONCLUSIONS

The design of this project was intended to fulfill three objectives;

1) Collect baseline data to increase the general understanding of the Lake Metonga ecosystem.
2) Collect detailed information regarding invasive plant species within the lake, with the primary emphasis being on Eurasian watermilfoil.
3) Collect sociological information from Lake Metonga stakeholders regarding their use of the lake and their thoughts pertaining to the past and current condition of the lake and its management.

The three objectives were fulfilled during the project and have led to a good understanding of the Lake Metonga ecosystem, the folks that care about the lakes, and what steps can be taken by the LMA to protect and enhance the system.

Lake Metonga contains *Excellent* water quality compared to other deep lowland drainage lakes. Total phosphorus, and chlorophyll-a parameters are less than mean values of other deep lowland drainage lakes and lower than the mean values of lakes in the Northern Lakes and Forests ecoregion. Water clarity is much higher than comparative lakes of the same type and with the same ecoregion. Trend analysis indicates that a step-wise increase in water clarity and total phosphorus, which are theorized to be driven by the establishment of zebra mussels in Lake Metonga.

Lake Metonga falls within the headwaters of the Wolf River Watershed which ultimately drains to the Lake Winnebago System. Lake Metonga contains a small watershed compared to the size of the lake, with approximately three acres of land draining to each acre of the lake. Much of the land within the watershed consists of those types that deliver the least amount of phosphorus to the lake, such as forest and wetlands. Having a small watershed, the land use around the immediate shoreline areas are going to have a large influence over the lake's water quality. Approximately 57% of Lake Metonga's shoreline consists of the two most impactful categories (*urbanize*d and *developed–unnatural* shoreland, whereas 24% consists of shorelines in the two most ecologically beneficial categories (*developed–natural* and *undeveloped*). It is fundamental to the health of Lake Metonga to preserve natural shorelands and take steps towards shifting the proportion of developed shorelines into less impactful categories.

Lake Metonga is a popular destination for anglers that primarily target yellow perch and walleye. While riparian stakeholders believe the fishery is currently *fair* to *good*, they also believe that the fishery has *remained the same* or *gotten worse* since they first started fishing the lake. Fisheries managers and the Lake Metonga Association have invested large amounts of time and effort into Lake Metonga's fishery including stocking efforts, fish crib installations, and bullhead removal.

Changes in aquatic plant abundance within Lake Metonga have been noted on Lake Metonga. Following the establishment of rusty crayfish in the late 1970s, universal accounts of vegetation declines were noted. Rusty crayfish populations continue to impact native aquatic vegetation within the lake. Having a woodier base, EWM is less impacted by rusty crayfish than native vegetation. Although specific surveys have not been conducted to confirm, the primary aquatic plant biomass within Lake Metonga is currently EWM. EWM inhabits the littoral band around Lake Metonga in waters of approximately 6-15 feet where more organic sediments exist.

The LMA, in conjunction within WDNR grants, have invested a large amount of money attempting to manage the EWM population of Lake Metonga with herbicides. The strategies employed following the initial detection were considered the *Best Management Practice (BMPs*) of the time, but now are typically considered insufficient to fully kill the target plant. Onterra believes the largest advances in BMPs in regards to EWM management was gained as a part of a cooperative research project between the WDNR, US Army Corps of Engineers Research and Development Center (USACE), and private consultants. This program took place roughly from 2009 to 2016. The LMA was one of the first lake organizations in northern Wisconsin to become involved with this research project and should be commended for their valuable role in herbicide management across the Midwest.

Unfortunately, the primary lesson learned from this research is that spot treatments in general are difficult to achieve multi-year EWM population suppression, with the parameters present in Lake Metonga being particularly challenging. Obtaining sufficient herbicide concentrations in exposed and off-shore parts of Lake Metonga to kill the EWM is almost impossible using the herbicide chemistries currently being employed in the state. Areas that are more protected from water exchange, such as Strawberry Bay and the northeastern part of Lake Metonga near the Crandon park and boat landing have yielded better and more consistent control. As the LMA considers herbicide management in the future, attention to newer technologies and use-patterns will be important to meet management goals.

Continued monitoring of the EWM population on Lake Metonga has shown relatively large changes over time, including reductions in years where no active management occurred. On some lakes that have had EWM as long as it has been present in Lake Metonga, the EWM population can reach a quasi-equilibrium with fluctuations from year to year based upon environmental conditions (e.g. ice-out timing, number of warm/sunny days, water levels, etc). While the EWM population and density will fluctuate, the footprint of EWM within Lake Metonga is not likely to change much. The reason EWM does not inhabit certain areas of the lake is not because it has not yet been exposed to the area, rather the site specifics are not conducive for EWM growth.

In recent years, the LMA has taken coordinated and calculated steps to increase its capacity to protect and manage Lake Metonga. As a part of this project, the LMA spent considerable time and effort developing and administering the association/riparian stakeholder survey. The LMA's diligent work developing and distributing the survey played a key role in achieving a successful response rate of 69%. These survey results allowed the LMA to gain an understanding of how their constituents use the lake and their perception on its historic and future management. As grant funding opportunities become more competitive and the cost of lake management activities increase, it will be important for the Lake Metonga Association to operate in a strong and efficient manner.

# 5.0 IMPLEMENTATION PLAN

## *Management Goal 1: Manage Eurasian Watermilfoil and Prevent Establishment of New Invasive Species*

| **Management Action:** | Creation of an *Aquatic Plant and AIS Management Committee* |
|---|---|
| **Timeframe:** | Starting 2020 |
| **Facilitator:** | Board of Directors |
| **Description:** | The LMA historically has had a core group, many of which were board members, that focused on EWM management. The creation of a dedicated committee will ensure that division of labor occurs within the LMA. The *Aquatic Plant and AIS Management Committee* would be charged with AIS and EWM management, Clean Boats Clean Waters watercraft inspections, future AIS aquatic plant and animal (e.g. rusty crayfish, zebra-mussel) monitoring activities. The *Aquatic Plant and AIS Management Committee* would also deal with funding, cost analysis, risk assessment, treatment strategy, and data review. This committee would be comprised of 2-4 individuals, with at least one member being on the LMA board of directors. |
| **Action Steps:** | |
| | See description above. |

| **Management Action:** | Monitor Lake Metonga entry points for AIS. |
|---|---|
| **Timeframe:** | Starting 2020 |
| **Facilitator:** | Aquatic Plant and AIS Management Committee |
| **Description:** | Lake Metonga is a popular regional destination by recreationists and anglers, making the lake vulnerable to new infestations of exotic species. The intent of a watercraft inspection program would not only be to prevent additional invasive species from entering the lake through its public access point, but also to prevent the infestation of other waterways with invasive species that originated in Lake Metonga. The goal would be to cover the primary landings during the busiest times in order to maximize contact with lake users, spreading the word about the negative impacts of AIS on lakes and educating people about how they are the primary vector of its spread.<br><br>The LMA has historically participated in the WDNR's Clean Boats Clean Waters (CBCW). The LMA currently has paid watercraft monitors at the two main public access locations between 400 and 600 hours per season. The *Aquatic Plant and AIS Management Committee* has set a goal of a minimum of 400 hours of watercraft inspections annually divided amongst the two public landings. The LMA would continue to apply for cost share assistance to fund this program through |

| | |
|---|---|
| | the WDNR's streamline CBCW program. The Mole Lake Sokaogon Chippewa Community historically has contributed $4,000-$5,000 to the LMA to assist with the local share of the CBCW program at Lake Metonga. The LMA has installed a publicly accessible pressure washer at the south landing to promote decontamination procedures upon entry and exit of the lake. Additional prevention measures the LMA is considering includes:<br>▪ Pressure washer station at north landing (require water source)<br>▪ Tool Kit Kiosk<br>▪ Increased signage<br>▪ Designated decontamination area<br>▪ Internet Landing Installed Device Sensor (I-LIDS)<br>The LMA recently updated their boat landing signage to include updated information relating to the AIS present in Lake Metonga (i.e. EWM, rusty crayfish, and zebra mussel) and the historic monitoring of the EWM population within Lake Metonga. |
| **Action Steps:** | |
| | See description above. |

| **<u>Management Action:</u>** | Conduct nuisance management actions towards EWM |
|---|---|
| **Timeframe:** | 2020 and beyond |
| **Facilitator:** | Aquatic Plant and AIS Management Committee |
| **Description:** | The LMA has historically attempted to manage the lake-wide EWM population of Lake Metonga through spatially targeted spot herbicide treatments. The LMA participated in the forefront of field research, engaging in projects with the WDNR, US Army Corps of Engineers Research and Development Center (USACE), and Onterra that aimed to increase the efficacy and longevity of herbicide management of EWM.<br><br>While some herbicide treatments showed promise, the unpredictability of spot treatments state-wide has resulted in less favorability of this strategy with WDNR regulators. The WDNR recommended the LMA adopt a *Nuisance Management and Containment Strategy*, which targeted main access and high use areas for management with herbicides. While multi-year control continues to be the goal of these efforts, the LMA would like to obtain at least seasonal control to reduce navigation and use impediment in important areas of the lake.<br><br>The LMA Planning Committee discussed the applicability of mechanical harvesting to accomplish this action and ultimately decided it will focus on hand-harvesting and herbicide application methods but will continue to educate themselves on the applicability and risks of mechanical harvesting methods. |

When a Late Season EWM Mapping Survey documents colonized EWM populations that are *highly dominant* or greater in density and are impacting navigation/recreation within the lake, herbicide spot treatment would be considered by the LMA. Areas containing high use or riparian frontage would be prioritized for treatment. The LMA would devise a strategy where a sufficiently large treatment area can be constructed to hold concentration and exposure times for exposed sites. Future spot herbicide treatments would likely need to consider herbicides (diquat, florpyrauxifen-benzyl, etc) or herbicide combinations (2,4-D/endothall, diquat/endothall, etc) thought to be more effective under short exposure situations than with traditional weak-acid auxin herbicides (e.g. 2,4-D, triclopyr). However, these claims continue to be investigated in the field. Advancements in research into new herbicides and use patterns will need to be integrated into future management strategies, including effectiveness, native plant selectivity, and environmental risk profile.

If the LMA decides to pursue future herbicide management towards EWM, the following set of bullet points would occur:

- Early consultation with WDNR would occur.
- The proceeding annual AIS monitoring report would outline the precise control and monitoring strategy.
  - Monitoring EWM efficacy by comparing annual late-summer EWM mapping surveys.
  - If grant funds are being used or new-to-the-region herbicide strategies are being considered, the WDNR may request a quantitative evaluation monitoring plan be constructed that is consistent with the *Draft Aquatic Plant Treatment Evaluation Protocol (October 1, 2016*):

    https://dnrx.wisconsin.gov/swims/downloadDocument.do?id=158140137

    This generally consist of collecting quantitative point-intercept sub-sampling on sites before the treatment (pre) and summer following the treatment (post). Herbicide concentration monitoring may also occur surrounding the treatment in these instances.
- An herbicide applicator firm would be selected in late-winter and a conditional permit application would be applied to the WDNR.
- A focused pretreatment survey would take place approximately a week or so prior to treatment (approx. 2-3 weeks after ice-out). This site visit would evaluate the growth stage of the EWM (and native plants) as well as to confirm the proposed treatment area extents and water depths. This information would be used to finalize the permit, potentially with adjustments and dictate approximate ideal treatment timing.
- Unless specified otherwise by the manufacturer of the herbicide, an early-season use-pattern would occur. This would consist of the herbicide treatment occurring when mid-depth water temperatures are roughly below 65°F and active growth tissue is confirmed on the target plants.

| | |
|---|---|
| | Considerations would also be given to completing the herbicide application after the Mole Lake Sokaogon Chippewa Indians has finished their spring open-water spear harvest. |
| **Action Steps:** | |
| | See description above |

## *Management Goal 2: Monitor Aquatic Vegetation on Lake Metonga*

| | |
|---|---|
| **<u>Management Action:</u>** | Conduct professional late-season EWM Mapping Surveys |
| **Timeframe:** | Continuation of current effort |
| **Facilitator:** | Aquatic Plant and AIS Management Committee |
| **Description:** | As the name implies, the Late-Season EWM Mapping Survey is completed towards the end of the growing season when the plant is at its anticipated peak growth stage, allowing for a true assessment of the amount of this exotic within the lake. For Lake Metonga, this survey would likely take place in mid-September to very early-October. This survey would include a complete meander survey of the lake's littoral zone by professional ecologists and mapping using GPS technology (sub-meter accuracy is preferred).<br><br>Late- Season EWM Mapping Surveys have been conducted annually on Lake Metonga since 2007, allowing for lake stakeholders to understand annual EWM populations as well as population dynamics which proved to be useful. These surveys are used as the trigger within the previous management goal for nuisance management. The LMA board has approved annual late-season EWM mapping surveys. |
| **Action Steps:** | |
| | See description above as this is an established program. |

| | |
|---|---|
| **<u>Management Action:</u>** | Coordinate Periodic Point-Intercept Surveys |
| **Timeframe:** | Every 3-5 years depending on management strategies being employed |
| **Facilitator:** | Aquatic Plant and AIS Management Committee |
| **Description:** | The point-intercept method as described Wisconsin Department of Natural Resources Bureau of Science Services, PUB-SS-1068 2010 (Hauxwell et al. 2010) has been conducted on Lake Metonga in the past. At each point-intercept location within the *littoral zone*, information regarding the depth, substrate type (soft sediment, sand, or |

| | |
|---|---|
| | rock), and the plant species sampled along with their relative abundance (rake fullness) on the sampling rake is recorded.<br><br>The WDNR generally indicates that repeating a point-intercept survey every five years will generally suffice to meet WDNR planning requirements unless large-scale aquatic plant management is taking place and more frequent monitoring is requested for the specifically targeted areas. In some instances of particularly aggressive active management, the WDNR may require annual point-intercept surveys.<br><br>While the WDNR is not opposed to more frequent data collection, grant opportunities are reserved for necessary data collection only. |
| **Action Steps:** | |
| | See description above as this is an established program. |

| **Management Action:** | Coordinate Periodic Community Mapping (floating-leaf and emergent) Surveys |
|---|---|
| **Timeframe:** | Every 10 years unless prompted |
| **Facilitator:** | Aquatic Plant and AIS Management Committee |
| **Description:** | In order to understand the dynamics of the emergent and floating-leaf aquatic plant communities in Lake Metonga, a community mapping survey would be conducted approximately every 10 years unless a specific rationale prompts a shorter interval. Such a rationale would include timing the survey to occur at near high and near low water levels. Surveys were completed in 2005 and 2018 near the peak of the water levels and in 2013 near lowest water levels. If another survey takes place in 2025 or 2026 this would again be near the low water level according to recent predictions (Watras et al 2013). It would be good to collect repetitive data in both the highest and lowest water levels to determine if changes are due to water level or some other environmental or human cause.<br><br>This survey would delineate the margins of floating-leaf (e.g. water lilies) and emergent (e.g. cattails, bulrushes) plant species using GPS technology (preferably sub-meter accuracy) as well as document the primary species present within each community. Changes in the footprint of these communities can be strong and early indicators of environmental perturbation as well as provide information regarding various habitat types within the system. |
| **Action Steps:** | |
| | See description above as this is an established program. |

## ***Management Goal 3:*** **Maintain Current Water Quality Conditions**

| | |
|---|---|
| **Management Action:** | Monitor water quality parameters through WDNR Citizens Lake Monitoring Network. |
| **Timeframe:** | Continuation of current effort. |
| **Facilitator:** | Board of Directors |
| **Description:** | Monitoring water quality is an important aspect of every lake management planning activity. Collection of water quality data at regular intervals aids in the management of the lake by building a database that can be used for long-term trend analysis. Early discovery of negative trends may lead to the reason of why the trend is occurring.<br><br>Volunteer water quality monitoring should be completed annually by Lake Metonga riparians through the Citizen Lake Monitoring Network (CLMN). The CLMN is a WDNR program in which volunteers are trained to collect water quality information on their lake. The LMA currently monitor a single site in Lake Metonga (at the deep hole) under the advanced CLMN program. This includes collecting Secchi disk transparency, as well as sending in water chemistry samples (chlorophyll-*a*, and total phosphorus) to the Wisconsin State Laboratory of Hygiene (WSLH) for analysis. The samples are collected three times during the summer and once during the spring. It is important to note that as a part of this program, the data collected are automatically added to the WDNR database and available through their Surface Water Integrated Monitoring System (SWIMS).<br><br>It also must be noted that the CLMN program may be changing in the near future with sample analysis cost coverage not available annually. Recently there has been a move to have new CLMN volunteers collect samples for three years and then stop so that additional lakes can be funded. If a long-term record is desired by the LMA then it will be important to maintain the volunteer data collection without a lapse. The LMA board will need to review the specifics of the revised program when available and potentially modify this management action. |
| **Action Steps:** | |
| 1. | Trained CLMN volunteer(s) collects data, enters data into SWIMS, and report results to association members during annual meeting. |
| 2. | CLMN volunteer and/or LMA board would facilitate new volunteer(s) as needed |

## *Management Goal 4:* Increase the LMA's Capacity to Communicate with Lake Stakeholders and Facilitate Partnerships with Other Management Entities

| | |
|---|---|
| **Management Action:** | Creation of an *Outreach Committee* |
| **Timeframe:** | Starting 2020 |
| **Facilitator:** | Board of Directors |
| **Description:** | The goal of this committee would be to increase the LMA's membership, fundraising and capacity, volunteerism, and education. The LMA has set and met internal goals for membership enrollment but aims to continue momentum. By continuing to demonstrate a clear mission that is not limited to being a social organization, the LMA would increase its capacity and influence on Lake Metonga. This committee would be comprised of 4-6 individuals, with at least one member being on the LMA board of directors. The formation of sub-committees will also be considered to meet specific outreach objectives. The *Outreach Committee* specifically focus on education, communication, membership, volunteerism, and fundraising. |
| **Action Steps:** | |
| | See description above. |

| | |
|---|---|
| **Management Action:** | Maintain or increase fundraising & capacity building |
| **Timeframe:** | Starting 2020 |
| **Facilitator:** | *Outreach Committee* |
| **Description:** | The *Outreach Committee* would play an active role in organizing LMA events. Some events are focused on increasing the LMA's exposure, such as maintaining booths at Kentuck Days and at Art in the Square as well as possible fundraisers. The Annual 4th of July Boat Parade and Summer Picnic also promotes the LMA. The Weeds and Walleyes Banquet is the primary external fundraising event for the LMA. *The Outreach Committee* would work to include pertinent educational opportunities at these forums, as applicable. The committee would also investigate creating and moderating a possible dedicated LMA Facebook Page, allowing another resource for building a sense of community, as well as providing information on upcoming events or providing links to educational pieces posted on the LMA's website. |
| **Action Steps:** | |
| | See description above. |

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|---|---|
| **Management Action:** | Increase volunteerism within the LMA |

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|---|---|
| **Timeframe:** | Starting 2020 |
| **Facilitator:** | *Outreach Committee* |
| **Description:** | The *Outreach Committee* will be tasked with maintaining and increasing volunteerism within the LMA. In addition to promotion through, newsletters, the website, annual meetings, Facebook, etc., a door-to-door campaign may be applicable. |
| **Action Steps:** | |
| | See description above. |

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|---|---|
| **<u>Management Action:</u>** | Routinely education and communicate to all lake stakeholders |
| **Timeframe:** | Starting 2020 |
| **Facilitator:** | *Outreach Committee* |
| **Description:** | The Outreach Committee would be responsible for distributing content to Lake Metonga stakeholders through the website, newsletters, special mailings, and social events. Additional educational avenues, may also be pursued which may include periodic dedicated speaker events (mixers) and potluck gatherings. This committee would also be responsible for distribution of quarterly newsletters.<br><br>The LMA will continue to make the education of lake-related issues a priority. These may include educational materials, awareness events, and demonstrations for lake users as well as activities which solicit local and state government support.<br><br>*Example Educational Topics*<br>• Importance of natural landscapes<br>• Wildlife harassment<br>• Promote existing ordinances<br>• Boating regulations & safety<br>• Lake Metonga History<br>• General Lake Ecology<br>• Fisheries<br>• Rusty Crayfish<br>• Water levels<br>• Shoreline erosion – individuals<br>• Swimmers Itch/Waterfowl<br>• Zebra mussel/filamentous algae |
| **Action Steps:** | |
| | See description above. |

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|---|---|
| **Management Action:** | Conduct Periodic Riparian Stakeholder Surveys |
| **Timeframe:** | Every 5-6 years |
| **Facilitator:** | *Outreach Committee* |
| **Description:** | Approximately once every 5-6 years, the *Outreach Committee* would facilitate a project where an updated stakeholder survey would be distributed to the Lake Metonga riparian property owners. Periodically conducting an anonymous stakeholder survey would gather comments and opinions from lake stakeholders to gain important information regarding their understanding of the lake and thoughts on how it should be managed. This information would be critical to the development of a realistic plan by supplying an indication of the needs of the stakeholders and their perspective on the management of the lake.<br><br>The stakeholder survey could partially replicate the design and administration methodology conducted during spring 2019, with modified or additional questions as appropriate. The survey would again receive approval from a WDNR Research Social Scientist, particularly if WDNR grant funds are used to offset the cost of the effort. |
| **Action Steps:** | |
| | See description above |

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|---|---|
| **Management Action:** | Continue LMA's involvement with other entities that have responsibilities in managing (management units) Lake Metonga |
| **Timeframe:** | Continuation of current efforts |
| **Facilitator:** | *Outreach Committee* |
| **Description:** | The waters of Wisconsin belong to everyone and therefore this goal of protecting and enhancing these shared resources is also held by other entities. Some of these entities are governmental while others organizations rely on voluntary participation.<br><br>It is important that the LMA actively engage with all management entities to enhance the association's understanding of common management goals and to participate in the development of those goals. This also helps all management entities understand the actions that others are taking to reduce the duplication of efforts. Each entity will be specifically addressed in the table on the next page: |
| **Action Steps:** | |
| | See table guidelines on the next pages. |

| Partner | Contact Person | Role | Contact Frequency | Contact Basis |
|---|---|---|---|---|
| **Town of Lincoln** | Clerk/Treasurer (Tressa Votis 715.478.1295) | Lake Metonga falls within the township | LMA representative attend committee meetings as applicable | Aspects that involve the township government such as ordinances, building and zoning, and funding opportunities |
| **City of Crandon** | Clerk/Treasurer (Cindy Bradley 715.478.2400) | Lake Metonga is adjacent to the City | LMA representative attend committee meetings as applicable | Aspects that involve the City government such as building and zoning and funding opportunities |
| **Forest County Chamber of Commerce** | General staff (715.478.3450) | Provides information and networking | Once a year, or more as needed. May check website for updates (http://www.goforestcounty.com/ | The Chamber of Commerce serves a valuable role in promoting local businesses, tourism, and community |
| **Forest County Lakes & Rivers Association** | President (Pam Schroeder 715.473.3803) | Protects Forest Co. waters through facilitating discussion and education. | Once a year, or more as needed. May check website for updates (http://www.fcal-wis.org) | Become aware of training or education opportunities, partnering in special projects, or networking on other topics pertaining to Forest Co. waterways. |
| **Forest County Board of Supervisors** | Chair (Tom Tallier 715.473.2191) | Oversees the operation of county government in Forest County. | As needed | Ensure the board understands the LMA's management perspective. |
| **Forest County Land & Water Cons. Dept.** | Steve Kircher (Conservationist) or Cassidy Neilitz (Technician) (715-478-1387) | Oversees conservation efforts for land and water projects. | Once a year, or more as needed. May check website for updates (https://forestcountylandandwater.org) | Provides educational and technical assistance to the public on land and water resource management |
| **Wisconsin Department of Natural Resources** | Fisheries Biologist (Greg Matzke– 715.528.4400) | Manages the fishery of Lake Metonga along with Mike Preul (Mole Lake) | Once a year, or more as issues arise. | Stocking activities, scheduled surveys, survey results, volunteer opportunities for improving fishery. |
| | Lakes Coordinator (Scott Van Egeren – 715.471.0007) | Oversees management plans, grants, all lake activities. | As needed and when herbicide treatment permits are being considered. | Assist with lake management and lake management planning activities. |
| | Citizens Lake Monitoring Network contact (Sandra Wickman – 715.365.8951) | Provides training and assistance on CLMN monitoring, methods, and data entry. | As needed | Late winter: arrange for training as needed, in addition to planning out monitoring for the open water season. Late fall: report monitoring activities. |
| **Mole Lake Sokaogon Chippewa Community** | Biologist (Mike Preul– 715.528.4400) | Tribe enacts conservation efforts through research, documentation, education, and outreach. | As needed and when herbicide treatment permits are being considered. | Tribe is active in fisheries and habitat management programs, and has been a financial supporter of the LMA in the past. |
| **Great Lakes Indian Fish and Wildlife Commission** | Manoomin (wild rice) Biologist (Lisa David – 715.682.6619) | Oversees management and conservation within the ceded territory | As needed and when herbicide treatment permits are being considered. | Assists the Voigt Intertribal Task Force Committee regarding inland harvest seasons and resource management issues in the ceded territory |

## *Management Goal 5:* Improve Lake and Fishery Resource

| | |
|---|---|
| **Management Action:** | Creation of a *Fisheries & Habitat Committee* |
| **Timeframe:** | Starting 2020 |
| **Facilitator:** | Board of Directors |
| **Description:** | The *Fisheries & Habitat Committee* would be the LMA's point of contact for WDNR and tribal fisheries managers. This would include working with fisheries managers during ongoing bullhead removal projects, future walleye stocking plans, and potential panfish enhancement programs. Further, this committee would be responsible for fish and wildlife habitat enhancement activities, such as shoreland restoration, shoreland protection, and course-woody habitat improvements. The *Fisheries & Habitat Committee* would coordinate with the *Outreach Committee* on pertinent wildlife related initiatives, such as wildlife protection (loons, eagles, etc.) and undesirable wildlife (Canada geese, cormorants, etc.). This committee would be comprised of 4 - 6 individuals, with at least one member being on the LMA board of directors. |
| **Action Steps:** | |
| | See description above. |

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|---|---|
| **Management Action:** | Educate stakeholders on the importance of shoreland condition and shoreland restoration and protection |
| **Timeframe:** | Ongoing effort |
| **Facilitator:** | *Fisheries & Habitat Committee* |
| **Description:** | As discussed in the Shoreland Condition Section (3.3), the shoreland zone of a lake is highly important to the ecology of a lake. When shorelands are developed, the resulting impacts on a lake range from a loss of biological diversity to impaired water quality. Because of its proximity to the waters of the lake, even small disturbances to a natural shoreland area can produce ill effects.<br><br>The *Fisheries & Habitat Committee* would coordinate with the *Outreach Committee* to focus specific education on the importance of shoreland condition and the resources that are available (planning and funding). Partial funding for shoreland restoration activities is available through the WDNR Healthy Lakes Initiative. The *Fisheries & Habitat Committee* would also strive to initiate a Healthy Lakes shoreline restoration project to serve as a demonstration site, being publicized to lake users so they may want to follow suit on their properties.<br><br>The WDNR's Healthy Lakes Implementation Plan allows partial cost coverage for native plantings in transition areas. This reimbursable |

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| | grant program is intended for relatively straightforward and simple projects. More advanced projects that require advanced engineering design may seek alternative funding opportunities, potentially through Forest County.<br><br>As discussed in the Shoreland Condition Section (3.3), the Healthy Lakes & Rivers Grant program provides cost share for implementing the following best practices:<br>• Rain Garden<br>• Rock Infiltration<br>• Diversion<br>• Native Plantings (35' of contiguous plantings along the shoreline 10' wide)<br>• Fish Sticks<br><br>The cost share allows $1,000 per practice, up to $25,000 per annual grant application. More details and resources for the program are included within the Shoreland Condition Section (3.3) and can be found at:<br>https://healthylakeswi.com<br><br>Approximately 22% of Lake Metonga's shoreline is *natural/undeveloped* and could be the focus of preservation efforts. This would be accomplished through education of property owners, or direct preservation of land through implementation of conservation easements or land trusts that the property owner would approve of. Valuable resources for this type of conservation work include the WDNR, UW-Extension, and Forest County Land & Water Conservation Department. Several websites of interest include:<br>• Conservation easements or land trusts: (www.northwoodslandtrust.org)<br>• UW-Extension Shoreland Restoration: (https://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/shoreland/default.aspx)<br>• WDNR Shoreland Zoning website: (http://dnr.wi.gov/topic/ShorelandZoning/)<br><br>WDNR land acquisition grants are available to pay for the costs of property purchases and conservation easements. Scott Van Egeren (WDNR lakes biologist) or Jill Sunderland (WDNR environmental grants specialist) can be contacted with questions about this specific grant program. |
| **Action Steps:** | |
| | See description above |

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| **Management Action:** | Educate stakeholders on the importance of course woody habitat |
| **Timeframe:** | Ongoing effort |
| **Facilitator:** | *Fisheries & Habitat Committee* |
| **Description:** | An opportunity for education and habitat enhancement is present in order to help the ecosystem reach its maximum fishery potential. Often, property owners will remove downed trees, stumps, etc. from a shoreland area because these items may impede watercraft navigation shore-fishing or swimming. However, these naturally occurring woody pieces serve as crucial habitat for a variety of aquatic organisms, particularly fish. The Shoreland Condition Section (3.3) and Fisheries Data Integration Section (3.6) discuss the benefits of coarse woody habitat in detail.<br><br>The WDNR's Healthy Lakes Implementation Plan allows partial cost coverage for fish stick projects. This reimbursable grant program is intended for relatively straightforward and simple projects. More advanced projects that require advanced engineering design may seek alternative funding opportunities, potentially through the county.<br>• 75% state share grant with maximum award of $25,000; up to 10% state share for technical assistance<br>• Maximum of $1,000 per cluster of 3-5 trees (best practice cap)<br>• Implemented according to approved technical requirements (WDNR Fisheries Biologist) and complies with local shoreland zoning ordinances<br>• Buffer area (350 $ft^2$) at base of coarse woody habitat cluster must comply with local shoreland zoning or:<br>  o The landowner would need to commit to leaving the area un-mowed<br>  o The landowner would need to implement a native planting (also cost share thought this grant program available)<br>• Coarse woody habitat improvement projects require a general permit from the WDNR<br>• Landowner must sign Conservation Commitment pledge to leave project in place and provide continued maintenance for 10 years<br><br>The *Fisheries & Habitat Committee* would coordinate with the *Outreach Committee* to educate stakeholders on the importance of adding coarse woody habitat (i.e. fish stick projects). The *Fisheries & Habitat Committee* would also strive to initiate a Healthy Lakes fish sticks project to serve as a demonstration site, being publicized to lake users so they may want to install on their properties. In addition, LMA will also consider using a grant process to enhance woody habitat expansion and shoreline restoration activities for members in good standing.<br><br>It's important to reiterated the important of working with the local WDNR fisheries biologist (Greg Matzke) prior to implementing fish stick |

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| | projects to ensure the activity will be beneficial for the fish species being managed for. |
| **Action Steps:** | |
| | See description above |

| **Management Action:** | Continue the Loon Watch program |
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| **Timeframe:** | Ongoing effort |
| **Facilitator:** | *Fisheries & Habitat Committee* |
| **Description:** | The Loon Watch Program is operated through the Sigurd Olson Environmental Institute from Northland College. The purpose of the program is to provide a picture of common loon reproduction and population trends on northern Wisconsin lakes. Loon watch volunteers send in a yearly report on sightings of any loon activity, number counts, chicks observed, and markings on a lake map where loons were seen.<br><br>The LMA would continue participation in the Loon Watch Program in conjunction with the Sigurd Olson Environmental Institute from Northland College. This program would include placement of artificial loon nesting platforms, as well as monitoring according to the Loon Watch Program. The *Fisheries & Habitat Committee* would ensure that a dedicated volunteer is in place to send in a yearly report on sightings of any loon activity, number counts, chicks observed, and markings on a lake map where loons were seen. |
| **Action Steps:** | |
| | See description above |

| **Management Action:** | Continue bald eagle monitoring program |
|---|---|
| **Timeframe:** | Ongoing effort |
| **Facilitator:** | *Fisheries & Habitat Committee* |
| **Description:** | The *Fisheries & Habitat Committee* will monitor bald eagle nests and habitat through the continued use of live web cameras as has been done historically. Live camera footage can be found at www.lakemetongawi.org and scrolling down the page to the appropriate link. |
| **Action Steps:** | |
| | See description above |

# 6.0 METHODS

Baseline water quality conditions were studied to assist in identifying potential water quality problems in Lake Metonga (e.g., elevated phosphorus levels, anaerobic conditions, etc.). Water quality was monitored at the deepest point on the lake that would most accurately depict the conditions of the lake (Map 1). Samples were collected using WDNR Citizen Lake Monitoring Network (CLMN) protocols which occurred once in spring and three times during the summer. In addition to the samples collected by Lake Metonga Association, members, professional water quality samples were collected at subsurface (S) and near bottom (B) depths once in spring, winter, and fall. Although LMA members collected a spring total phosphorus sample, professionals also collected a near bottom sample to coincide with the bottom total phosphorus sample. Winter dissolved oxygen was determined with a calibrated probe and all samples were collected with a 3-liter Van Dorn bottle. Secchi disk transparency was also included during each visit.

All samples that required laboratory analysis were processed through the Wisconsin State Laboratory of Hygiene (SLOH). The parameters measured, sample collection timing, and designated collector are contained in the table below.

| | **Spring** | | **June** | **July** | **August** | **Fall** | | **Winter** | |
|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **S** | **B** | **S** | **S** | **S** | **S** | **B** | **S** | **B** |
| Total Phosphorus | ■♦ | ■ | ♦ | ♦ | ♦ | ■ | ■ | ■ | ■ |
| Dissolved Phosphorus | ■ | ■ | | | | | | ■ | ■ |
| Chlorophyll-*a* | ■ | | ♦ | ♦ | ♦ | ■ | | | |
| Total Kjeldahl Nitrogen | ■ | ■ | ● | ● | ● | ■ | | ■ | ■ |
| Nitrate-Nitrite Nitrogen | ■ | ■ | ● | ● | ● | ■ | | ■ | ■ |
| Ammonia Nitrogen | ■ | ■ | ● | ● | ● | ■ | | ■ | ■ |
| Laboratory Conductivity | ■ | ■ | | | | | | | |
| Laboratory pH | ■ | ■ | | | | | | | |
| Total Alkalinity | ■ | ■ | | | | | | | |
| Total Suspended Solids | ■ | ■ | | | | ■ | ■ | ■ | ■ |
| Calcium | ■ | | | | | | | | |

♦ indicates samples collected as a part of the Citizen Lake Monitoring Network.
● indicates samples collected by volunteers under proposed project.
■ indicates samples collected by consultant under proposed project.

## *Watershed Analysis*

The watershed analysis began with an accurate delineation of Lake Metonga's drainage area using U.S.G.S. topographic survey maps and base GIS data from the WDNR. The watershed delineation was then transferred to a Geographic Information System (GIS). These data, along with land cover data from the National Land Cover Database (NLCD – Fry et. al 2011) were then combined to determine the watershed land cover classifications. These data were modeled using the WDNR's Wisconsin Lake Modeling Suite (WiLMS) (Panuska and Kreider 2003)

### *Point-Intercept Macrophyte Survey*

Comprehensive surveys of aquatic macrophytes were conducted on Lake Metonga to characterize the existing communities within the lake and include inventories of emergent, submergent, and floating-leaved aquatic plants within them. The point-intercept method as described in the Wisconsin Department of Natural Resource document, Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry, and Analysis, and Applications (WDNR PUB-SS-1068 2010) was used to complete this study.

### *Floating-Leaf & Emergent Plant Community Mapping*

During the species inventory work, the aquatic vegetation community types within Lake Metonga (emergent and floating-leaved vegetation) were mapped using a Trimble Pro6T Global Positioning System (GPS) receiver with sub-meter accuracy. Furthermore, all species found during the point-intercept surveys and the community mapping surveys were recorded to provide a complete species list for the lake.

### *AIS Mapping Surveys*

During these surveys, the entire littoral area of the lake was surveyed through visual observations from the boat. Field crews may supplement the visual survey by deploying a submersible camera along with periodically doing rake tows. The AIS population is mapped using sub-meter GPS technology by using either 1) point-based or 2) area-based methodologies. Large colonies >40 feet in diameter are mapped using polygons (areas) and were qualitatively attributed a density rating based upon a five-tiered scale from *highly scattered* to *surface matting*. Point-based techniques were applied to EWM locations that were considered as *small plant colonies* (<40 feet in diameter), *clumps of plants*, or *single or few plants*.

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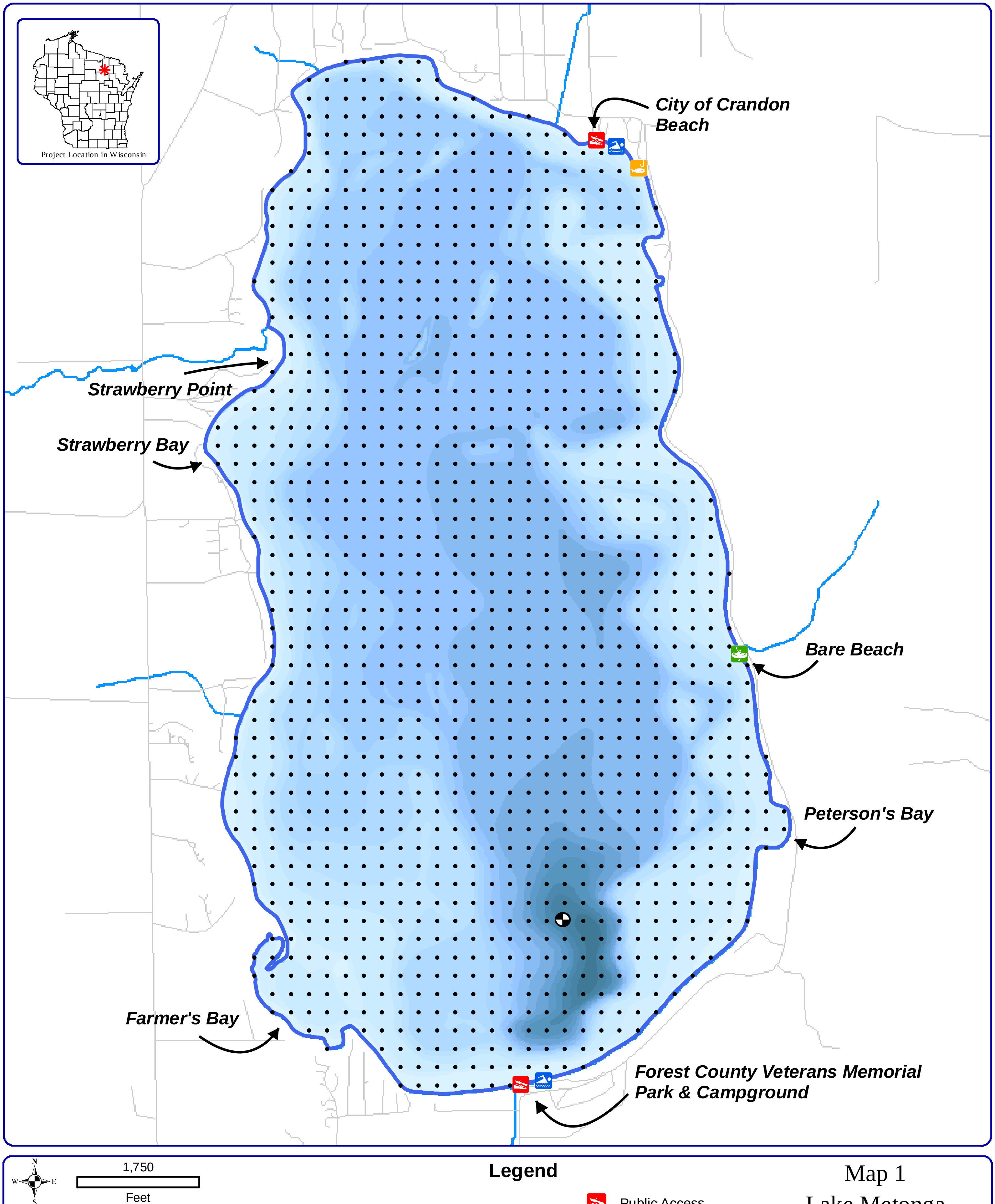


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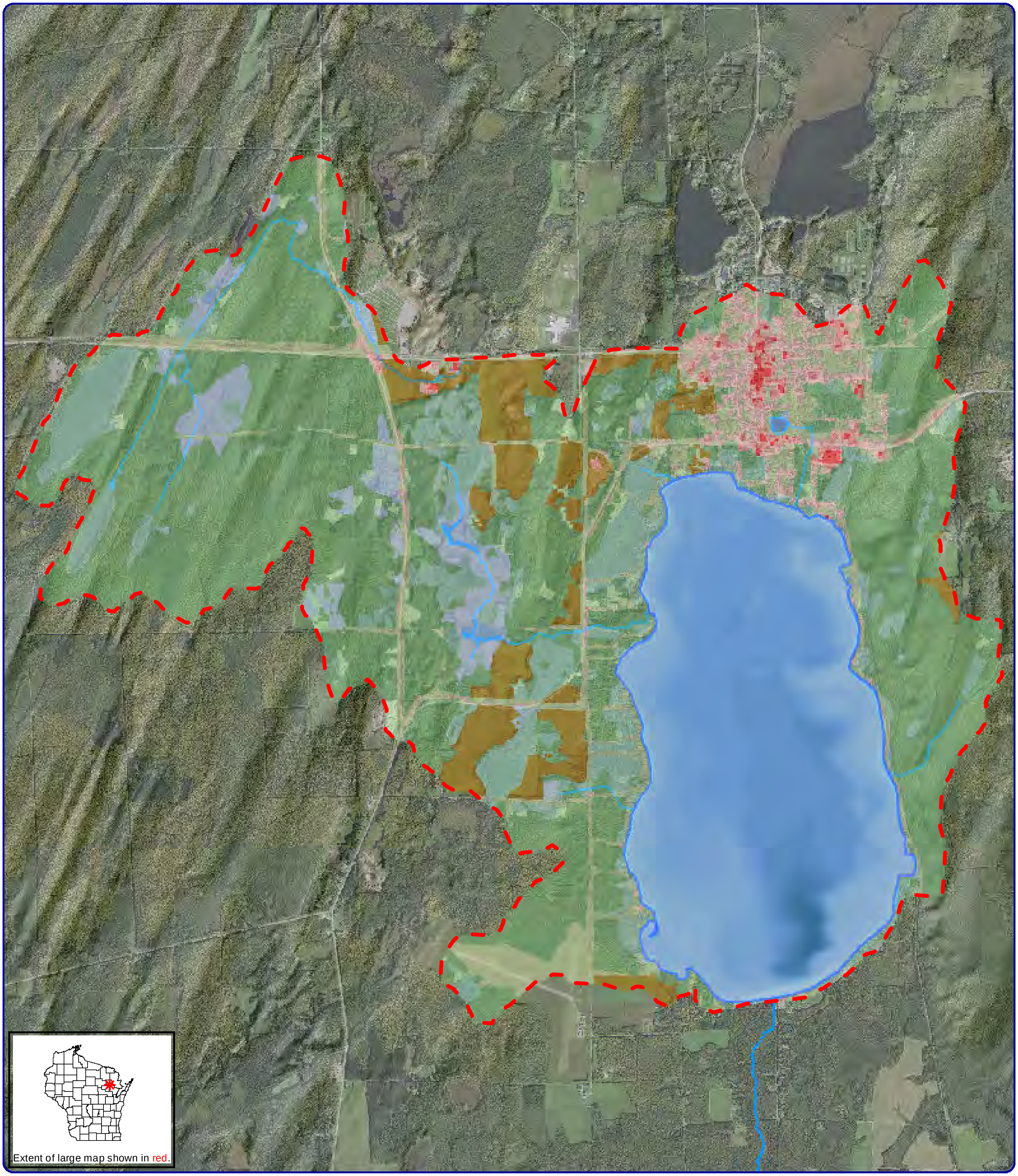
Sources:
Roads and Hydro: WDNR
Bathymetry: Modeled by Onterra
Map Date: August 2, 2019

Map 1
Lake Metonga
Forest County, Wisconsin
**Project Location & Lake Boundaries**




N
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1,400
Feet


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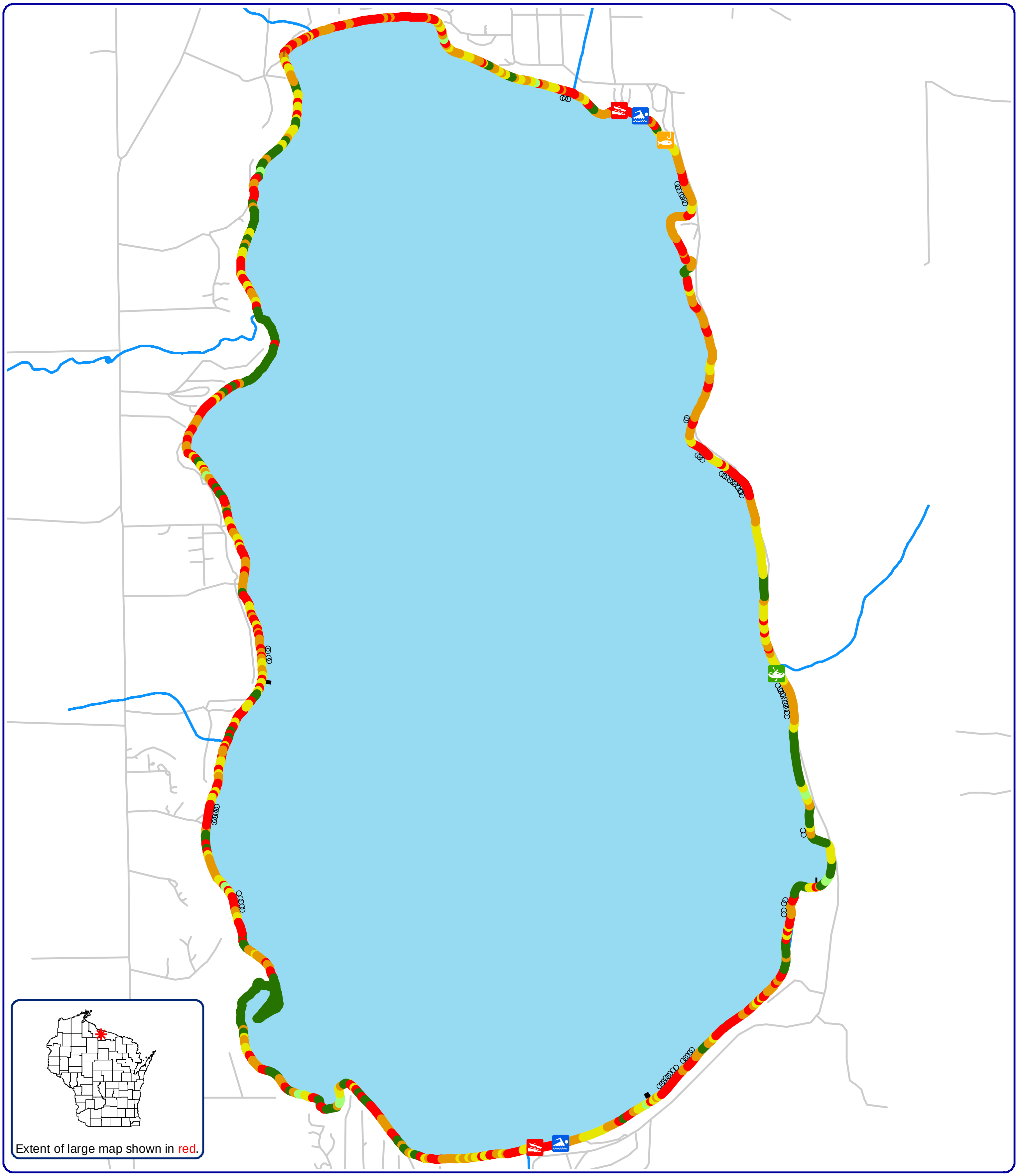
**Sources:**
Hydro: WDNR
Bathymetry: WDNR Digitized by Onterra
Orthophotography: NAIP 2017
Land Cover: NLCD, 2011
Watershed Boundaries: Onterra, 2019
**Map Date:** August 2, 2019
*File Name: Map2_MetongaForest_WS.mxd*

**Legend**

- Forest
- Forested Wetlands
- Pasture/Grass
- Open Water
- Wetland
- Row Crop Agriculture
- Rural Open Space
- Rural Residential
- Urban - High Density
- Urban - Medium Density

Map 2
Lake Metonga
Forest County, Wisconsin
# Watershed Boundaries & Land Cover Types

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Feet

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**Sources**
Hydro: WDNR
Shoreland Assessment: Onterra, 10/30-31/2018
Orthophotography: NAIP, 2017
Map date: April 3, 2019 AMS
*Filename: Metonga_SCA_2018.mxd*

**Legend**

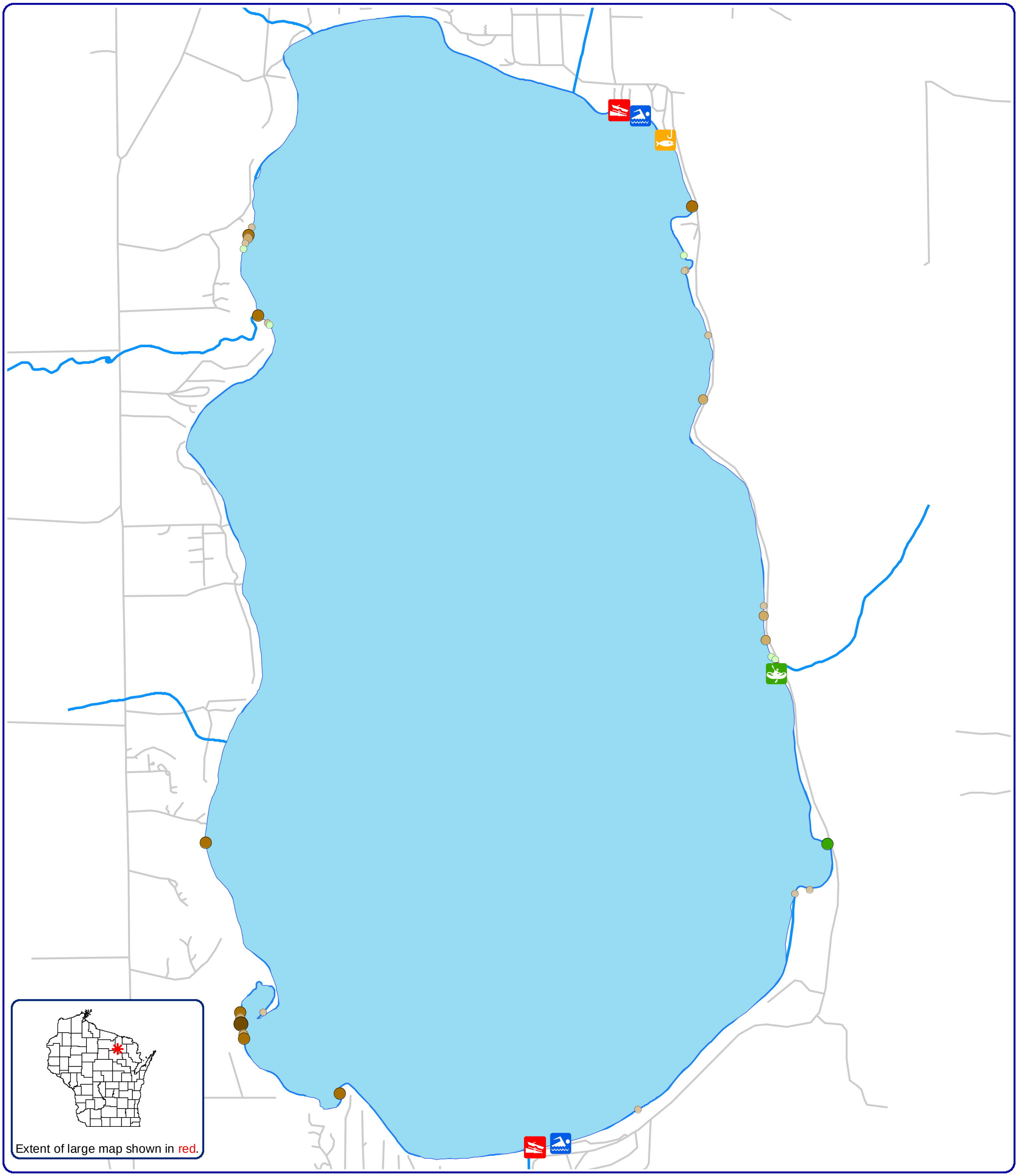
- Natural/Undeveloped
- Developed-Natural
- Developed-Semi-Natural
- Developed-Unnatural
- Urbanized

Seawall Modifier

- Masonary/Wood Seawall
- Rip-Rap

Map 3
Lake Metonga
Forest County, Wisconsin

**Shoreland Condition Assessment**

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Feet

## Legend

| 2-8 Inch Pieces | 8+ Inch Pieces | Cluster of Pieces |
|---|---|---|
| No Branches | No Branches | No Branches |
| Minimal Branches | Minimal Branches | Minimal Branches |
| Moderate Branches | Moderate Branches | Moderate Branches |
| Full Canopy | Full Canopy | Full Canopy |

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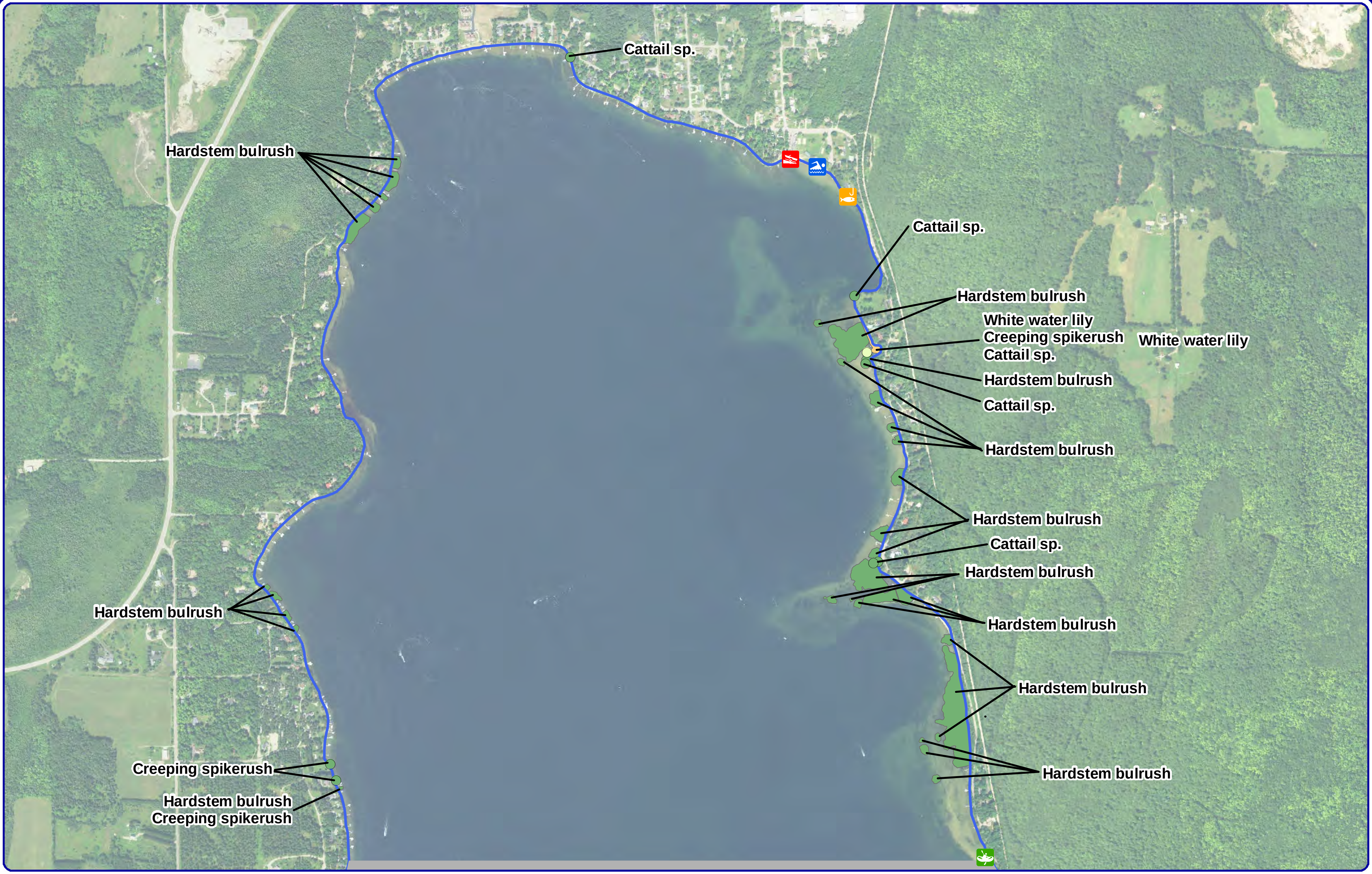
**Sources**
Hydro: WDNR
CWH Survey: Onterra, 10/30-31/2018
Orthophotography: NAIP, 2017
Map date: November 8, 2018 AMS
*Filename: Metonga_CWH_2018.mxd*

# Map 4
# Lake Metonga
Forest County, Wisconsin
## Coarse Woody Habitat

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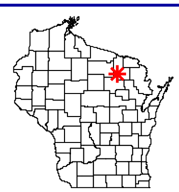
**Sources**
Hydro: WDNR
Aquatic Plants: Onterra, 7/28/2018, 8/2/2018
Orthophotography: NAIP, 2018
**Map date:** November 6, 2018 JLW/AMS
*Filename: Metonga_Comm_2018_North.mxd*


Project Location in Wisconsin

**Legend**

**Small Plant Communities**
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

**Large Plant Communities**
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

Map 5

Lake Metonga
Forest County, Wisconsin

**Aquatic Plant Communities - North**


1,000

Feet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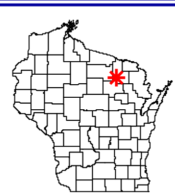
**Sources**
Hydro: WDNR
Aquatic Plants: Onterra, 7/28/2018, 8/2/2018
Orthophotography: NAIP, 2018
**Map date:** Novemeber, 6, 2018 JLW/AMS
*Filename:MapX_Metonga_Comm_2018_South.mxd*



Project Location in Wisconsin

## Legend

**Small Plant Communities**
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

**Large Plant Communities**
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

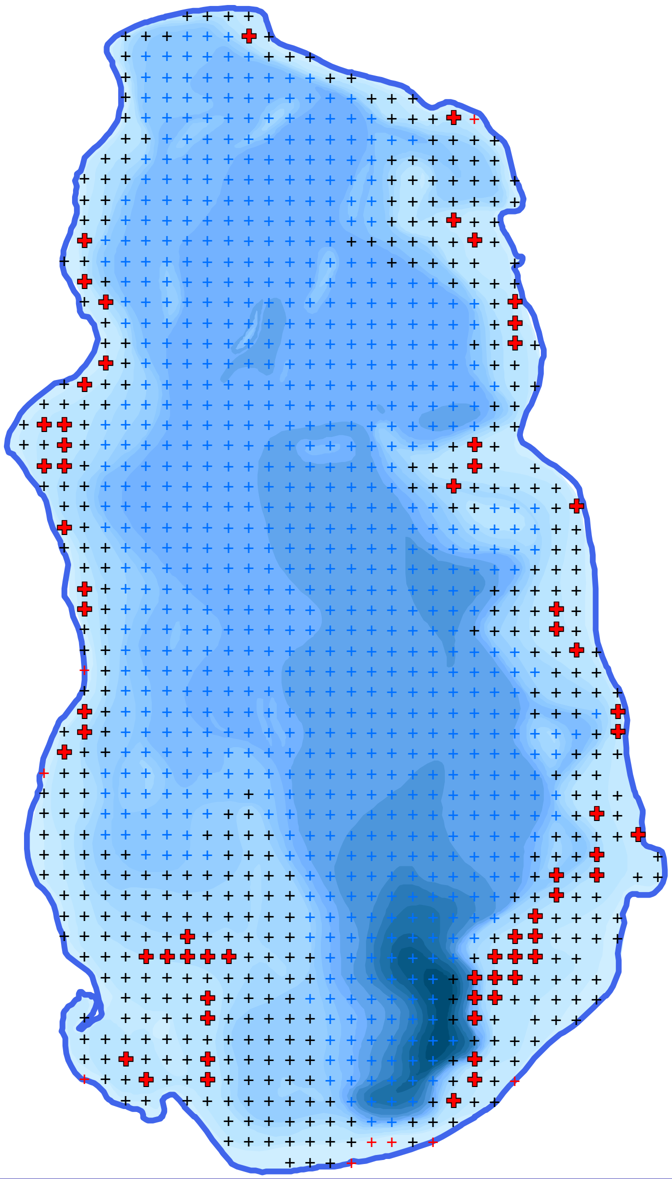
Map 6

# Lake Metonga

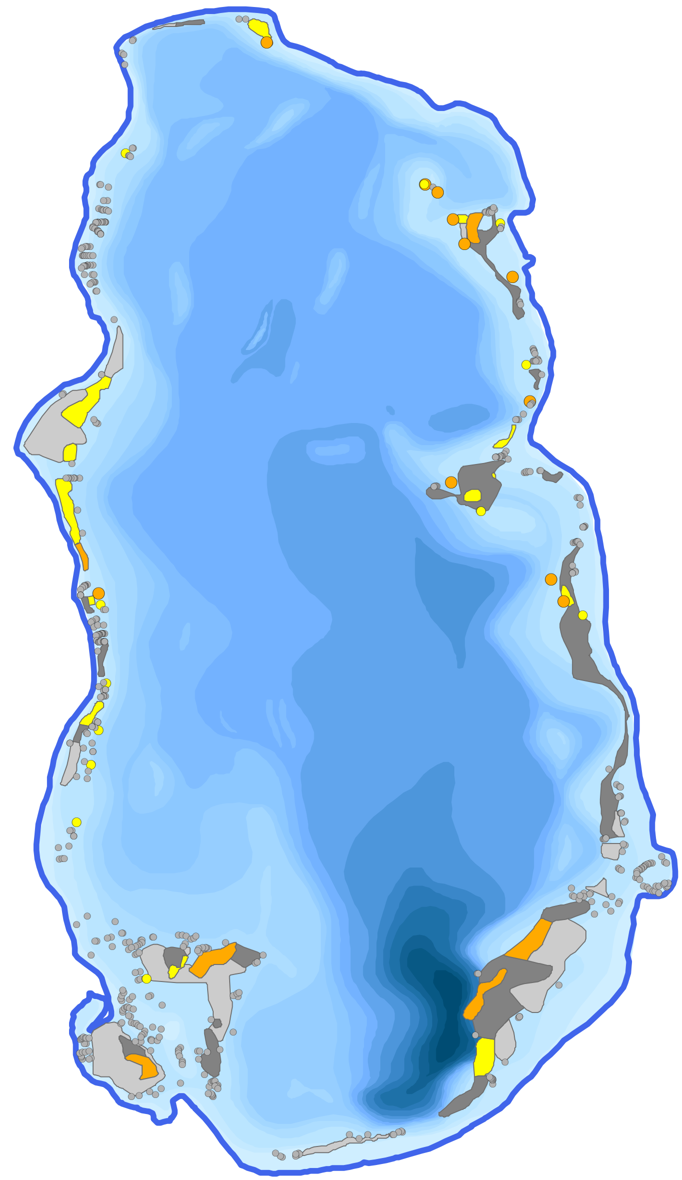
Forest County, Wisconsin

# Aquatic Plant Communities-South

# Summer 2018 Point-Intercept Survey



# Summer 2018 EWM Mapping Survey



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Feet

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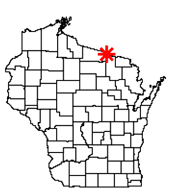
**Sources:**
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Point-Intercept Survey: Onterra, 7/23-24/2018
EWM Mapping Survey: Onterra, 10/2/2018
**Map Date:** August 6, 2019



Project Location in Wisconsin

**Legend**

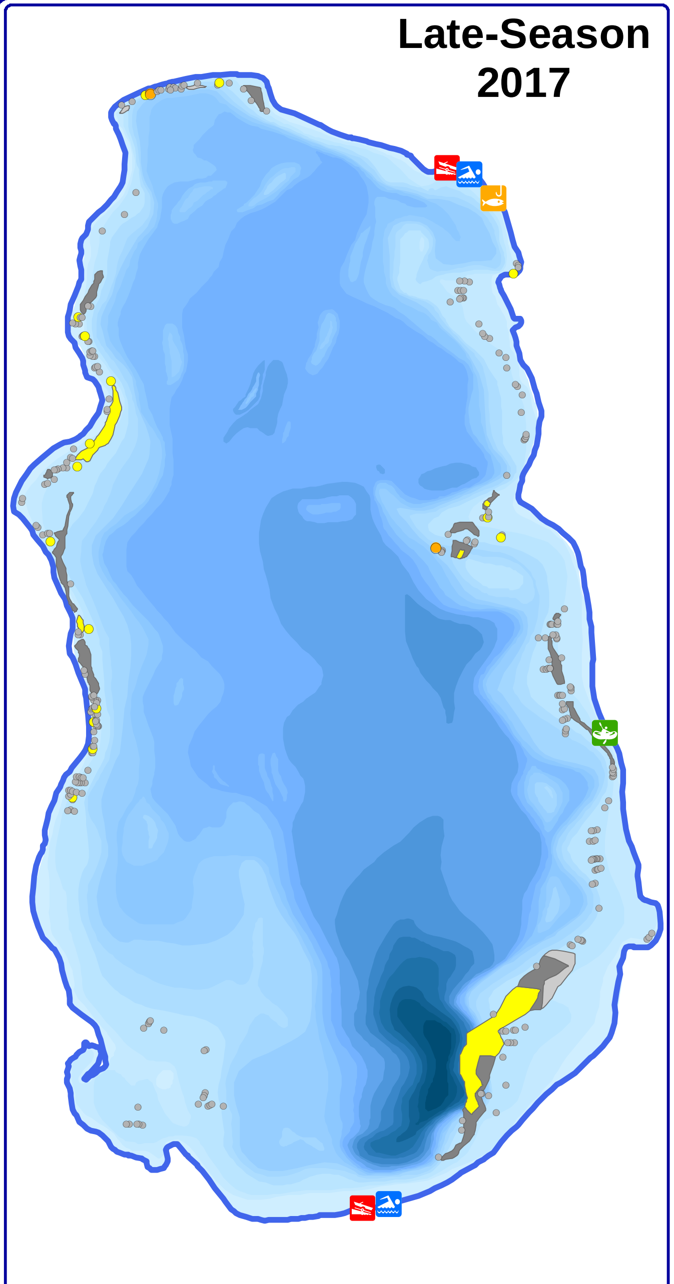
**Left Frame**
- > Max Depth of Plant Growth
- No EWM, Within Littoral Zone
- EWM Present

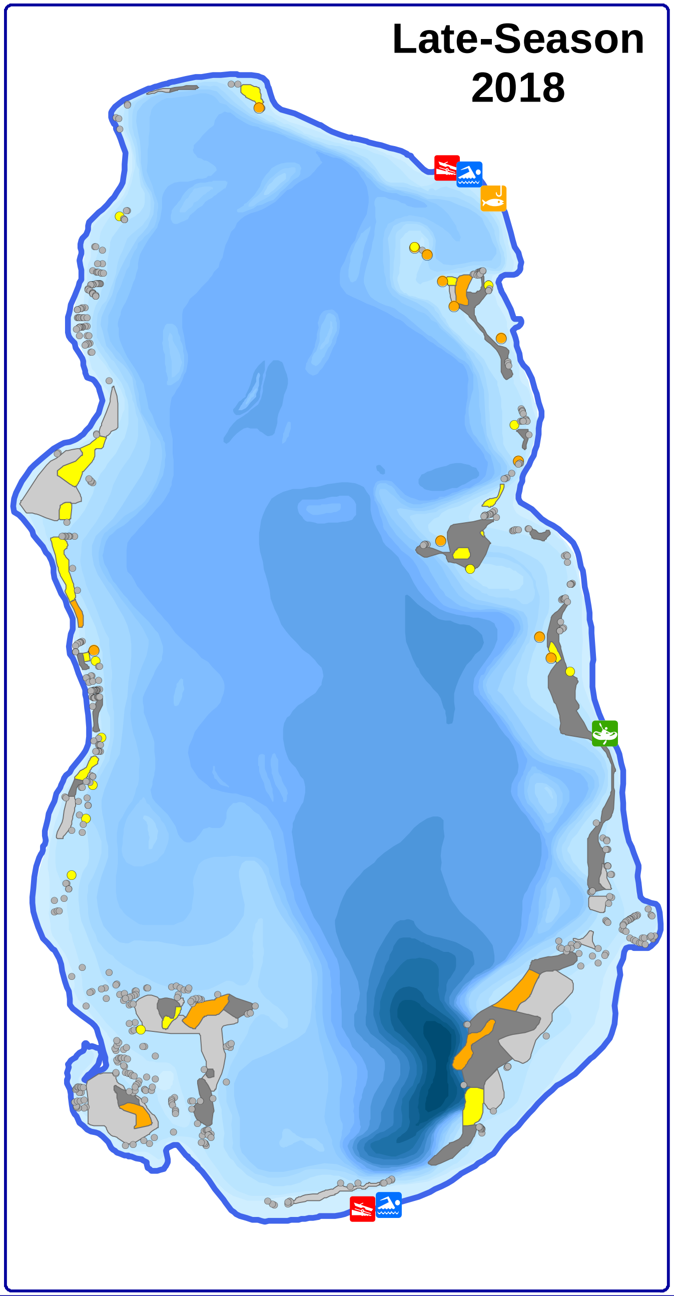
**Right Frame**
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony

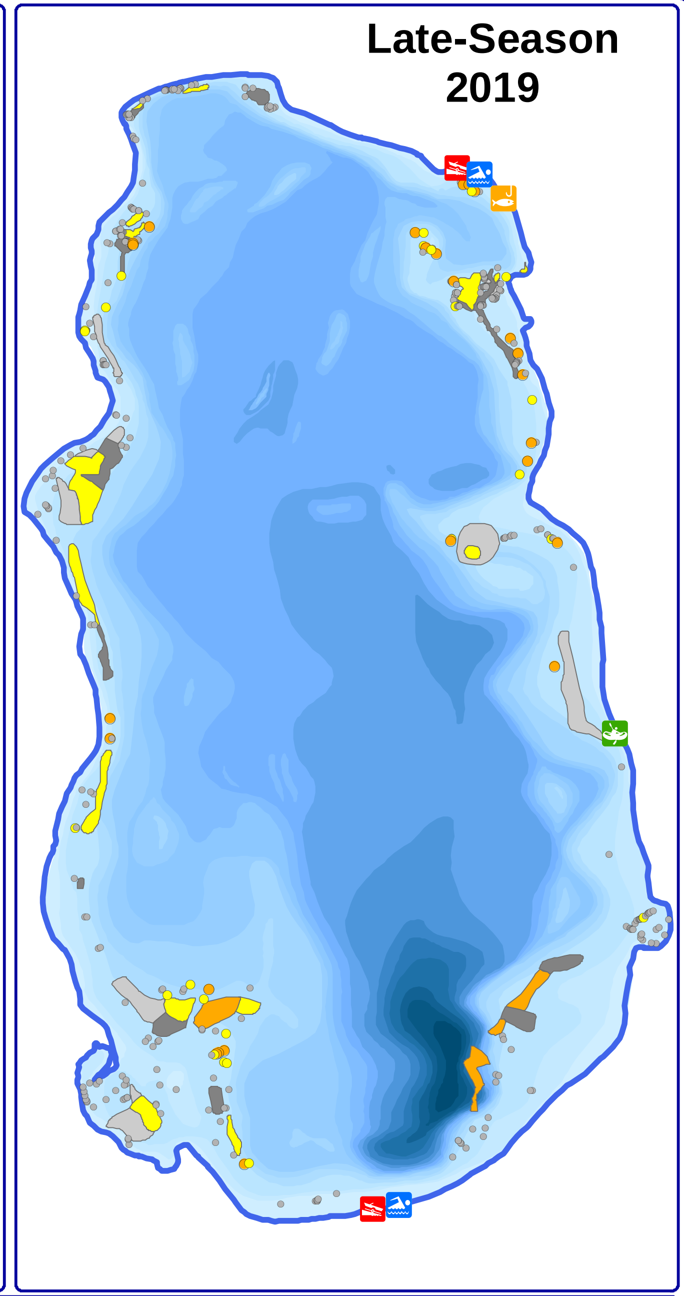
Map 7

Lake Metonga
Forest County, Wisconsin

**Summer 2018 Comparison**
**EWM Mapping vs PI Survey**




N
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2,500

Feet

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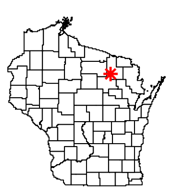
**Sources:**
Roads and Hydro: WDNR
Aquatic Plants:
Onterra, 9/21/2017
Onterra, 10/2/2018
Onterra, 9/20/2019, 10/2/2019
**Map Date:** January 9, 2020 - EJH



Project Location in Wisconsin

**Legend**

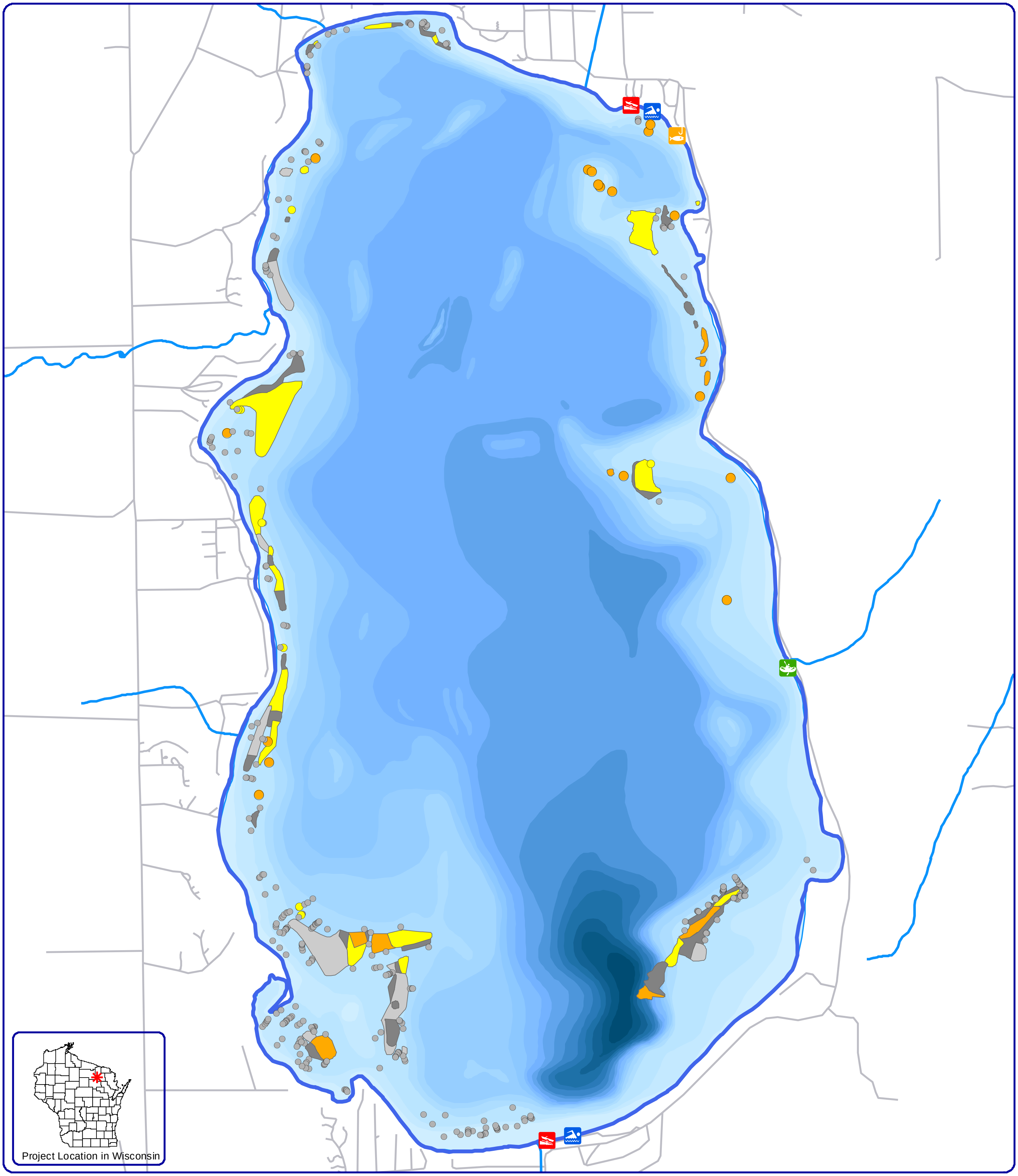
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony

Map 8

Lake Metonga

Forest County, Wisconsin

**EWM Survey Results**
**2017-2019**




N
W E
S
1,700
Feet

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*De Pere, WI 54115*
*920.338.8860*
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**Sources**
Roads and Hydro: WDNR
Bathymetry: Onterra
Aquatic Plants: Onterra, 2020
**Map Date:** November 10, 2020 - HAL
**Filename:** *Metonga_EWM_PB_Sept20.mxd*

**Legend**
***EWM Survey (9/25/2020, 9/28/2020)***
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony

Map 9
Lake Metonga
Forest County, Wisconsin
**2020 Late-Season EWM Survey Results**