Pelican Lake

Oneida County, Wisconsin

Comprehensive Management Plan

August 2024

Official First Draft

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Acknowledgements

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

Pelican Lake Planning Committee

Bob Mott – Planning Committee Chair	Scott Sankey	Jim Frymark
Kerry Romsa - President	Dennis VandenHeuvel	Brian Schell
Bob Kraetsch	Steven Tripp	Graham Ness
Kelly Kraetsch	Rick Steiner	
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TABLE OF CONTENTS

FIGURES

TABLES

PHOTOS

MAPS

APPENDICES

1.0 INTRODUCTION

Pelican Lake is a drainage lake situated in the Towns of Schoepke and Enterprise, WI with a maximum depth of 39 feet. Based on heads-up digitizing of 2022 *National Agriculture Imagery Program* (NAIP) orthophoto (aerial photograph), the lake was determined to be 3,544 acres. Water flows north out of Outlet Bay through the South Pelican Dam, into the Pelican River, which ultimately drains into the Wisconsin River in Rhinelander (Figure 1.0-1, Map 1). This eutrophic lake has a relatively large watershed when compared to the size of the lake.

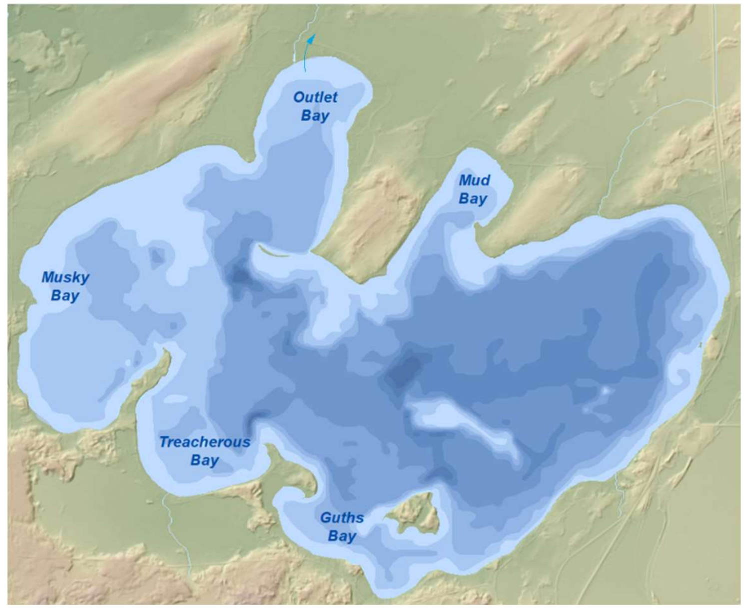


Figure 1.0-1. Pelican Lake, Oneida County.

The Wisconsin River Reservoir system consists of 21 Wisconsin Valley Improvement Company (WVIC) water storage reservoirs used to maintain a nearly uniform flow of water as practicable in the Wisconsin River by storing surplus water in reservoirs for discharge when water supply is low to improve the usefulness of the rivers for hydropower, flood control, and public use (Figure 3.1-3). Of these 21 reservoirs, 16 are natural-lake reservoirs and 5 are man-made reservoirs constructed between 1911 and 1937. The man-made reservoirs account for 73% of WVIC's usable water storage.

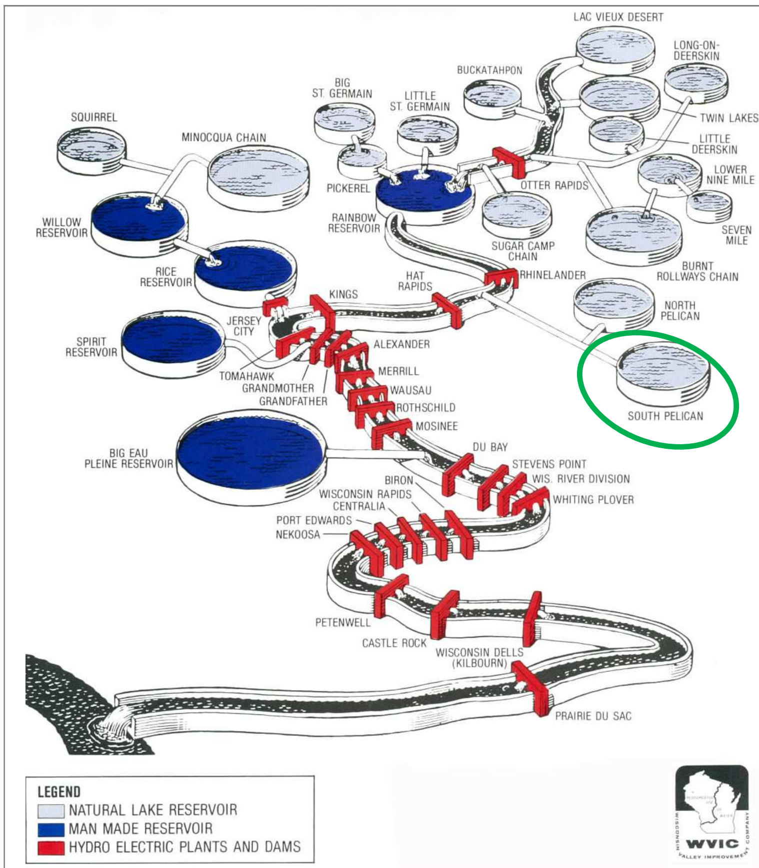


Figure 1.0-2. WVIC reservoir system. Pelican Lake is outlined in green. Adapted from WVIC website.

Natural lake reservoir water levels are maintained within a relatively narrow range in comparison to the five man-made reservoirs which exhibit changes of water levels that could span 10-20 feet in a single year. Pelican Lake is one of the natural lake reservoirs in the WVIC system, and has an operational range of 6 inches during the summer months. The water levels need to be kept between

1,591.98 and 1,591.48 between April 1 and October 31 of each year. Winter drawdowns cannot exceed 1,589.98, which is two feet below full pool (Figure 1.0-3). In addition to establishing a range of water levels, minimum outflows are also set to make sure the downstream riverine systems are not negatively impacted by abnormally low flows. Pelican Lake must maintain a minimum flow, such that the water control structure has a 1 inch gate opening. The Pelican Lake Association, WDNR, and WVIC have been in recent communication as it relates to the dam operating order and FERC license.

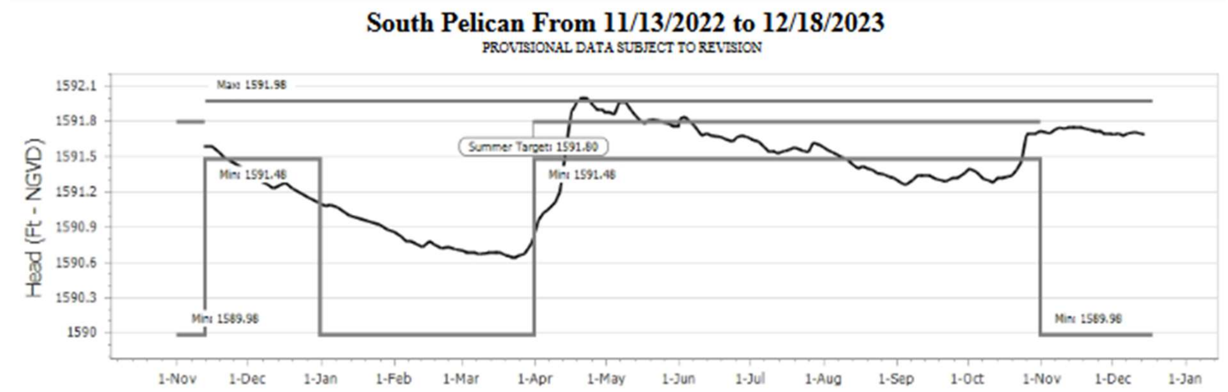


Figure 1.0-3. South Pelican water levels. Data extracted from WVIC website: https://www.wvic.com/Content/Data--Reports.cfm .

Pelican Lake is managed by the Pelican Lake Association (PLA), formerly called the Pelican Lake Property Owners Association, which was founded to preserve, protect, and enhance the waters of Pelican Lake and its watershed. The PLA previously completed a comprehensive management planning project in 2013. Since that plan's development, the PLA has been managing and monitoring Eurasian watermilfoil (EWM).

With Onterra's assistance, the PLA successfully applied for a WDNR grant in November of 2022 to update the PLA's 2013 management plan for the lake as well as consider changes that have occurred on the lake since that time. This was completed by gathering and analyzing historical and current ecological data, identifying threats, determining goals and values of stakeholders, present feasible management actions, and increase the lake group's capacity to implement the management plan. Fieldwork for this effort was conducted during the summer of 2023, with planning discussions and public outreach occurring during the spring and summer of 2024.

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

2.1 Strategic Planning Committee Meetings

Planning committee meetings were used to gather comments, create management goals and actions and to deliver study results.

Planning Committee Meeting – EWM Management Information

On May 5, 2023, approximately 8 planning committee members met with Eddie Heath about the forthcoming management planning project with specific attention to the EWM population of Pelican Lake. This meeting focused on EWM alternative management analysis, risk assessments, and pros/cons of various techniques such as herbicide treatment, mechanical harvesting, and manual removal (includes DASH).

Planning Committee Meeting I

On April 17, 2024, Eddie Heath met with the PLA Planning Committee at the Pelican Lake Fire Department's conference room. This roughly five-hour meeting largely consisted of a presentation of the available data from the system to serve a solid foundation for developing the management goals and associated actions aimed to reach those goals in the second planning committee meeting.

Planning Committee Meeting II

The second planning committee meeting was again held at the Pelican Lake Fire Department on May 16, 2024. This meeting concentrated on the development of management goals and actions that make up the framework of the implementation plan by the PLA planning committee. This meeting had extensive discussions on varying management options, how each technique could be used in reaching potential management goals, and risk assessment of the techniques. Following the meeting, Onterra created a draft written Implementation Plan attempting to capture the collective sentiments of the planning committee. Comments were generated by the planning committee and were integrated into the finale version of the Implementation Plan Section (5.0) presented here.

2.2 Management Plan Review and Adoption Process

On August 14, 2024, the Official First Draft of the PLA's *Comprehensive Management Plan* for Pelican Lake was supplied to WDNR (lakes and fisheries programs), GLIFWC, the Sokaogon Chippewa Community (Mole Lake Tribe), and Oneida County by Onterra via email.

At that time, the Official First Draft was made available for public review on the PLA website and advertised as an official public comment period through an email blast to all association members.

Eddie Heath of Onterra presented the draft Implementation Plan developed by the PLA Planning Committee on August 10, 2024, to the general public at the Pelican Lake Fire Department. The meeting was also streamed using the PLA's Zoom Link. This meeting further alerted the PLA and Pelican Lake riparians that the draft plan would soon be on the website and an opportunity to provide written comments on the draft plan.

2.3 Stakeholder Survey

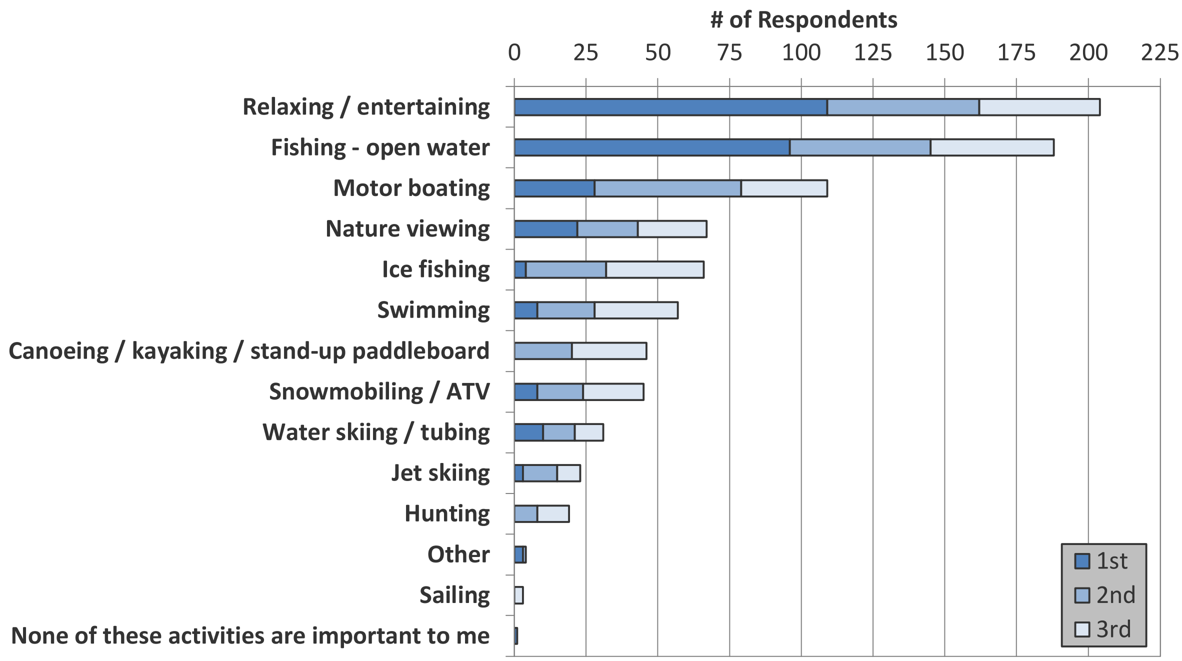
As a part of this project, a stakeholder survey was distributed to Pelican Lake Association members and riparian property owners around Pelican Lake in 2023. The survey was designed by Onterra staff and the Pelican Lake Association planning committee and reviewed by a WDNR social scientist. From August 28th to October 19th, the 12-page, 45-question survey was posted online through Survey Monkey for survey-takers to answer electronically. If requested, a hard copy was sent with a self-addressed stamped envelope for returning the survey anonymously. The returned hardcopy surveys were entered into the online version by a Pelican Lake Association volunteer for analysis. Fifty-two percent of the surveys were returned upon the survey closing date. Please note that typically a benchmark of a 60% response rate is required to portray population projections accurately, and make conclusions with statistical validity. 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 who use and care for Pelican Lake. 39% of respondents indicated that they live on the lake as year-round residents, 26% they visit on weekends through the year, and 24% visit during the summer months only. 71% of respondents have owned or rented from their property for 11 or more years, and 49% have for over 25 years.

The following sections (Water Quality, Watershed, Aquatic Plants and Fisheries Data Integration) discuss the stakeholder survey data with respect these particular topics. Figures 2.3-1 and 2.3-2 highlight other questions found within this survey. More than half of survey respondents indicate that they use a motor boat with greater than 25 hp, pontoon, canoe/kayak, or a combination of these three vessels on Pelican Lake (Question 18). The importance of responsible boating activities is increased during weekends and holidays when boat traffic is highest. As seen on Question 9, several of the top recreational activities on the lake involve boat use. Although boat traffic was ranked 13th on a list of stakeholder's top concerns regarding the lake (Question 21). Meaning, survey respondents have other higher concerns and boat traffic is a lower concern on the lake.

A concern of stakeholders noted throughout the stakeholder survey (see Question 43 and survey comments – Appendix B) was water levels within Pelican Lake and the management of the dam. This topic is touched upon in the Summary & Conclusions section as well as within the Implementation Plan.

Question 9: Please rank up to three activities that are important reasons for owning your property on or near Pelican Lake, with 1 being the most important.



Question 18: What types of watercraft do you currently use on Pelican Lake?

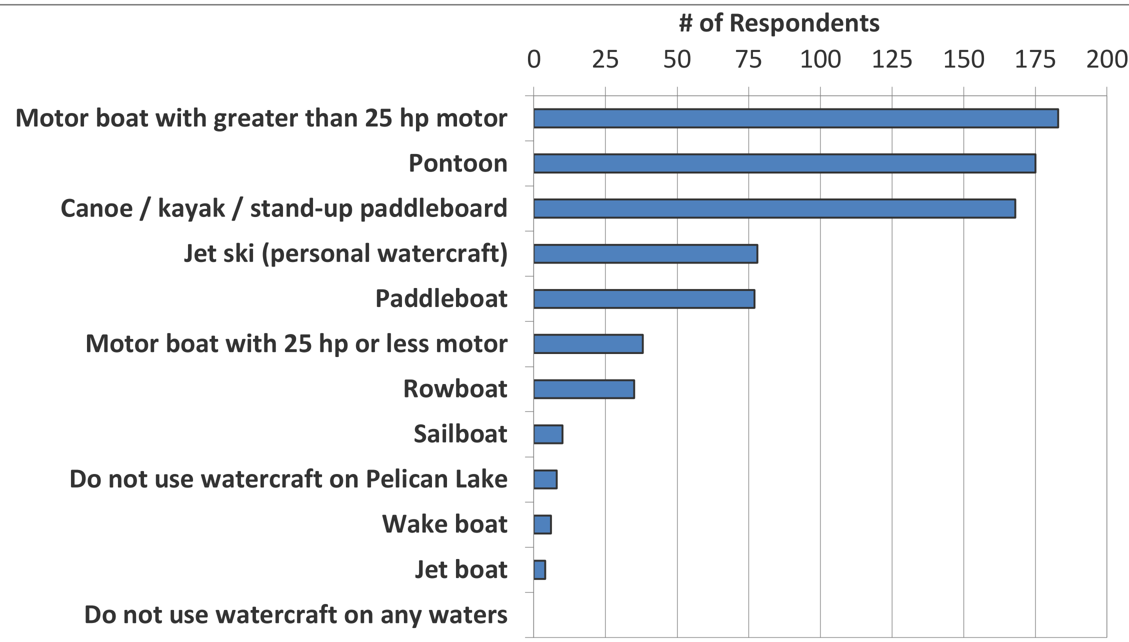


Figure 2.3-1. Select survey responses from the Pelican Lake stakeholder survey. Additional questions and response charts may be found in Appendix B.

Question 21: From the list below, please rank your top three concerns regarding Pelican Lake, with 1 being your greatest concern.

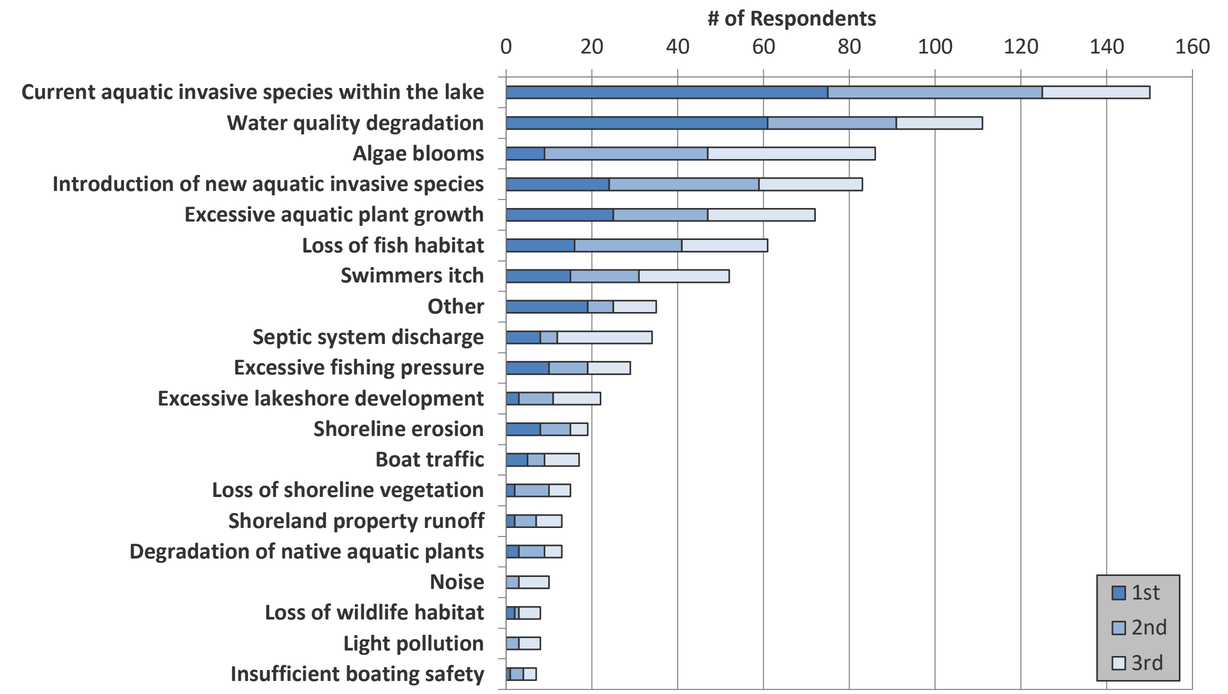


Figure 2.3-2. Select survey responses from the Pelican Lake stakeholder survey. Additional questions and response charts may be found in Appendix B.

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 Pelican Lake 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 Pelican Lake 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) (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 2020 Consolidated Assessment and Listing Methodology* (WDNR 2019) 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 Pelican Lake 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 (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, watershed, and hydrology, Pelican Lake is classified as a shallow lowland drainage lake (category 2 on Figure 3.1-1).

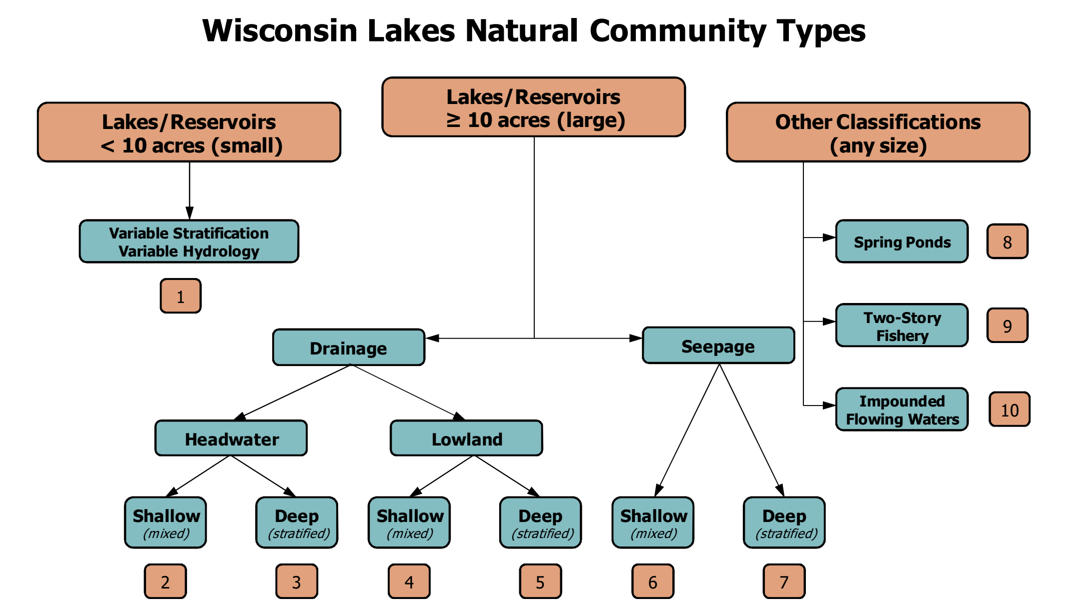


Figure 3.1-1. Wisconsin Lake Natural Communities. Adapted from WDNR 2017.

(Garrison et al. 2008) developed statewide 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. Pelican Lake is within the Northern Lakes and Forests ecoregion.

Figure 3.1-2. Location of Pelican Lake within the ecoregions of Wisconsin. After (Nichols 1999).

The Wisconsin 2020 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 Pelican Lake 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.

Pelican Lake Water Quality Analysis

Pelican Lake Long-term Trends

Pelican Lake is fortunate to have a long and consistent water quality dataset extending back to the late 1980s. These data have been collected through the WDNR Long-term Trends sampling program, Wisconsin Valley Improvement Company sampling, and volunteer sampling through the WDNR Citizens Lake Monitoring Network.

Total phosphorus values in Pelican Lake fluctuate greatly from year-to-year (3.1-3). Growing season values range from 4 µg/L in March 1994 to 60 µg/L in August 2003. Much of the time, the concentrations range in the *Good* to *Fair* range for shallow lowland drainage lakes, but occasional values occur in the *Excellent* category and a handful have occurred in the poor category. The weighted summer mean value for the entire dataset is in the high *Good* category and slightly better than the median value for shallow lowland drainage lakes. The mean is higher than that found in lakes of all types within the Northern Lakes and Forests Ecoregion.

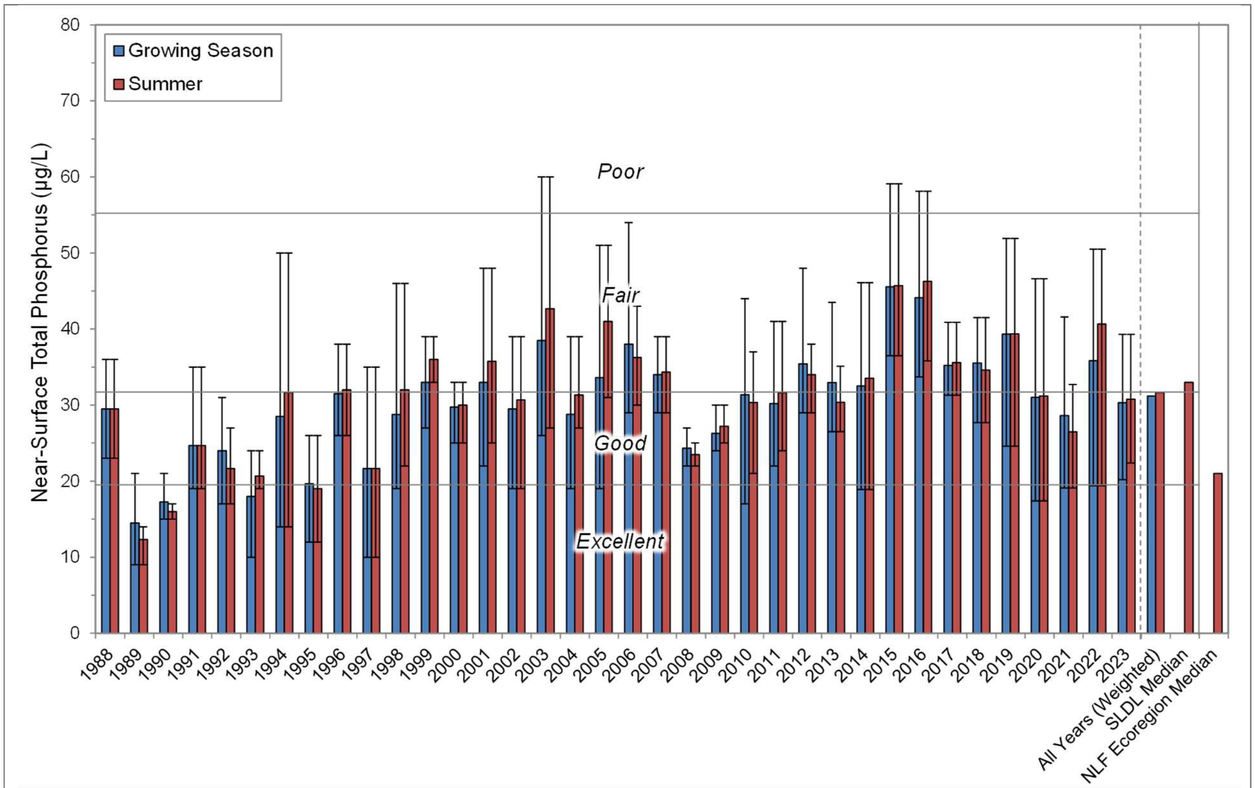


Figure 3.1-3. Pelican Lake, statewide class 2 lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Chlorophyll-*a* concentrations fluctuate greatly in Pelican Lake as well (Figure 3.1-4). Concentrations range between 1.2 µg/L in June 2007 to 56.9 in September 2007. Most of the values fall in the *Good* and *Fair* categories for shallow lowland drainage lakes, but several values have exceeded the *Poor* threshold. The weighted summer mean value is higher than the medial values for both shallow lowland drainage lakes and the ecoregion. Year-to-year means follow the same basic pattern that the phosphorus values follow, which is discussed more below.

Chlorophyll-*a* concentrations in Pelican Lake are on average higher than expected given the concentration of phosphorus. These data indicate that Pelican Lake has the capacity to develop algal blooms which are likely perceivable by lake users. The threshold at which algal blooms are considered to become a nuisance is above 20 µg/L. The 20 µg/L threshold is based upon user perception and is not an indicator of increased risk. It is simply the concentration at which lake users typically notice the algae and may conclude that the lake is not good for swimming that the time, but other recreational activities, like boating, are appropriate. As illustrated in Figure 3.1-4, the error bars exceed this threshold in most years, indicating that at least one sample during that year was collected during an algal bloom. Pelican Lake was evaluated every two-year cycle from 2014 to 2024; Pelican Lake's chlorophyll-*a* concentrations exceeded 30% of days above 20 µg/L, one of the criteria for placement on the Clean Water's Act 303(D) Impaired Waters list.

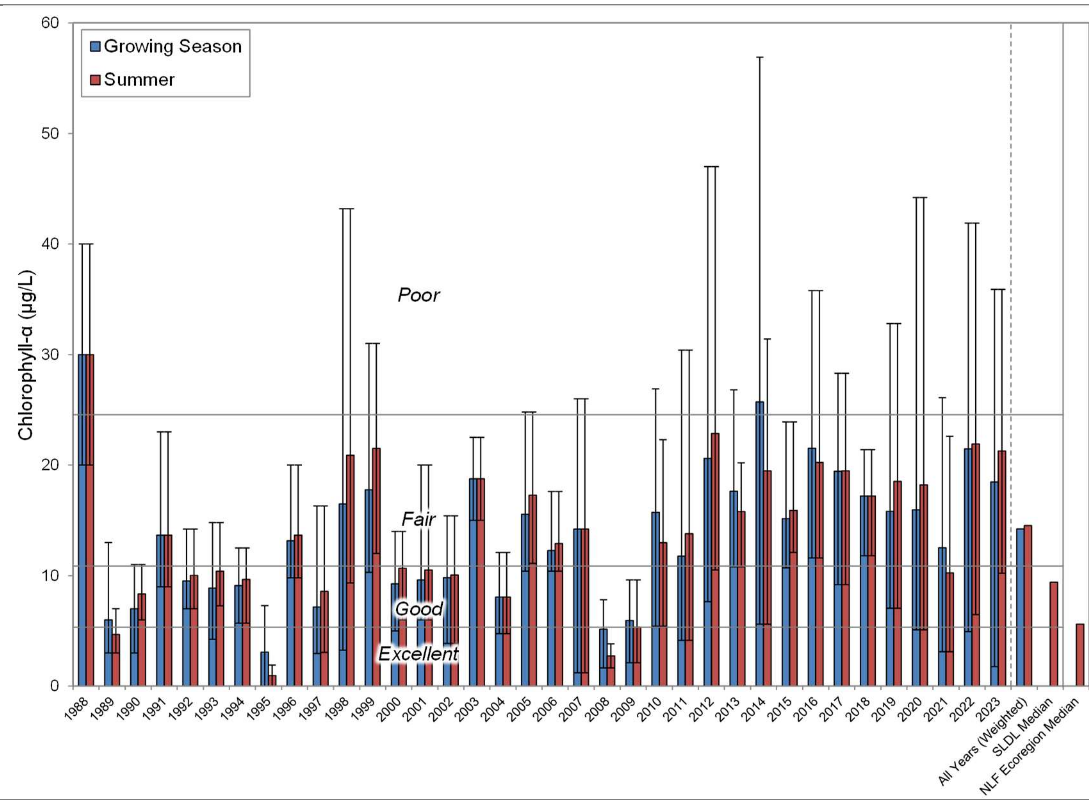


Figure 3.1-4. Pelican Lake, statewide class 2 lakes, and regional chlorophyll-a concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Secchi disk transparency values for Pelican Lake can be found in Figure 3.1-5. Overall, the summer weighted mean value of 6.4 feet is slightly better than the median value for other shallow lowland drainage lakes, but shallower than the Northern Lakes and Forest Ecoregion median. Like phosphorus and chlorophyll-*a* values, the transparency data fluctuate greatly, but for the most part, remain in the *Good* category with many values extending well into the *Excellent* category. The highest value of 18 feet occurred in May 2007, while the shallowest reading of 1 foot occurred during the summers of 2012 and 2014.

During the 2013 planning project, the limiting nutrient in Pelican Lake was determined to be phosphorus. Examining nitrogen and phosphorus values since then leads to the same conclusion. For instance, using midsummer nitrogen and phosphorus concentrations from Pelican Lake during 2023, a nitrogen:phosphorus ratio of 19:1 was calculated. Lakes with a ratio of 15:1 or greater are considered phosphorus limited; therefore, like most lakes in Wisconsin, phosphorus tends to control algal growth in Pelican Lake.

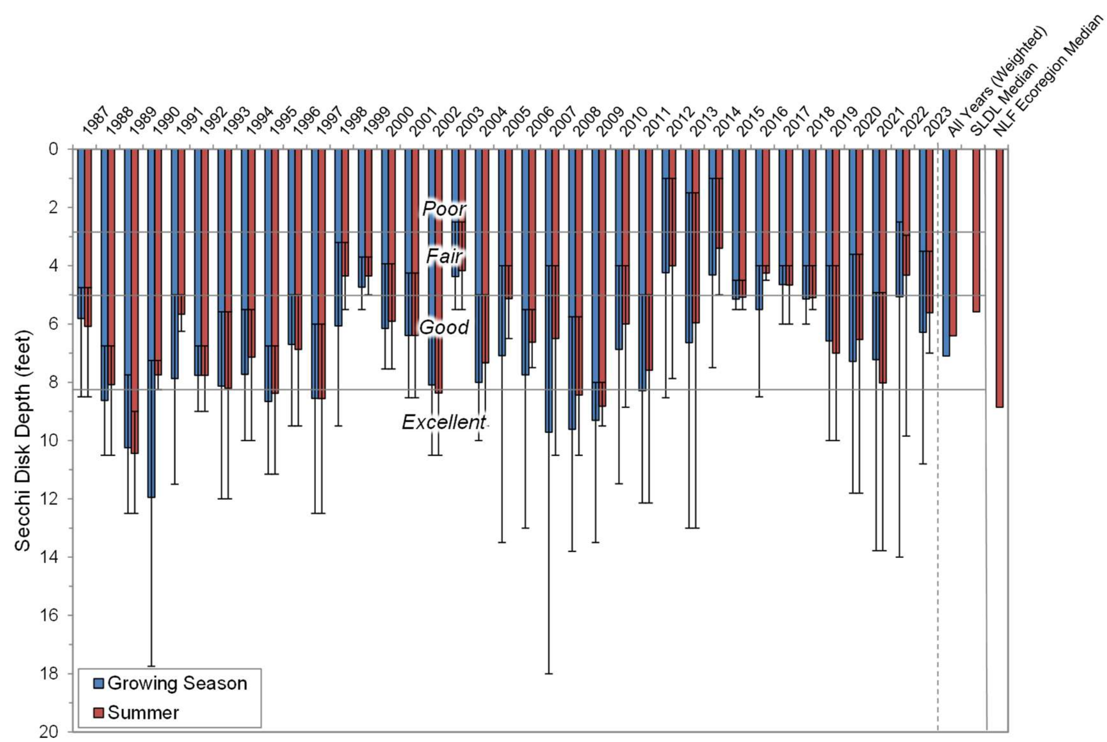


Figure 3.1-5. Pelican Lake, statewide class 2 lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

As alluded to above, the relationship between Pelican Lake's trophic parameters, phosphorus, chlorophyll-*a*, and Secchi transparency, is strong. Phosphorus is the limiting nutrient in the lake, so as its concentrations increase and decrease, so does the abundance algae, which is represented in chlorophyll-*a* concentrations that increase and decrease with the phosphorus. In most Wisconsin lakes, the most abundant particulate causing turbidity and decreasing water clarity is algae. So, as algae increase and decrease, Secchi disk values fall and rise.

Figure 3.1-6 displays average growing season mean values for the Pelican Lake trophic parameters. The pattern described above is apparent. Further, while there is great fluctuation in all three datasets, the increasing trend in phosphorus and chlorophyll-*a*, along with the decreasing trend in Secchi disk transparency is also apparent. This pattern for phosphorus was also discussed in the 2013 management plan for results up to 2011. The chlorophyll-*a* trend line was also displayed for the same time period, but was relatively flat; therefore, the apparent trend in Figure 3.1-6 is heavily influenced by the chlorophyll-*a* concentrations recorded since 2011.

It is difficult to determine if the trends are part of a long-term natural cycle or if there is some unnatural, increasing source of phosphorus entering the lake that is driving the trend. Internal nutrient loading may be part of this trend, but the limited data available only indicates its possibility, not its actual role or magnitude.

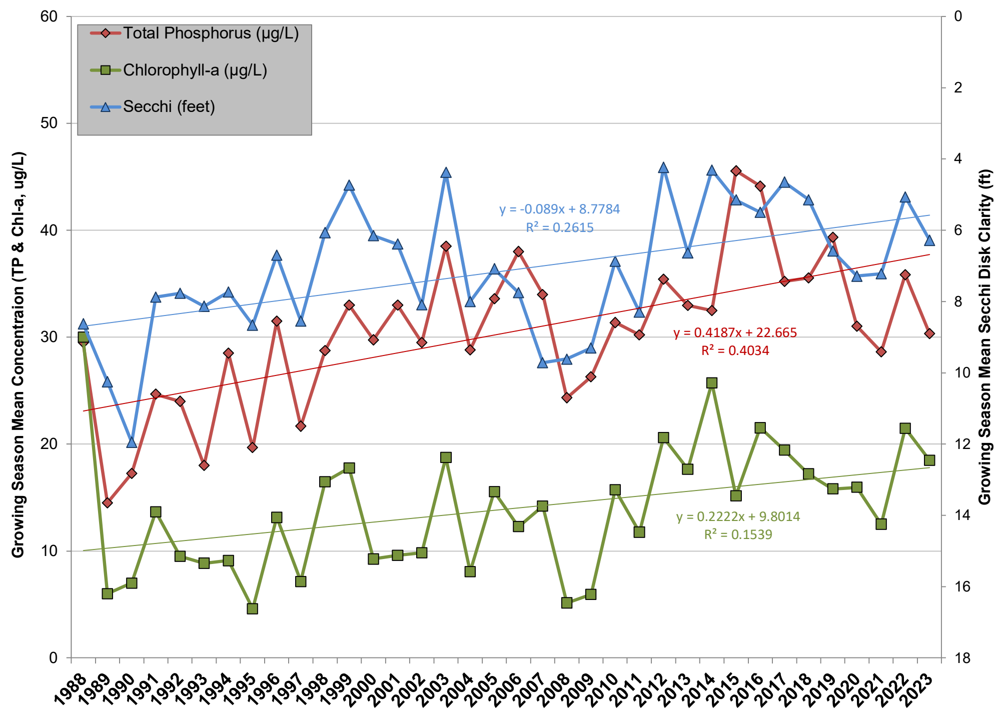


Figure 3.1-6. Pelican Lake growing season mean TP, chlorophyll-*a*, and Secchi disk clarity values. TP = total phosphorus. Note that a high chlorophyll-*a* value of 71 µg/L from August 2003 was removed from the analysis because it was possibly a false reading.

Shallow, mixed lakes like Pelican have a different pattern of internal nutrient loading than deep, stratified lakes. Pelican Lake is considered polymictic, meaning that it may stratify for short periods during the summer, but the stratification is weak, so a moderate wind event can overcome the differences in density between the stratified layers and mix the lake. Deep lakes that only mix (turnover) during the spring and fall are called dimictic lakes. In these lakes, the stratification sets up early in the summer and is stable throughout the growing season. During the fall when surface waters start to cool, that dense water sinks and starts the turnover process. In the spring as the ice comes off, water temperature increase slightly on the surface and as it reaches 4°C (39.2°F), the temperature at which it is most dense, the lake begins to turnover. As temperatures warm, the surface waters become less dense and remain at the top. The deepest layer, the hypolimnion, contains the coldest water, which remains essentially cutoff from the top layer (epilimnion) due to the differences in density. As the summer progresses, the hypolimnion can become anoxic due to bacterial decomposition utilizing the layer's oxygen content. This causes iron-bound phosphorus in the sediment to dissolve in the overlaying water. In some lakes, the hypolimnetic phosphorus concentrations can reach incredibly high levels, well over 300 µg/L, which is typically ten times or greater what is found in the epilimnion. However, the density gradient prevents the elevated phosphorus from reaching the surface waters where it can be utilized by algae. It is not until the fall turnover that the phosphorus is mixed within the lake's volume. If the hypolimnetic concentrations are sufficient to remain high throughout the winter, they may impact the following growing season's algal growth. In these lakes, internal nutrient loading is considered a significant source of phosphorus in the lake's nutrient budget. Some level of internal phosphorus loading occurs naturally in many deep, stratified lakes, but in most, it is not enough to affect the following season's algal growth.

In many polymictic lakes that weakly stratify for short periods of time during the growing season, the oxygen levels in the bottom layer may not decrease to the point that phosphorus is released from the sediment before the lake mixes again. Or, if the bottom layer becomes anoxic and the phosphorus concentration is increased, the volume of that layer may not be sufficient to impact the concentrations of phosphorus lakewide once the lake mixes again. However, in some polymictic lakes, especially productive shallow lakes, the phosphorus concentrations in the temporary hypolimnion increase quickly and the volume of the layer is large, so when the lake mixes, the phosphorus concentration increases throughout the lake. It may be a small increase, but the increase produces a slight increase in algal abundance. The algae persist and retain the phosphorus in the water column and later in the growing season, when the lake stratifies and then mixes again, more phosphorus is mixed into the lake volume, utilized by algae, and retained in the water column. If this pattern repeats several times throughout the growing season, these shallow lakes see steady increases in total phosphorus, which includes the phosphorus within the algae, as the growing season progresses.

Appendix C contains temperature and dissolved oxygen profiles primarily collected by the WDNR. In many years, the lake was visited while it was stratified and during those visits, the bottom waters had become anoxic. While there are several, good examples include, July 2004, September 2009, June and August 2010, and July 2023. Not a tremendous amount of near-bottom phosphorus data exists for Pelican Lake; however, as an example of how different the concentrations can be during stratification, during the July 2023 sampling completed by Onterra, the near surface concentration was 25.7 µg/L, while the near-bottom concentration collected in anoxic conditions, was 62.4 µg/L.

Figure 3.1-7 displays near-surface total phosphorus data from Pelican Lake. In many years, the increasing pattern of growing season concentrations discussed above can be seen. To truly understand the significance of internal phosphorus loading in Pelican Lake, near-surface and near-bottom total phosphorus samples would need to be collected in tandem with temperature/dissolved oxygen profiles on a frequent basis throughout several growing seasons. With those data, the mass of phosphorus being added to the lake's phosphorus budget could be calculated and its significance in the budget could be determined.

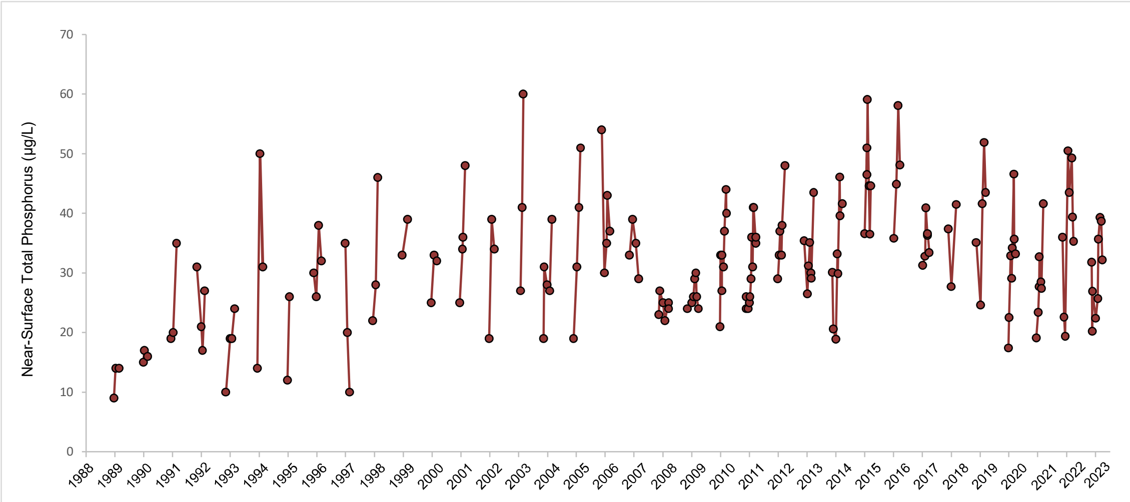


Figure 3.1-7. Pelican Lake growing season, near-surface, total phosphorus concentrations.

Pelican Lake Trophic State

Figure 3.1-8 contain the TSI values for Pelican Lake. The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning mainly in the eutrophic range. In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on total phosphorus and chlorophyll-*a* TSI values, it can be concluded that Pelican Lake is a eutrophic state. The fact the three values are tightly grouped within many years is another indicator of the strong relationship between the trophic parameters.

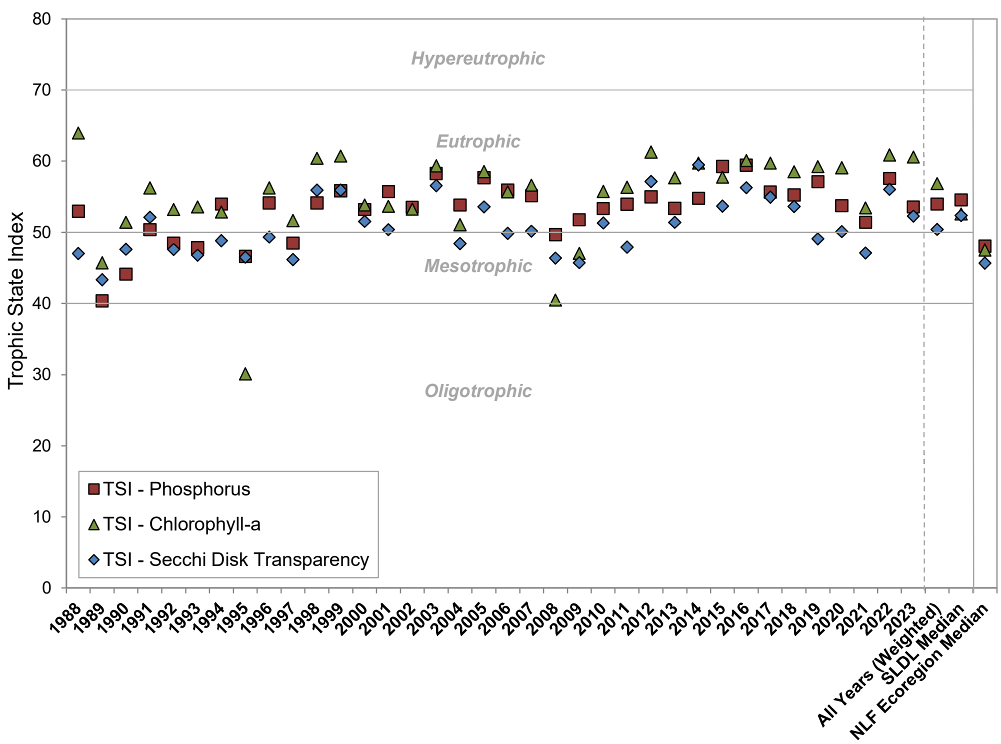


Figure 3.1-8. Pelican Lake, statewide class 2 lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Chloride In Pelican Lake

Pelican Lake association members have expressed concerns over possible increases in chloride concentrations in Pelican Lake. Chloride levels in Pelican Lake have been monitored in the early 1970s, during the 1990s, , and during 2023 (Figure 3.1-9). Chloride occurs naturally in Wisconsin's waters at low levels (2-3 mg/L). Higher levels of chloride or trends in increasing chloride levels have been associated with the application of chloride-based road salts (typically sodium chloride) within the lake's watershed (Dugan 2017). Studies have shown that ecological impacts are often observed when chloride concentrations increase into the 100-1000s mg/L (Dugan 2017), and the Canadian government considers concentrations within this range to be chronically toxic (exposure to elevated concentrations over extended time periods) (Evans M. 2001).

Chloride concentrations in Pelican Lake in the 1970s were near-normal, but showed a moderate increase during the 1990s. In 2023, the values were slightly higher than in the 1990s. All values are much lower than would bring about ecological impacts, as described above and much lower the WDNR chronic toxicity criterion of 395 mg/L. The PLA is concerned that locally higher chloride levels may exist near the

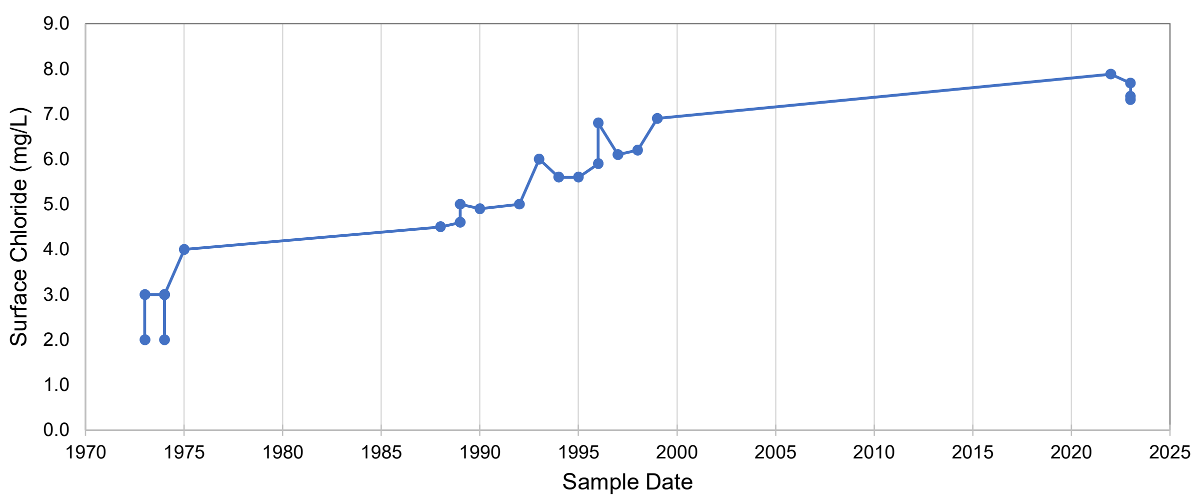
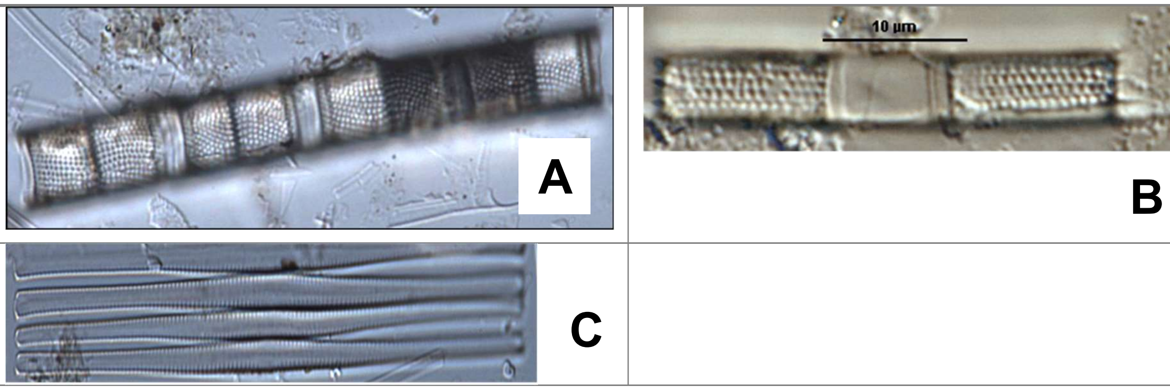


Figure 3.1-9. Pelican Lake chloride concentrations.

Paleoecology

Primer on Paleoecology and Interpretation

Questions often arise concerning how a lake's water quality has changed through time as a result of watershed disturbances. In most cases, there is little or no reliable long-term data. They also want to understand when the changes occurred and what the lake was like before the transformations began. Paleoecology offers a way to address these issues. The paleoecological approach depends upon the fact that lakes act as partial sediment traps for particles that are created within the lake or delivered from the watershed. The sediments of the lake entomb a selection of fossil remains that are more or less resistant to bacterial decay or chemical dissolution. These remains include frustules (silica-based cell walls) of a specific algal group called diatoms, cell walls of certain algal species, and subfossils from aquatic plants. The diatom community are especially useful in reconstructing a lake's ecological history as they are highly resistant to degradation and are ecologically diverse. Diatom species have unique features as shown in Photo 3.1-1, which enable them to be readily identified.



Photograph 3.1-1. Photomicrographs of the diatoms commonly found in the sediment core from Pelican Lake. The diatoms Aulacoseira ambigua (A) and A. granulata (B) are found floating in the open water. A. ambigua indicates lower nutrients while A. granulata indicates higher phosphorus concentrations. Fragilaria crotonensis (C) is more common with moderate phosphorus levels.

Certain taxa are usually found under nutrient poor conditions while others are more common under elevated nutrient levels. Some species float in the open water areas while others grow attached to objects such as aquatic plants or the lake bottom.

The chemical composition of the sediments may indicate the composition of particles entering the lake as well as the past chemical environment of the lake itself. By collecting an intact sediment core, sectioning it off into layers, and utilizing all of the information described above, paleoecologists can reconstruct changes in the lake ecosystem over any period of time since the establishment of the lake.

One often used paleoecological technique is collecting and analyzing top/bottom cores. The top/bottom core only analyzes the top (usually 1 cm) and bottom sections. The top section represents present day conditions and the bottom section is hoped to represent pre-settlement conditions by having been deposited at least 100 years ago. While it is not possible to determine the actual date of deposition of bottom samples, a determination of the radionuclide lead-210 estimates if the sample was deposited at least 100 years ago. The primary analysis conducted on this type of core is the diatom community leading to an understanding of past nutrients, pH, and general macrophyte coverage.

Pelican Lake Paleoecological Results

A sediment core was extracted by Onterra staff from the deep area of Pelican Lake on September 19, 2023 (Photograph 3.1-2) to determine how the water quality and lake ecology has changed during the last century. The total length of the core was 43 cm. The entire core was dark brown in color. The top 1 cm was kept for diatom analysis as it is assumed to represent present day water quality conditions. The section 40-42 cm was kept for analysis of the diatom community. It is assumed that this section represents conditions before the arrival Euroamerican settlers in the nineteenth century. An analysis is underway to determine if the bottom section was deposited at least 100 years ago.

Photograph 3.1-2. Photo of sediment core collected from Pelican Lake. The top 9 centimeters were black in color and the rest of the core was dark gray in color.

Diatom Community Changes

The most common type of diatoms present in both the top and bottom samples of the sediment core were planktonic diatoms which are those that grow in the open water of the lake (Figure 3.1-10). These diatoms comprised over 70% of the diatom community in the top and bottom samples. The most common taxa were in the group *Aulacoseira* spp. Shown in photograph 3.a-10. These diatoms are relatively large and heavy and are commonly found in larger lakes. These diatoms require currents derived from wind energy to stay in suspension. The two most common *Aulacoseira* were *A. ambigua* and *A. granulata*. The first diatom is usually found in lakes with low to moderate phosphorus concentrations while *A. granulata* is found in lakes with higher phosphorus levels. A. granulata was more common in the bottom sample compared with the top sample. This indicates that present day phosphorus levels are lower than they were historically. The reduction in phosphorus levels is also indicated by the greater presence of *Fragilaria crotonensis* in the top sample compared with the bottom sample. This diatom is found in lakes with moderate phosphorus concentrations.

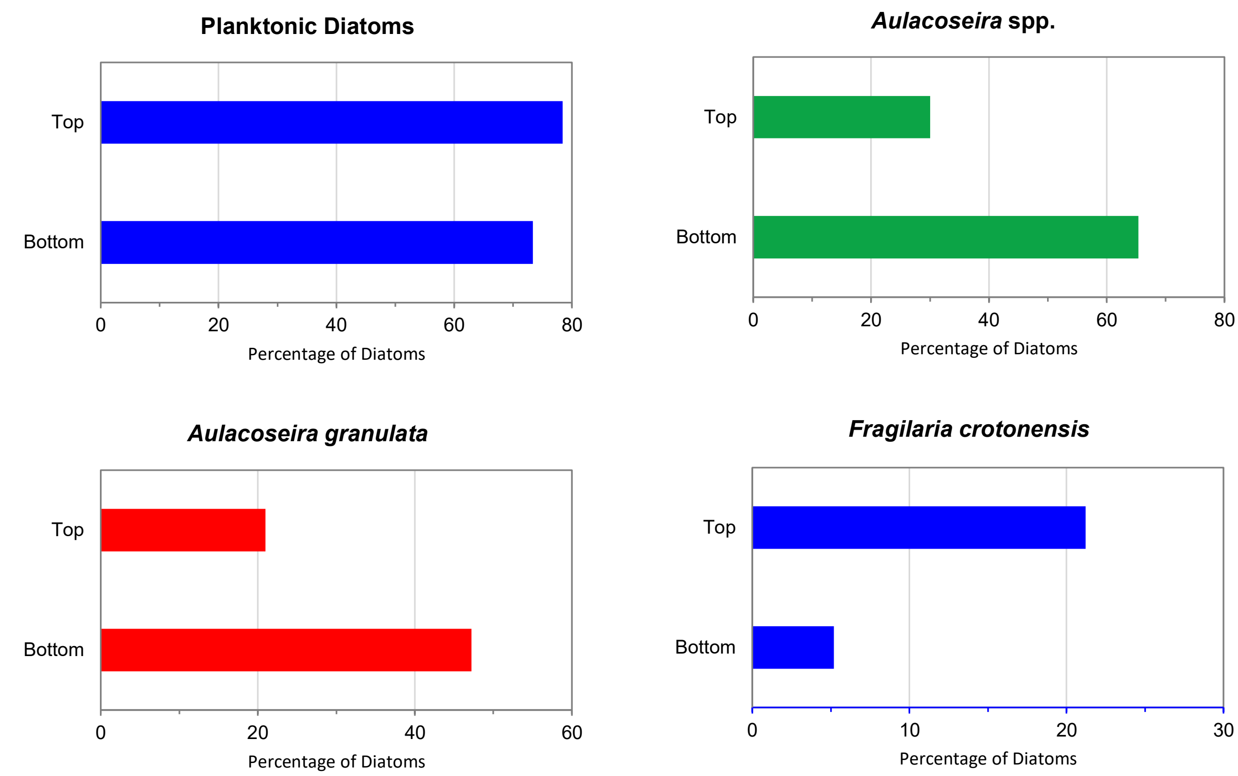


Figure 3.1-10. Changes in abundance of important diatoms found in the top and bottom of the sediment core from Pelican Lake. The decline in planktonic diatoms and the increase in the other diatoms depicted suggests there are more macrophytes now compared with historical times.

Lake Diatom Condition Index

The Lake Diatom Condition Index (LDCI) was developed by Dr. Jan Stevenson, Michigan State University (Stevenson et al. 2013). The LDCI uses diatoms to assess the ecological condition of lakes. The LDCI ranges from 0 to 100 with a higher score representing better ecological integrity. The index is weighted towards nutrients, but also incorporates ecological integrity by examining species diversity where higher diversity indicates better ecological condition. The index also incorporates taxa that are commonly found in undisturbed and disturbed conditions. The breakpoints (poor, fair, good) were determined by the 25th and 5th percentiles for reference lakes in the Upper Midwest. The LDCI was used in the 2007 National Lakes Assessment to determine the biological integrity of the nation's lakes.

The LDCI analysis indicates the biotic condition is in the poor range (Figure 3.1-11). The relatively poor condition of the lake is the result of elevated phosphorus concentrations.

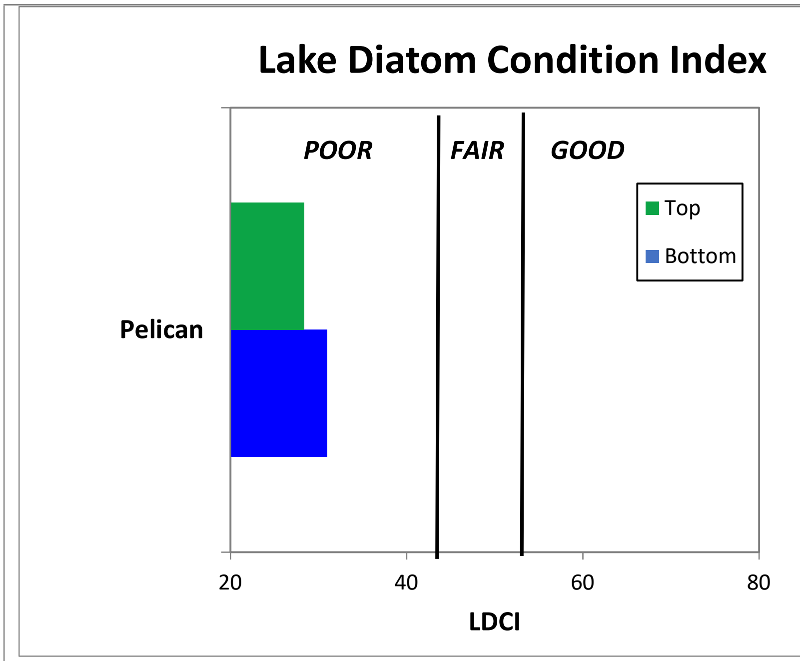


Figure 3.1-11. The Lake Diatom Condition Index (LDCI) for Pelican Lake. The biotic integrity is rated as fair in both the present time and historically.

Inference models

Diatom assemblages have been used as indicators of trophic changes in a qualitative way (Bradbury 1975), (Carney 1982), (Anderson et al. 1990) but quantitative analytical methods exist. Ecologically relevant statistical methods have been developed to infer environmental conditions from diatom assemblages. These methods are based on multivariate ordination and weighted averaging regression and calibration (Birks et al. 1990). Ecological preferences of diatom species are determined by relating modern limnological variables to surface sediment diatom assemblages. The species-environment relationships are then used to infer environmental conditions from fossil diatom assemblages found in the sediment core.

Weighted averaging calibration and reconstruction (Birks et al. 1990) were used to infer historical water column summer average phosphorus concentration in the sediment cores. A training set that consisted of 60 lakes was used. Training set species and environmental data were analyzed using weighted average regression software, C2 (Juggins 2014).

The diatom inferred phosphorus concentration in the top sample of Pelican Lake is nearly the same as the measured summer mean concentration in 2023 (Table 31.1). This indicates that the diatom model works well for the lake. The present day phosphorus concentration is much less than it was historically, being lower by about 20 µg/L.

Table 3.1-1. Diatom inferred phosphorus concentrations in core samples (µg/L).

Lakes	Phosphorus
Pelican Top	32
Pelican Bottom	56

In summary, the diatom community indicates that at the present time the phosphorus concentration is much lower than it was historically. This is supported by the change in the composition of the diatom community as well as the diatom inference model.

Stakeholder Survey Responses to Pelican Lake 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 3.1-12 and 3.1-13 display the 2012 and 2023 responses of members of Pelican Lake stakeholders to questions regarding their perceptions of water quality on Pelican Lake. During both surveys, the bulk of Pelican respondents indicated that they believe the water quality of Pelican Lake to be either *Fair* or *Good*, which based upon the water quality discussion above, is true. However, in 2012 more respondents noted that the lake's water quality is *Good* compared to those that responded that it is *Fair*. In 2023, more respondents classified their perception of the lake's water quality as *Fair* than *Good*, and more indicated that the water quality was *Very Poor* and *Poor* than in 2012.

In 2012, more respondents believed the lake's water quality remained the same as when they first visited it than those responding to the same question in 2023 (Figure 3.1-12). There was also an increase in respondents stating that the water quality somewhat degraded or severely degraded over time than in 2012.

In 2023, a question was asked what the single most important aspect was when they considered water quality. Nearly 30% responded that they considered water clarity as the most important. Twenty-one percent of respondents stated that algae blooms is the most important. As described above, water clarity and algal abundance are closely related in Pelican Lake. However, many respondents indicated that non-water quality related aspects of Pelican Lake are used to judge water quality. For example, over 20% state aquatic plant growth and over 15% state that water levels are used to judge water quality. Similar surveys completed with other lake groups have shown, just as the Pelican Lake 2023 survey results showed, that many lake users are likely considering "lake quality" more than "water quality" when responding to these questions.

Question 22: How would you describe the overall current water quality of Pelican Lake?

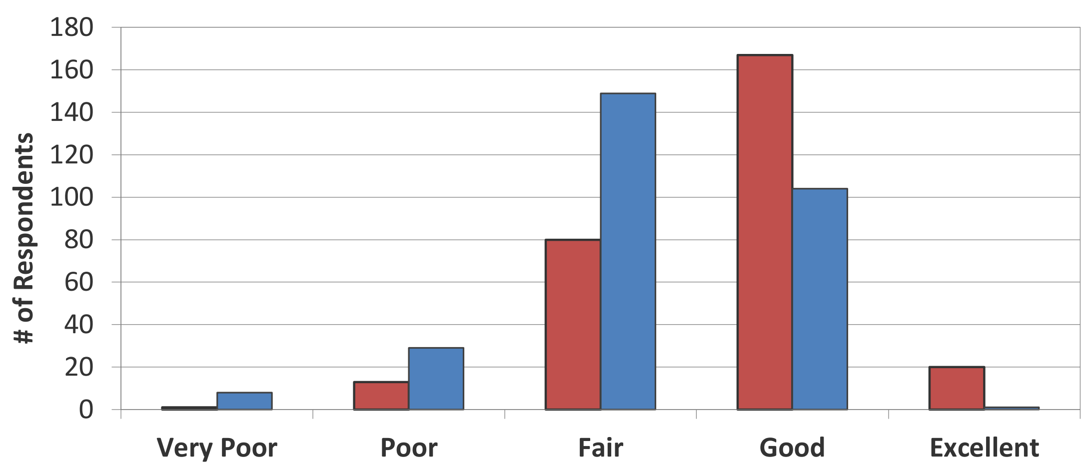


Figure 3.1-12. Stakeholder survey response regarding the overall water quality of Pelican Lake. Total responses in 293 in 2012 (red) and 291 in 2023 (blue).

Question 23: How has the overall water quality changed in Pelican Lake since you first visited the lake?

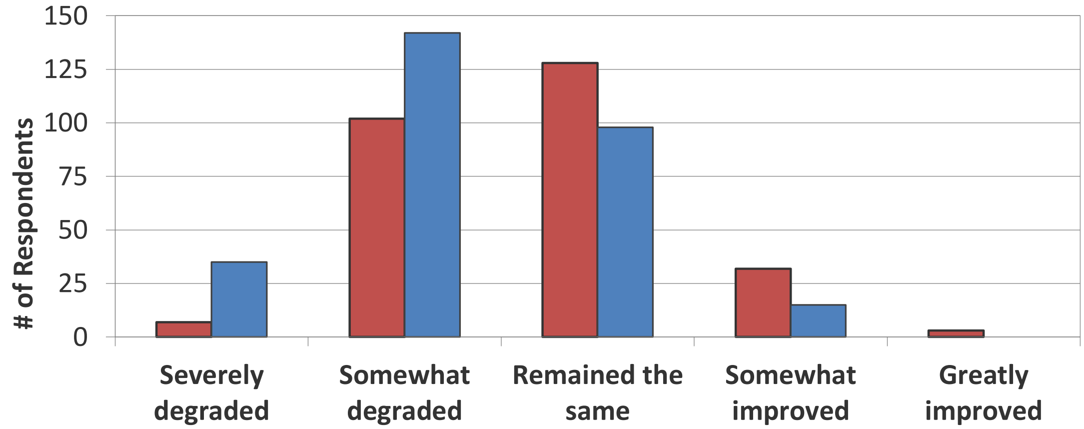


Figure 3.1-13. Stakeholder survey response regarding perceived changes in Pelican Lake water quality. Total responses in 293 in 2012 (red) and 290 in 2023 (blue).

3.2 Watershed Assessment

Watershed Modeling

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.

> 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.

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.

Land Cover Classification Assessment

The Pelican Lake watershed is reassessed in this report utilizing two current databases: 1) the 2021 National Land Cover Database (NLCD), and 2) and the WDNR 2019 Digital Elevation Model (DEM). The NLCD is a spatial reference and descriptive database of the land cover for the conterminous United States, provided by the U.S. Geological Survey (USGS 2023). Each 3-year update of the NLCD includes higher resolution delineations and increased classification of land cover types. The WDNR DEM utilizes county-based land elevations developed with Light Detection and Ranging (LiDAR). LiDAR is a remote sensing method of pulsed lasers, that can be used to chart the surface of the earth (NOAA 2023). Overall, the WDNR DEM allows for much more precise delineation of watershed boundaries due to the high resolution of the elevation data.

In the 2013 plan, Pelican Lake was determined to have a watershed area of approximately 13,920 acres. Like most of the lakes in the Northwoods of Wisconsin, Pelican Lake's watershed was found to be predominately forested (37%) and included large areas of wetlands (30%) (Figure 3.2-1). The lake's surface area (3,585 acres), at 26%, also made up a considerable portion of the watershed resulting in a watershed to lake area ration of 3:1. Pasture/grass lands, row crops, rural residential and medium density urban lands made up the remaining 7% of the watershed.

While the watershed assessments are included in reports from 2012 and 2024, the land cover is determined using data from NLCD 2006 and NLCD 2021, respectively. The NLCD is typically updated every three years and each year that the database is updated, as mentioned above, the resolution of the land cover delineation increases, as well as some of the classifications. As a result, comparing land cover delineations from the same lake from different time periods, is not always like comparing "apples to apples". This is especially the case with Pelican Lake because the comparisons are being made between datasets that are over a decade apart. In Figure 3.2-1, the landcover reported in 2013 and 2024 are compared.

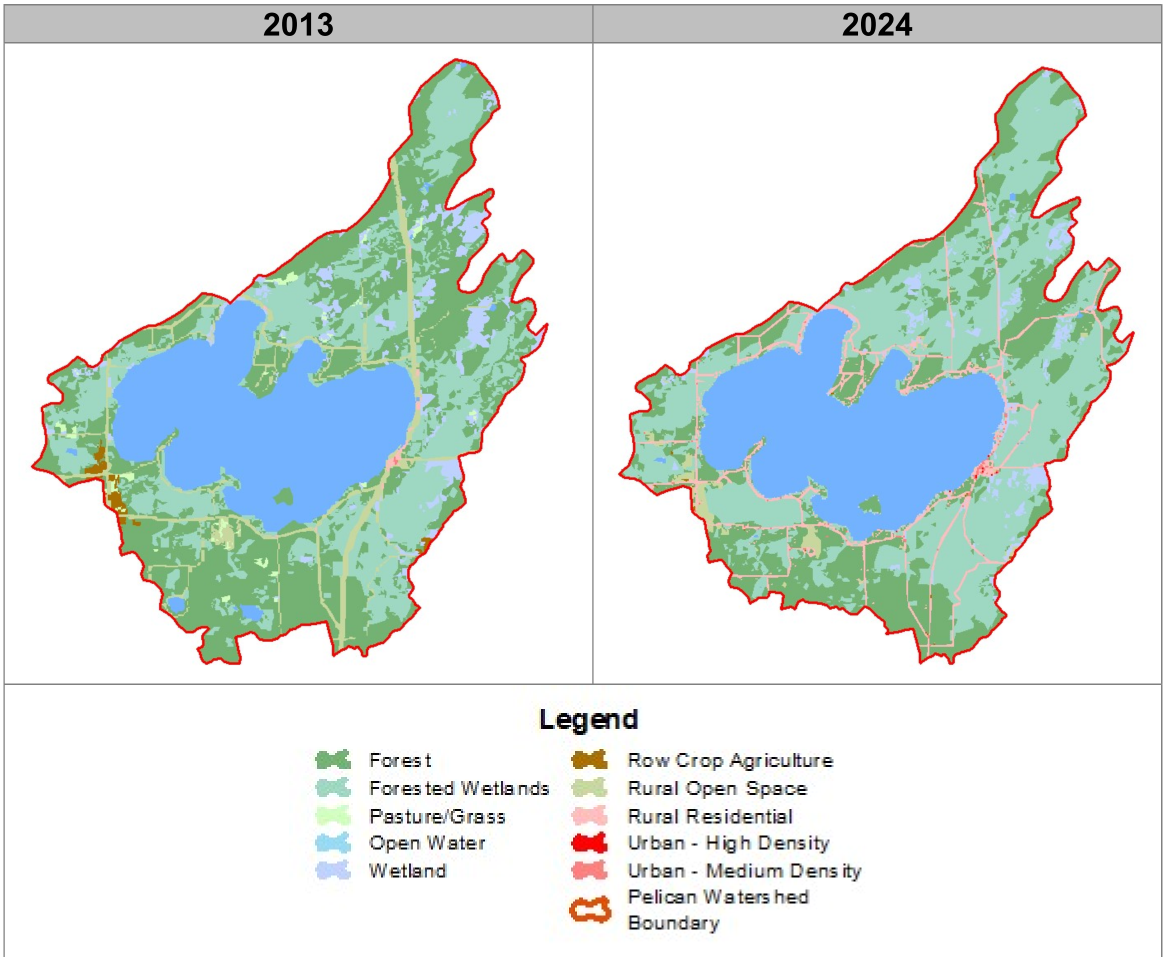


Figure 3.2-1. Pelican Lake watershed land cover in the 2013 report versus 2024.

The watershed outline as reported in 2024 (13,781 acres) is slightly smaller than that of the reported 2013 watershed outline (13,918 acres). As well, there are significant changes in some of the landcover types that are attributed to both the decrease in the updated watershed delineation, as well as the increased resolution and reclassification of landcover as described earlier.

Utilizing the 2019 DEM, the watershed boundary or Pelican Lake was redrawn. While it retains the same general shape the higher resolution elevation model created a slightly different outline and justified the exclusion of Eagle and Silver lakes on the watershed's south end because they are considered isolated and ultimately do not drain to Pelican Lake (Figure 3.2-1). The decrease in size of the overall watershed is primarily due to the clipping of these two lakes, which were included in the 2013 reported watershed.

There were significant changes to the acreage of forest, wetlands, and rural residential landcover types within Pelican Lake's watershed (Figure 3.2-3). This is not to say that the landcover itself has actually changed within the watershed; rather, as explained before, the classification has changed within the NLCD due to the increased resolution of the database itself over the years. For instance, land that was mapped as forest in the 2013 watershed assessment has now been reclassified as wetlands, meaning the 2021 mapping is able to detect forested wetlands instead of just classifying them as forests. This can also be seen in the reclassification of pasture grass landcover as rural residential, which is considered to be slightly more developed land in comparison to pasture grass (Figure 3.2-3).

Table 3.2-1. Pelican Lake watershed land cover.

WiLMS Landcover Classification	2006 NLCD Acres	2021 NLCD Acres	Difference Acres	Percent Change By Ratio
Forest	5098	3865	-1233	▼ -76%
Wetland	4179	5405	1227	▲ 129%
Open Water	79	9	-70	▼ -12%
Pelican Lake	3551	3551	0	▬ 0%
Rural Residential	29	759	730	▲ 2638%
Pasture Grass	898	167	-731	▼ -19%
Urban - High Density	0	1	1	▲ 1%
Ubran - Medium Density	0	15	15	▲ 15%
Row Crops	85	9	-76	▼ -10%
Total Acreage	**13918**	**13781**		

Pelican Lake Watershed 2013 & 2024 Phosphorous Modeling

In the 2013 watershed delineation, the phosphorus loading was largely contributed by forest (20%), wetlands (18%), and Pelican Lake itself (45%). Similarly, in the 2024 reported watershed delineation, Pelican Lake itself contributed 49% of phosphorous, wetlands contributed 25%, and forest contributed 16% of phosphorous loading (Map 2, Figure 3.2-2).

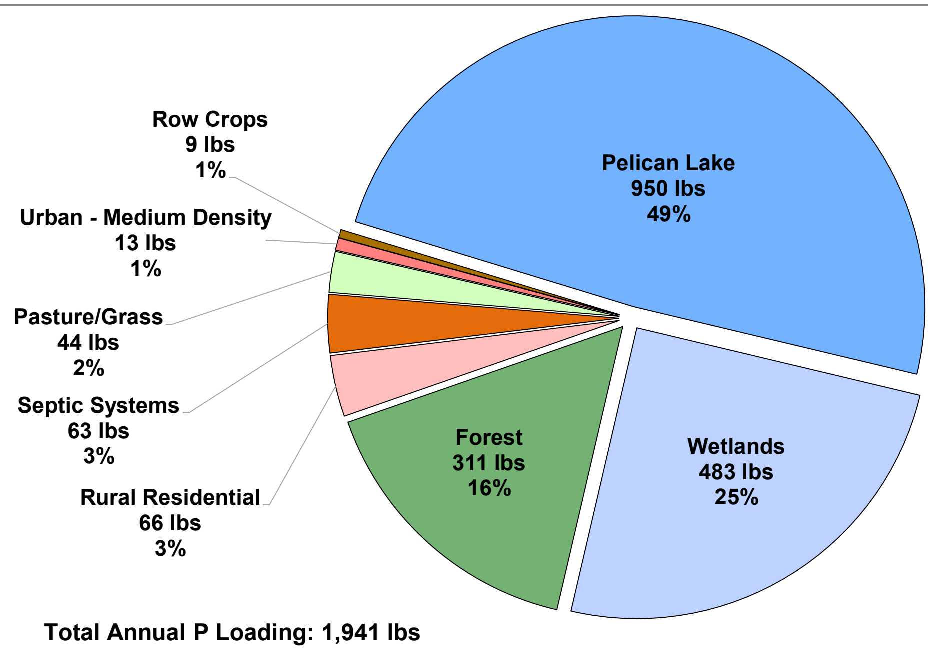


Figure 3.2-2. Pelican Lake watershed phosphorus loading in pounds. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

The total phosphorus load modeled for Pelican Lake during the 2013 assessment was 2,112 pounds. The updated model, utilizing the new watershed delineation and 2021 NLCD, yielded a similar annual load of 1,941 pounds. Considering the lake's volume and flushing rate (0.26 times per yr), the model predicted a growing season mean phosphorus concentration ranging from 12 µg/L to 34ugl. The actual growing season mean for Pelican Lake is 31.1 µg/L, so the model represents the lake relatively well.

Pelican Lake's watershed is in good condition. Over 40% of the lake's annual phosphorus load originates from wetlands and forests, the two best land cover types to have in a watershed because they export the least amount of phosphorus. The largest contributor is the lake's surface itself, so the three highest sources of phosphorus to the lake are unchangeable, while those contributors that are controllable account for so little of the phosphorus load that further reducing them would not improve water quality. Keeping the watershed healthy by promoting the conservation of forests and wetlands should be the primary goal of the association.

Pelican Lake Shoreland Condition

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 inland). 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.

On Pelican Lake, the shoreline condition of the entire lake was surveyed during the summer of 2011. Onterra staff only considered the area of shoreland 35 feet inland from the water's edge, and did not assess the shoreline on a property-by-property basis. During the survey, Onterra staff examined the shoreline for signs of development, and assigned one of the five descriptive categories (Figure 3.2-4) to areas of the shoreland.

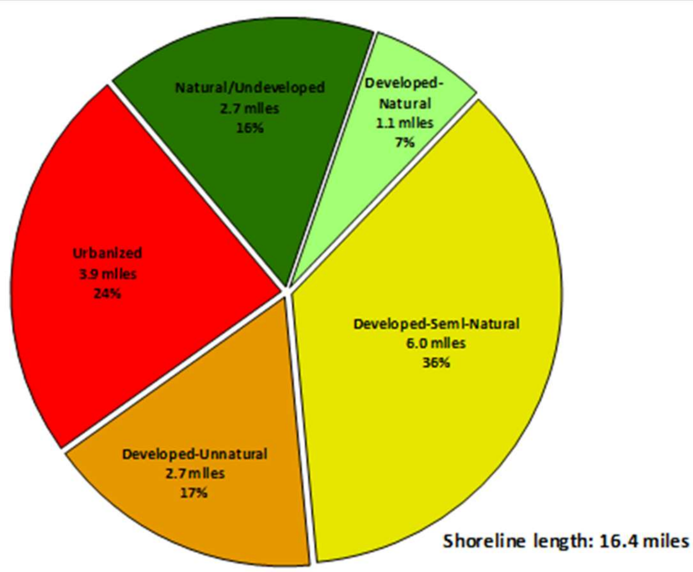


Figure 3.2-3. Pelican Lake shoreland categories and total lengths. Based upon a late summer 2011 survey.

Pelican Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 3.8 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 3.2-3). 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, 6.6 miles of urbanized and developed–unnatural shoreline were observed. If restoration of the Pelican Lake shoreline 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.

3.3 Aquatic Plants

Primer on Data Analysis & Data Interpretation

Photograph 3.3-1. Native aquatic plants. Photo credit Onterra.

Native aquatic plants are an important element in every healthy aquatic ecosystem, providing food and habitat to wildlife, improving water quality, and stabilizing bottom sediments (Photograph 3.3-1). Because most aquatic plants are rooted in place and are unable to relocate in wake of environmental alterations, they are often the first community to indicate that changes may be occurring within the system. Aquatic plant communities can respond in a variety of ways; there may be increases or declines in the occurrences of some species, or a complete loss. Or, certain growth forms, such as emergent and floating-leaf communities may disappear from certain areas of the waterbody. With periodic monitoring and proper analysis, these changes are relatively easy to detect and provide relevant information for making management decisions.

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 completed on Pelican Lake in 2011 and 2023. 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). Also, 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. The point-intercept survey produces a great deal of information about a lake's aquatic vegetation and overall health. These data are analyzed and presented in numerous ways; each is discussed in more detail the following section.

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 Pelican Lake in 2011 and 2023. 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. Obviously, all of the plants cannot be counted in a lake, so samples are collected from pre-determined areas. In the case of the whole-lake point-intercept survey completed on Pelican Lake, plant samples were collected from plots laid out on a grid that covered the lake. Using the data collected from these plots, an estimate of occurrence of each plant species can be determined. 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 Pelican Lake to be compared to other lakes within the region and state.

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

As discussed in the Water Quality Section primer (3.1), Pelican Lake falls within the Northern Lakes and Forests (NLF) *ecoregion* (Figure 3.1-2), and the floristic quality of its aquatic plant community will be compared to other lakes within this ecoregion as well as the entire State of Wisconsin.

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 is 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 Pelican Lake is compared to data collected by Onterra and the WDNR Science Services on 212 lakes within the Northern Lakes and Forests (lakes only, does not include flowages) Ecoregion and on 392 lakes throughout Wisconsin.

Community Mapping

A key component of any aquatic plant community assessment is the delineation of the emergent and floating-leaf aquatic plant communities within each lake as these plants are often underrepresented during the point-intercept survey. 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 Pelican Lake were mapped using a Trimble Global Positioning System (GPS) with sub-meter accuracy.

Pelican Lake Aquatic Plant Survey Results

The point intercept surveys conducted by Onterra occurred on Pelican Lake on August 22, 2011 and July 18, 2023 (Appendix D). Additional surveys were completed by Onterra on Pelican Lake to create the aquatic plant community map (Map 5) during these same years as well. During the two point-intercept and aquatic plant community mapping surveys, 61 species of plants were located in Pelican Lake (Table 3.3-1).

Table 3.3-1. Aquatic plant species located on Pelican Lake during the 2011 and 2023 surveys.

Growth Form	Scientific Name	Common Name	Status in Wisconsin	Coefficient of Conservatism	2011	2023
Emergent	*Acorus calamus*	Sweetflag	Non-Native - Naturalized	N/A	I	
	Bolboschoenus fluviatilis	River bulrush	Native	5	I	I
	Calla palustris	Water arum	Native	9	I	I
	Carex comosa	Bristly sedge	Native	5	I	
	Carex lasiocarpa	Narrow-leaved woolly sedge	Native	9	I	
	Carex sp. (sterile)	Sedge sp. 1	Native	N/A		I
	Decodon verticillatus	Water-willow	Native	7	I	I
	Eleocharis palustris	Creeping spikerush	Native	6	X	X
	Equisetum fluviatile	Water horsetail	Native	7	X	
	Iris versicolor	Northern blue flag	Native	5	I	
	Lythrum salicaria	Purple loosestrife	Non-Native - Invasive	N/A		I
	Phragmites australis subsp. americanus	Common reed	Native	5	X	I
	Pontederia cordata	Pickerelweed	Native	9	X	I
	Sagittaria latifolia	Common arrowhead	Native	3	I	I
	Sagittaria rigida	Stiff arrowhead	Native	8		I
	Schoenoplectus acutus	Hardstem bulrush	Native	5	X	X
	Schoenoplectus tabernaemontani	Softstem bulrush	Native	4	X	X
	Sparganium eurycarpum	Common bur-reed	Native	5	X	I
	Typha latifolia	Broad-leaved cattail	Native	1		I
	Typha spp.	Cattail spp.	Unknown (Sterile)	N/A	I	I
	Zizania spp.	Wild rice sp.	Native	8	I	I
FL	*Brasenia schreberi*	Watershield	Native	7		I
	Nymphaea odorata var. rosea	Pink water lily	Non-Native - Ornamental	N/A	I	I
	Nuphar variegata	Spatterdock	Native	6	X	X
	Nymphaea odorata	White water lily	Native	6	X	I
	Persicaria amphibia	Water smartweed	Native	5	I	
	Sparganium angustifolium	Narrow-leaf bur-reed	Native	9	I	I
	Sparganium fluctuans	Floating-leaf bur-reed	Native	10	I	
FL/E	*Sparganium emersum var. acaule*	Short-stemmed bur-reed	Native	8	I	I
Submergent	*Bidens beckii*	Water marigold	Native	8	X	X
	Ceratophyllum demersum	Coontail	Native	3	X	X
	Chara spp.	Muskgrasses	Native	7	X	X
	Elodea canadensis	Common waterweed	Native	3	X	X
	Elodea nuttallii	Slender waterweed	Native	7		X
	Isoetes spp.	Quillwort spp.	Native	8	X	X
	Myriophyllum sibiricum	Northern watermilfoil	Native	7	X	X
	Myriophyllum spicatum	Eurasian watermilfoil	Non-Native - Invasive	N/A		X
	Najas flexilis	Slender naiad	Native	6	X	X
	Najas guadalupensis	Southern naiad	Native	7		X
	Nitella spp.	Stoneworts	Native	7	X	X
	Potamogeton amplifolius	Large-leaf pondweed	Native	7	X	X
	Potamogeton berchtoldii	Slender pondweed	Native	7		X
	Potamogeton foliosus	Leafy pondweed	Native	6	X	
	Potamogeton friesii	Fries' pondweed	Native	8	X	X
	Potamogeton gramineus	Variable-leaf pondweed	Native	7	X	X
	Potamogeton illinoensis	Illinois pondweed	Native	6	X	X
	Potamogeton praelongus	White-stem pondweed	Native	8	X	X
	Potamogeton pusillus	Small pondweed	Native	7	X	X
	Potamogeton richardsonii	Clasping-leaf pondweed	Native	5	X	X
	Potamogeton robbinsii	Fern-leaf pondweed	Native	8	X	X
	Potamogeton spirillus	Spiral-fruited pondweed	Native	8	X	X
	Potamogeton X spathuliformis & other hybrids	Variable-leaf X Illinois pondweed & other hybrids	Native	N/A	X	
	Potamogeton zosteriformis	Flat-stem pondweed	Native	6	X	X
	Sagittaria sp. (rosette)	Arrowhead sp. (rosette)	Native	N/A	X	
	Utricularia vulgaris	Common bladderwort	Native	7	X	
	Vallisneria americana	Wild celery	Native	6	X	X
S/E	*Eleocharis acicularis*	Needle spikerush	Native	5	X	X
	Juncus pelocarpus	Brown-fruited rush	Native	8	X	
	Sagittaria graminea	Grass-leaved arrowhead	Native	9		I
FF	*Lemna trisulca*	Forked duckweed	Native	6	X	X
	Lemna turionifera	Turion duckweed	Native	2	X	
	Spirodela polyrhiza	Greater duckweed	Native	5	X	

X = Located on rake during point-intercept survey; I = Incidentally located; not located on rake during point-intercept survey
FL = Floating-leaf; F/L = Floating-leaf & Emergent; S/E = Submergent and/or Emergent; FF = Free-floating

The sediment within littoral areas of Pelican Lake is very conducive for supporting lush aquatic plant growth within its large bays. As discussed earlier, surveyors during the point-intercept survey rated each sampling location as sand, muck, or rock based upon how the rake "felt" when it touched the lake bottom. These data from 2023 indicate that approximately 50% of the sampling locations located within the littoral zone contained fine organic sediment (muck), 30% contained sand, and 20% contained rock (Figure 3.3-1).

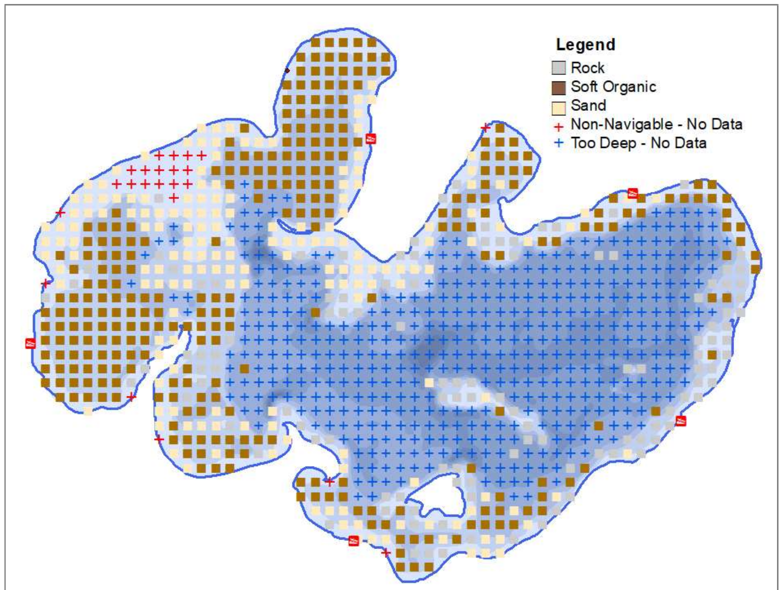


Figure 3.3-1. Proportion of substrate types within littoral areas. Created using data from 2023 point-intercept survey.

The maximum depth of plant growth was 15 feet in 2011 and 14 feet in 2023. Approximately 48% of the 2023 point-intercept sampling locations that fell within the maximum depth of aquatic plant growth, contained aquatic vegetation. This compared to 52% in 2011.

Figure 3.3-2 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). While the proportion of the littoral sampling locations was similar between 2011 and 2023, the vegetation ratings indicated denser vegetation in 2011. Map 3 shows that lower Musky Bay contained much higher density of vegetation in 2011 compared to 2023

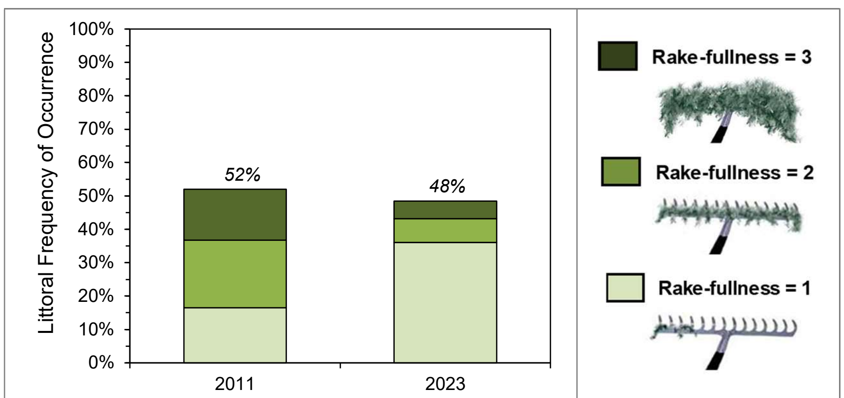


Figure 3.3-2. Pelican Lake aquatic vegetation total rake fullness ratings.

Figure 3.3-3 shows the littoral frequency of occurrence (LFOO) of aquatic plants from the 2011 and 2023 point-intercept surveys. These data indicate wild celery, flat-stem pondweed, and coontail are the most frequently encountered native aquatic plant species found in Pelican Lake (Photograph 3.2-1). Eurasian watermilfoil (15.1%) was the third-most frequently encountered species in the 2023 whole-lake point-intercept survey.

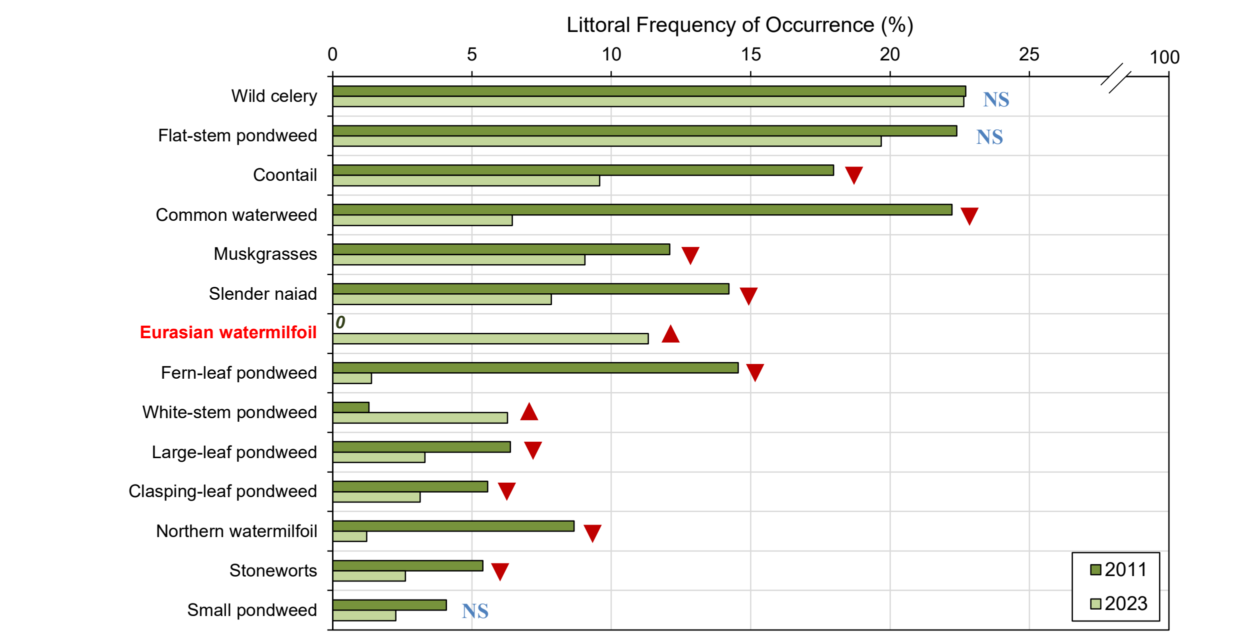


Figure 3.3-3. Littoral frequency of occurrence in 2011 and 2023. Statistically valid differences are indicated with a red arrow.

Wild celery produces long, ribbon-like leaves which emerge from a basal rosette, and it prefers to grow over harder substrates and is tolerant of low-light conditions. Its long leaves provide valuable structural habitat for the aquatic community while its network of roots and rhizomes help to stabilize bottom sediments. In mid- to late-summer, wild celery often produces abundant fruit which are important food sources for wildlife including migratory waterfowl. In 2023, wild celery was most abundant between 2 and 8 feet of water (Figure 3.3-4). The occurrence of wild celery was 22.7% in 2011 and remained roughly the same in 2023 at 22.6%.

Wild celery *(Vallisneria americana)*	Flat-stem pondweed *(Potamogeton zosteriformis)*	Coontail *(Ceratophyllum demersum)*	Common Waterweed *(Elodea canadensis)*
			

Photograph 3.3-2. Common plant species found during the 2011 and 2023 surveys. Photo credit Onterra.

Flat-stem pondweed is often more abundant in lakes with soft organic sediments like Pelican Lake. As its name implies, flat-stem pondweed can be distinguished from other thin-leaved pondweeds by its conspicuously flattened stem. Flat-stem pondweed can attain heights of 10 feet or greater, and provides excellent structural habitat for aquatic wildlife. In 2023, flat-stem pondweed was most abundant between 5 and 10 feet of water, slightly deeper than wild celery. The occurrence of flat-stem pondweed was also roughly the same in 2023 as 2011.

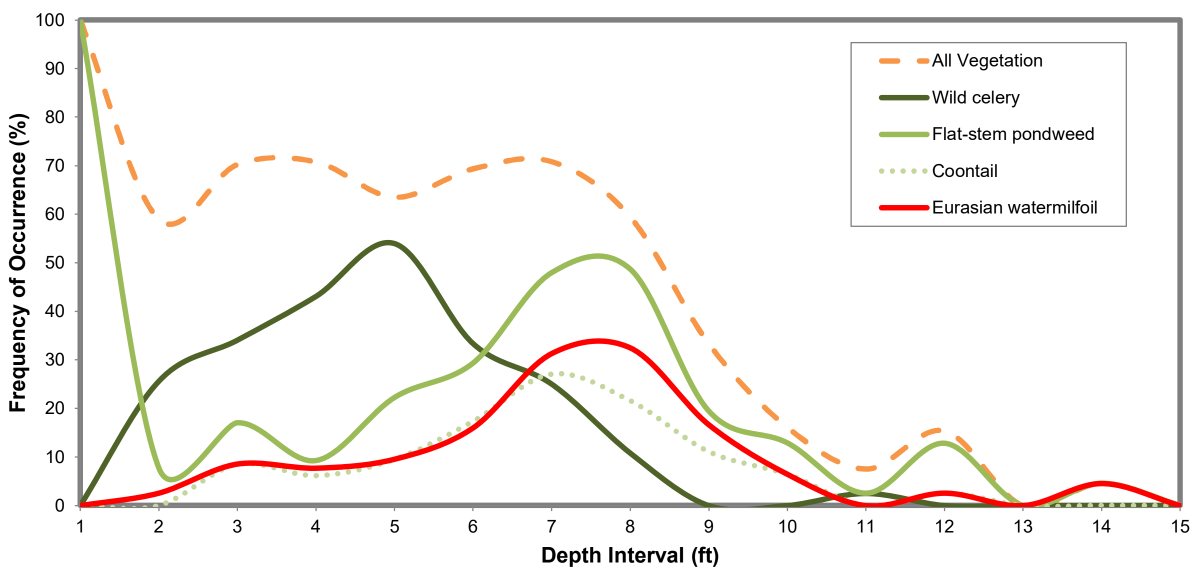


Figure 3.3-4. Depth of occurrence of select aquatic plants in 2023. Data from 203 point-intercept survey.

Coontail was the third most common native species in Pelican Lake during 2023; common waterweed was the sixth. These species are often discussed together due to the unique fact that coontail and common waterweed do not produce true roots (Photograph 2.1-6). While they sometimes form root-like structures and appear anchored to the sediment, these species are most often found growing entangled amongst other aquatic plants or matted at the surface. Because they lacks true roots, these species derive all of their nutrients directly from the water (Gross et al. 2003). This ability in combination with a tolerance for low-light conditions allows these species to become more abundant in productive waterbodies with higher nutrients and lower water clarity. These species provide excellent structural habitat for aquatic invertebrates and fish, especially in winter as they remain green under the ice. In addition, they compete for nutrients that would otherwise be available for free-floating algae and helps to improve water clarity. However, in some lakes such as Pelican Lake, coontail and common waterweed can form dense surface mats that interfere with recreation and navigation.

During 2011 coontail and common waterweed were the primary species contributing to dense plant areas such as lower Musky Bay and Outlet Bay (Map 4). The populations of both these species declined substantially in 2023 compared to 2011. As will be discussed in the next sub-section, populations of EWM have increased in these areas and are starting to also contribute to high biomass that interferes with recreation and navigation.

One way to visualize the distribution of aquatic plants is to look at the relative frequency of occurrence of aquatic plant species in Pelican Lake. Relative frequency of occurrence is used to evaluate how often each plant species is encountered in relation to all the other species found (Figure 3.3-5). Wild celery was found at roughly 22.5% of littoral sampling locations in 2011 and 2023. But relative to the abundance of other aquatic plants, wild celery comprises almost 19% of the population of plants in Pelican Lake in 2023 compared to 11% in 2011. Figure 3.3-6 illustrates that greater than 60% of Pelican Lake's plant community is comprised of six native species. Pelican Lake exhibits overall good plant diversity within the ecosystem.

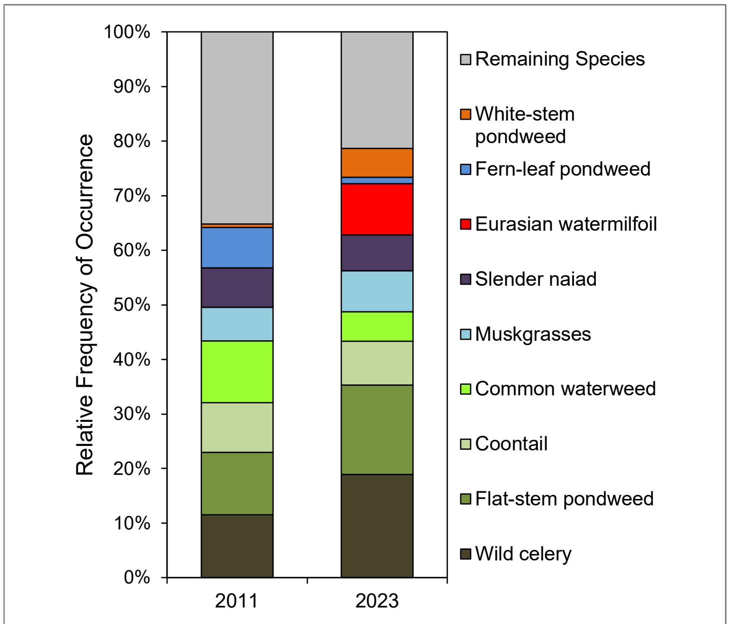


Figure 3.3-5. Relative frequency of occurrence of aquatic vegetation. Non-native species indicated with red.

Simpson's Diversity Index is a measure of both the number of aquatic plant species in a given community and their abundance. This measurement is important because plant communities with higher diversity are believed to be more resilient to disturbances and natural fluctuations that affect plant growth (e.g., changes water clarity, water levels, etc.). Plant communities with higher diversity also provide more diversity in habitat types and food sources for invertebrates, fish, and other wildlife. Higher species diversity leads to a healthier and more adaptive system that is resistant to disturbance and more stable over time. Unlike species richness which is simply the number of aquatic plant species within the community, species diversity considers how evenly those species are distributed throughout the community. The diversity metrics from Pelican Lake in both years indicate there is a greater than 90% likelihood that the next plant surveyed will be different than the previous (Figure 3.3-6)

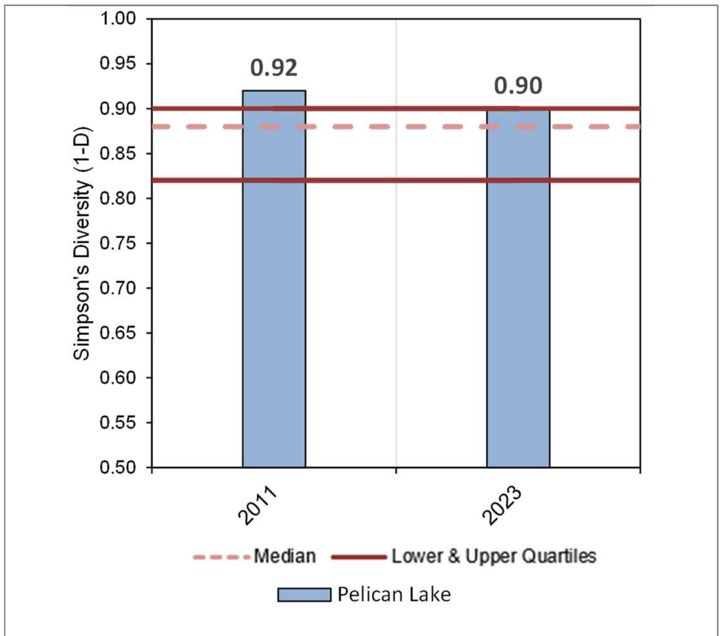


Figure 3.3-6. Simpson's Diversity Index. Solid lines indicate 25th and 75th percentiles for NLFL lakes; dashed line indicates median for NLFL lakes. Regional data created using Onterra & WDNR data.

While a method for characterizing diversity values of fair, poor, etc. does not exist, lakes within the same ecoregion may be compared to provide an idea of how Pelican Lake's diversity values rank. Using data collected by Onterra, quartiles were calculated for 212 lakes within the NLFL ecoregion (Figure 3.3-6). The Simpson's Diversity Index values were calculated using the 2011 and 2023 point-intercept survey data.

Data collected during the 2011 and 2023 aquatic plant surveys was also used to complete a Floristic Quality Assessment (FQA) which incorporates the number of native aquatic plant species recorded on the rake during the point-intercept survey and their average conservatism. The data used for these calculations does not include any incidental species (visual observations) but only considers plants that were sampled on the rake during the survey. For instance, while a total of 57 native species were located in Pelican Lake between both surveys, 39 were physically encountered on the rake while the remaining 18 species were located incidentally. Figure 3.3-7 displays the species richness, average conservatism, and floristic quality of Pelican Lake along with ecoregion and state median values.

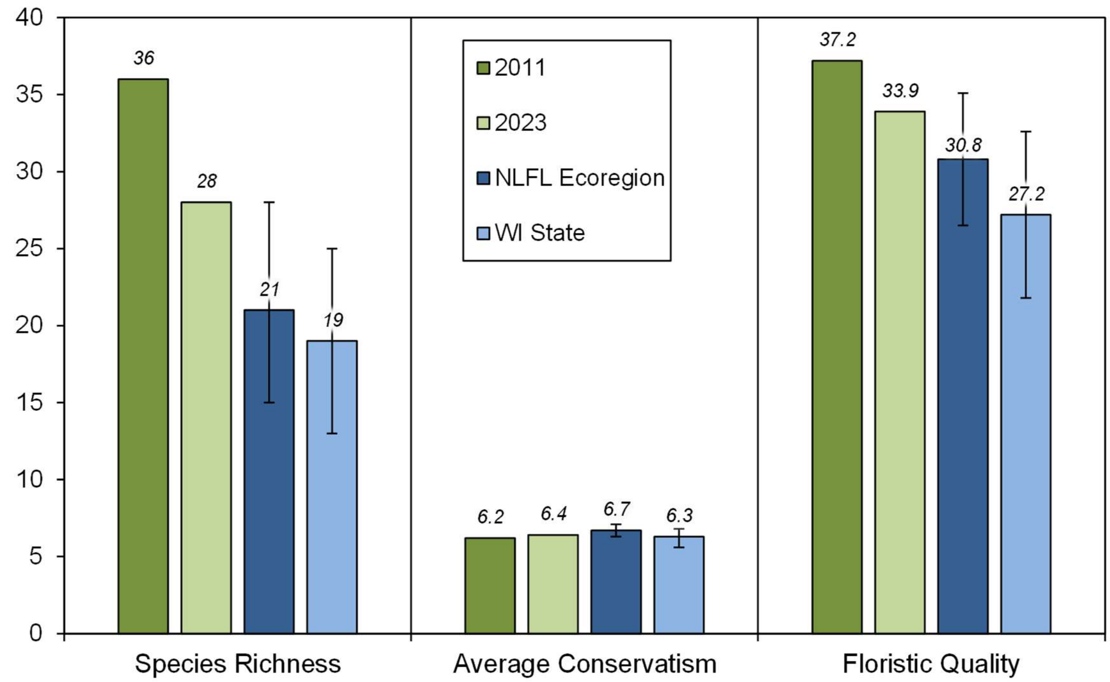


Figure 3.3-7. Floristic Quality Assessment. Error bars represent interquartile range of comparable. Regional and state medians calculated with Onterra and WDNR data. Analysis follows (Nichols 1999).

Map 5 shows the number of native species per sampling point during the available point-intercept surveys. The most recent survey in 2023 indicated that 1.1 native species were found at each point, down slightly from 1.9 native species per point in 2011. In some instances, higher species richness per sampling location can indicate complexity of the aquatic plant community, whereas other times in can indicate a high number of disturbance-tolerant species present.

Pelican Lake's native plant species richness values of 36 in 2011 and 28 in 2023 fall above the 75th percentile values for lakes within the NLFL ecoregion and lakes across Wisconsin. The average species conservatism values of 6.2 in 2011 and 6.4 in 2023 fall in line with state median values (50th percentile) and slightly below the ecoregion median. This indicates that there are a slightly higher amount of disturbance-tolerant species in Pelican Lake compared to other lakes in the region. Combining the species richness and average conservatism values, Pelican Lake's

Floristic Quality Index indicates higher quality aquatic plant community than the median of those in the state and in northern WI.

In 2023, Onterra ecologists also conducted a survey aimed at re-mapping emergent and floating-leaved plant communities in Pelican Lake. Emergent and floating-leaf plant communities are a wetland community type dominated by species such as cattails, bulrushes, and water lilies. Like submersed aquatic plant communities, these communities also provide valuable habitat, shelter, and food sources for organisms that live in and around the lake. In addition to those functions, floating-leaf and emergent plant communities provide other valuable services such as erosions control and nutrient filtration. These communities also lessen the force of wind and waves before they reach the shoreline which serves to lessen erosion. Their root systems help stabilize bottom sediments and reduce sediment resuspension. In addition, because they often occur in near-shore areas, they act as a buffer against nutrients and other pollutants in runoff from upland areas.

This is important to note because these communities are often negatively affected by recreational use and shoreland development. (Radomski and Goeman 2001) found a 66% reduction in vegetation coverage on developed shorelands when compared to the undeveloped shorelands 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 shorelands.

The most abundant emergent aquatic plant in Pelican Lake is hardstem bulrush. 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.

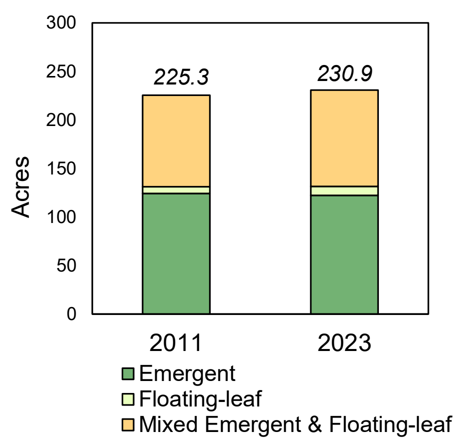


Figure 3.3-8. Acres of floating-leaf and emergent plant communities. Data from 2011 and 2023 community mapping surveys.

Photograph 3.3-3. Hardstem bulrush community on Pelican Lake. Native phragmites in back. Photo credit: Onterra.

Purple loosestrife, a non-native emergent shoreline plant, was first observed on Pelican Lake in 2010. During the 2023 aquatic plant surveys, Onterra ecologists found two purple loosestrife locations in Guths Bay along the south shoreline (Map 6)

The most abundant floating-leaf vegetation in Pelican Lake is spatterdock followed by white-water lily. Spatterdock leaves are divided by a round lobed sinus and adorns a yellow flower, whereas white-water lily has a pointed sinus with a showy white flower. During the 2011 point-intercept survey, Onterra ecologists verified the presence of a horticultural variety of white-water lily with pink flowers (*Nymphaea odorata var. rosea*). This ornamental variety was confirmed to persist in Pelican Lake in 2023, demonstrating overwintering capacity. In some lakes, the pink waterlily can cross pollinate with white water lily and act invasively.

Photograph 3.3-4. The non-native pink water lily. Photo credit Onterra.

Examination of the 2011 and 2023 data together shows that majority of the emergent and floating-leaf communities remained the same between the two surveys (Figure 3.3-8 and Figure 3.3-9). Emergent and floating-leaf plant communities often recede or expand in response to changes in water levels and human activity. On Pelican Lake, slight lakeward expansion of bulrush communities is observed in some areas. A portion of the retracted acreage on Figure 3.3-9 is access areas or lanes, being more pronounced than in 2011.

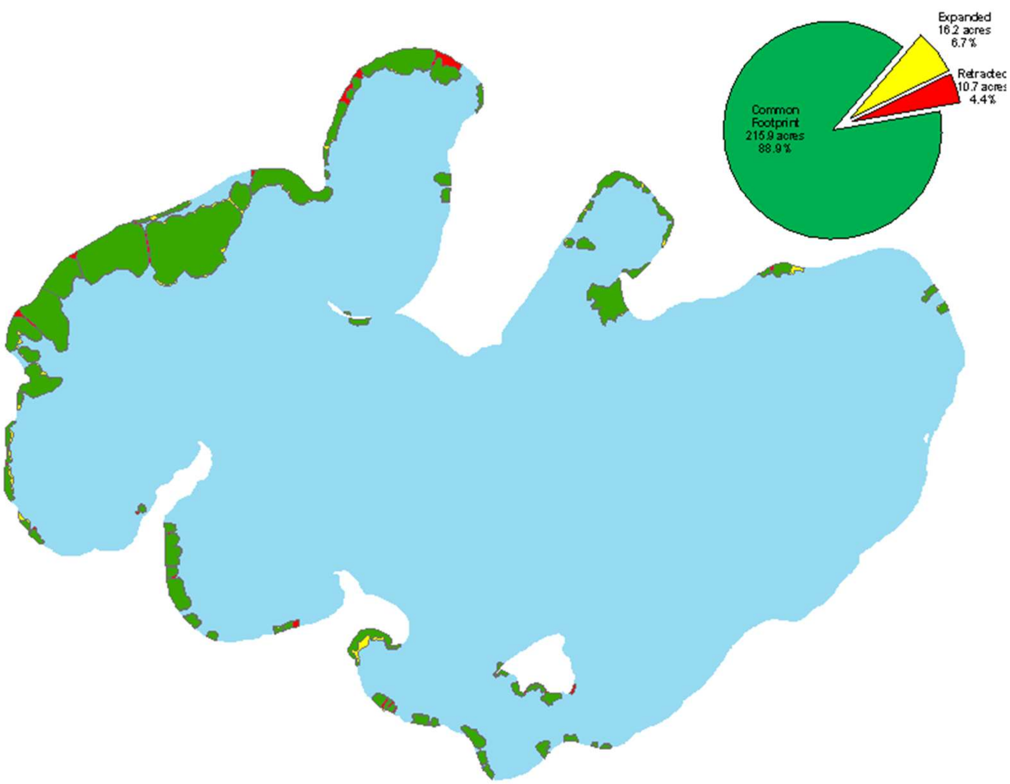


Figure 3.3-9. Footprint analysis of 2011-2023 colonized floating-leaf and emergent plant communities. Data from 2011 and 2023 community mapping surveys conducted by Onterra.

3.4 Eurasian Watermilfoil

It is important to note that two types of surveys are discussed in the subsequent materials: 1) point-intercept surveys and 2) EWM mapping surveys. Overall, each survey has its strengths and weaknesses, which is why both are utilized in different ways as part of this project.

The point-intercept survey provides a standardized way to gain quantitative information about a lake's aquatic plant population through visiting predetermined locations (Map 1) and using a rake sampler to identify all the plants at each location (Photograph 3.4-1). The survey methodology allows comparisons to be made over time, as well as between lakes. The point-intercept survey is most often applied at the whole-lake scale, but focused point-intercept surveys are often associated with management monitoring, such as herbicide treatment or mechanical harvesting.

Photograph 3.4-1. Point-intercept survey on a WI lake. Photo credit Onterra.

Photograph 3.4-2. EWM mapping survey on a Wisconsin lake. 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. EWM grows high in the water column, which can cause recreation and navigation impediments. This factor allows it to typically be mapped through surface observation. During an EWM mapping survey, the entire littoral area of the lake is surveyed through visual observations from the boat (Photograph 3.4-2). Field crews may supplement 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 are qualitatively attributed a density rating based upon a five-tiered scale from *highly scattered* to *surface matting*. Point-based techniques were applied to AIS locations that were considered as *small plant colonies* (<40 feet in diameter), *clumps of plants*, or *single or few plants*.

Eurasian watermilfoil is an invasive species, native to Europe, Asia and North Africa, that has spread to most Wisconsin counties (Figure 3.4-1). 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, Eurasian watermilfoil 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 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.

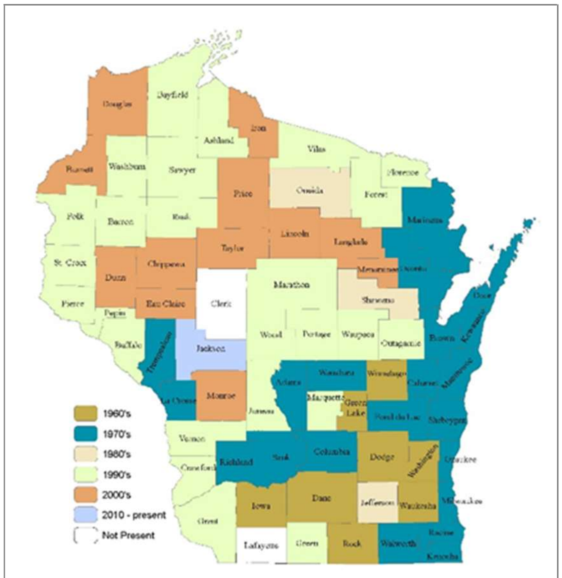


Figure 3.4-1. Spread of EWM within WI counties. WDNR Data 2022 mapped by Onterra.

The non-native plant that is of primary concern in Pelican Lake is Eurasian watermilfoil. In 2013, Onterra sent in invasive watermilfoil samples from the system to Montana State University (Dr. Ryan Thum) for genetic testing using a Rapid Assay Method (ITS). This test indicates whether the sample is northern watermilfoil, EWM, or a hybrid of the two (HWM). A limited number of individual plants have been confirmed as pure-strain EWM from Pelican Lake, no hybrid populations have been identified to date. Nearby lakes with confirmed HWM populations include Pickerel and Crane Lakes (Langlade County), Pine Lake (Forest County, and Pelican Lake (Lincoln County)

In general, HWM typically has thicker stems, is a prolific flowerer, and grows much faster than pure-strain EWM (LaRue et al. 2012). These conditions may likely contribute to this plant being particularly less susceptible to chemical control strategies (Glomski and Nehterland 2010), (Poovey et al. 2007), (Nault et al. 2018). In lakes that contain both EWM and hybrid watermilfoil (HWM), concern exists that the more-easily controlled EWM component of a lake's invasive milfoil population may be controlled by herbicide treatment, but the slightly less-susceptible HWM component will survive, rebound in a short period of time, and then comprise a larger proportion of the invasive milfoil population.

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.

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 clearest for unmanaged lakes in the Northern Lakes and Forests Ecoregion (NLF) and the North Central Hardwood Forests Ecoregion (NCHF) (Figure 3.4-2).

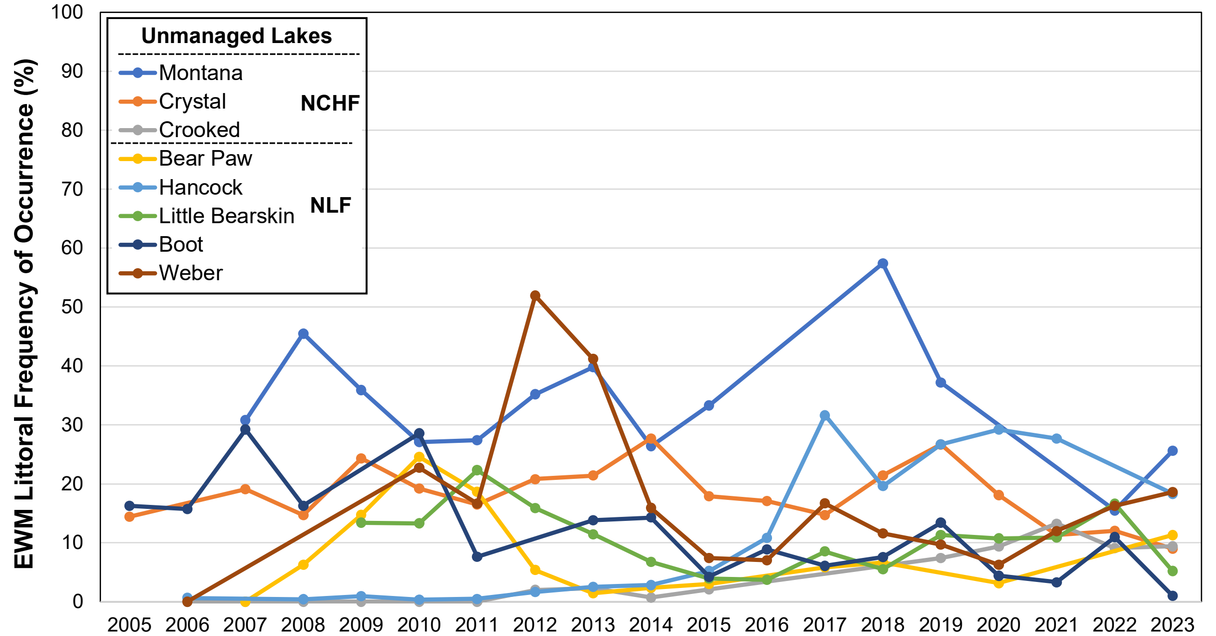


Figure 3.4-2. EWM LFOO in the NLF and NCHF Ecoregions without management. Data provided by and used with permission from WDNR.

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.

EWM population of Pelican Lake

Using data from the point-intercept surveys that have been completed in 2011 and 2023, the littoral frequency of occurrence of EWM can be compared over time. The frequency of occurrence of EWM saw a statistically valid increase in occurrence in 2023 (11.3%) compared to the 2011 (0.0%) survey on Pelican Lake. 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. For reference, both the point-intercept survey and EWM mapping surveys occurred in 2023 on Pelican Lake and are shown on Map 7. Particularly in low-density colonies such as those designated by Onterra as *highly scattered* and *scattered* (Map 7, top 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, bottom frame). As mentioned above, each survey has its strengths and weaknesses, which is why both are utilized in different ways as part of this project.

The first EWM mapping survey took place in 2011, where about a hundred individual EWM plants in addition to a 0.2-acre colony of *dominant* EWM. An aggressive approach was prompted on this newly identified population, where a 14.6-acre granular 2,4-D treatment took place in the spring of 2012. EWM reductions were observed in late-summer 2012, but more EWM existed than lake managers aimed for. A follow-up 2.8-acre granular 2,4-D treatment was conducted in spring 2013 with reductions observed but some EWM persisting. The targeted area of EWM in 2013 had completely rebounded by the summer of 2014. Although not fully understood at that time, herbicide spot treatments are difficult to effectively control EWM due to inevitable rapid dilution of the herbicide.

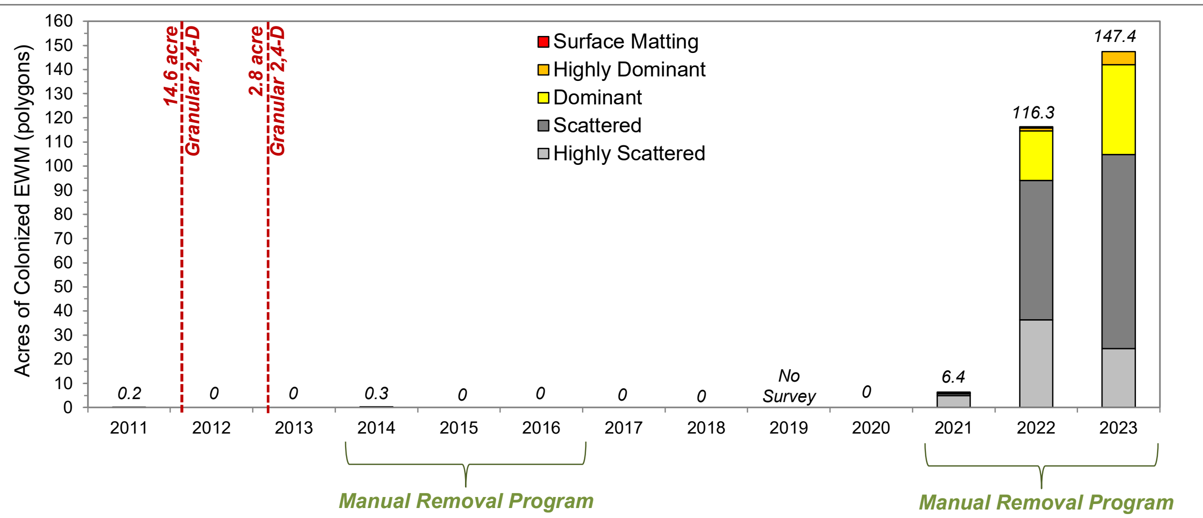


Figure 3.4-3. Pelican Lake acreage of colonized EWM (polygons) from 2011-2023. Created using data from Onterra EWM mapping surveys.

Starting in 2014, manual removal efforts were integrated into Pelican Lake's management strategy (Table 3.4-1). The contracted firm utilized Diver Assisted Suction Harvest (DASH) technology, which is a form of manual-removal which involves divers removing EWM and feeding them into a suctioned hose for delivery to the deck of the harvesting vessel. The DASH system is thought to be more efficient than manual removal alone as the diver does not have to go to the surface to deliver the pulled plants to someone on a boat. The DASH system also is believed to cause less fragmentation, as the plants are immediately transported to the surface using the pumping mechanism. Manual removal took place from 2014-2016. Not to completely discount the impact of the EWM manual removal efforts during this period, lake-wide EWM reductions were observed on Pelican Lake starting in 2016 (Map 8). EWM reductions continued in 2017-2019, with only a handful of EWM occurrences noted each year (Map 9).

Table 3.4-1. Professional hand-harvesting activities in Pelican Lake. Data extracted from Aquatic Plant Management annual reports.

Year	Number of Days	Underwater Time (hrs)	EWM Removed (cubic ft)
2014	2	10.2	440 gallons
2015	1	24.6	56 gallons
2016	2	37.3	10.9 cubic ft
2021	7	39.1	535 cubic ft
2022	6	37.0	481 cubic ft
2023	6	39.2	533 cubic ft

Starting in 2020, the EWM population began increasing again on Pelican Lake. The PLA initiated manual removal methods again in 2021 at a relatively high amount of effort. Despite the effort, EWM population continued to increase quickly, especially initially in lower Musky Bay. Manual removal efforts were directed toward Outlet Bay and Treacherous Bay in 2022, as the EWM population in Musky Bay was beyond what could be managed with manual removal techniques. A similar approach was taken in 2023, with the goal of the manual removal program pivoting away from population management and toward alleviating nuisance conditions impacting navigation.

Also in 2023, the PLA initiated a trial mechanical harvesting program where a 3.2-acre, 50-ft wide mechanical harvesting lane was constructed to allow traffic to pass from the public landing out of Lower Musky Bay (Figure 3.4-4). EWM colonies of *dominant*, *highly dominant*, and *surface matting* are those most likely to cause nuisance navigation and recreation. The nuisance navigation impediments in Lower Musky Bay are caused by a combination of EWM, but also native plants such as coontail and common waterweed. The PLA contracted to have the mechanical harvesting lane cut twice in 2023, the first cutting on June 23, 2023 and the second cutting on July 31, 2023. A full 8-hour day was needed in each instance to harvest the extent of the navigation lane.

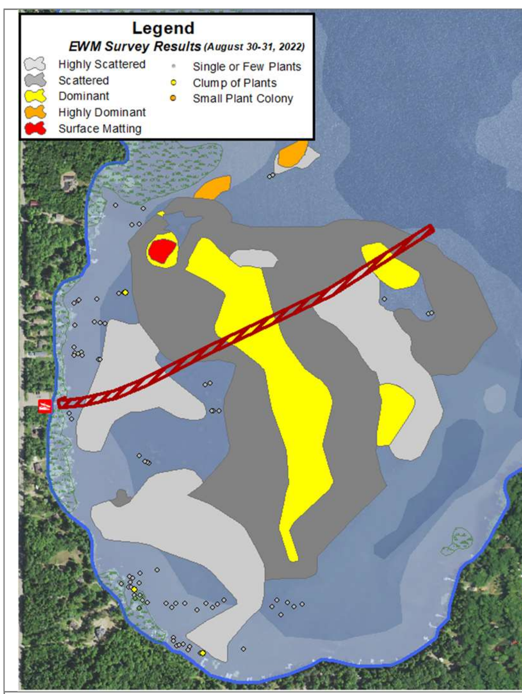


Figure 3.4-4. 2023 Mechanical harvest strategy.

Pelican Lake Future EWM Management Discussions

Maps 10-17 show the current EWM population of Pelican Lake. Some bays, like lower Musky Bay, had maintained or slightly lower EWM populations in 2023 compared to prior years. Large increases in EWM were observed in 2023 in Outlet Bay, whereas moderate EWM population increases were observed in Treacherous Bay.

In an effort to increase the flow of information between lake stakeholders and project planners, the PLA has piloted an interactive web map application for the system, allowing users to see the late-season EWM mapping survey and management areas as they relate to their property or favorite recreation and fishing spots. Various layers can be turned on and off, and some layers can be selected and a pop-up window will provide additional information. This platform allows a better understanding of the EWM population dynamics and management strategies over time. To directly access this interactive map:

https://onterra.maps.arcgis.com/apps/webappviewer/index.html?id=a539d2444d544880ac767486d68f1e9a

During the Planning Committee meetings, Onterra outlined three broad EWM population management perspectives for consideration, including a generic potential action plan for each (Figure 3.4-5). Onterra has extracted relevant chapters from the WDNR's *APM Strategic Analysis Document* to serve as an objective baseline for the PLA to weigh the benefits of the management strategy with the collateral impacts each management action may have on Pelican Lake ecosystem. These chapters are included as Appendix E. The PLA 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 methods for property owners
   - Lake organization does not oppose contracted manual removal efforts, but does not organize or pay for them
2. **Reduce EWM Population on a lake-wide level**
   (Lake-Wide Population Management)
   - Would rely on herbicide treatment strategies (risk assessment)
   - Will not eradicate EWM
   - Set triggers (thresholds) of implementation and tolerance
   - May be inconsistent with regulatory framework
3. **Minimize navigation and recreation impediment**
   (Nuisance Control)
   - Manual removal alone is not able to accomplish this goal, with herbicides or a mechanical harvester being required

Figure 3.4-5. 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, as shown in the WDNR Long-Term EWM Trends Monitoring Research Project on Figure 3.3-2. 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 most often the lake group chooses not to assist financially or with securing permits (only necessary if Diver Assisted Suction Harvest [DASH] is used). In some instances, the lake group may select this management goal, but also set an EWM population threshold or management *trigger* where they would revisit their management strategy if the population reached that level. Said another way, the lake group would let nature take its course up until populations reached a certain lake-wide level or site-specific density threshold. At that time, the lake group would investigate whether active management measures may be justified.

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 system 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 as management actions have unintended collateral impacts.

In early EWM populations, the entire population may be targeted through hand-harvesting or spot 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. In areas of the state that contain highly established and prevalent EWM populations, lake-wide population management is often considered too aggressive by local WDNR regulators. In these instances, the nuisance conditions are targeted for management and other areas are tolerated or avoided.

Nuisance Control: Some lake groups acknowledge that the most pressing issue 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.

There has been a change in preferred strategy amongst many lake managers and regulators when it comes to established EWM population in recent years. Instead of chasing the entire EWM population with management, focusing on the areas that are causing the largest impacts can be more economical and cause less ecological stress. The majority of EWM management in Wisconsin would be considered nuisance management, where dense areas that are causing navigation or recreation issues are prioritized for management and dense areas not meeting these criteria being left unmanaged. Mechanical harvesting and herbicide spot treatments are most typically employed to reach nuisance management goals, although hand-harvesting/DASH is sometimes employed to target small footprints.

Stakeholder Survey Responses to Eurasian Watermilfoil Management

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. Stakeholders were defined as a member of the PLA (with property on or off the lake) and riparian property owners who were not a member of the PLA. The return rate of the 2023 survey was 52%. Because the response rate was below

60% in 2023, it is important to reiterate that the stakeholder survey results need to be understood in the context of the respondents to the survey, not to the overall population sampled.

In 2023, riparian property owners and PLA members were asked about a number of management techniques for the future management of EWM on Pelican Lake. Figure 3.4-6 highlights the responses for common EWM management techniques. Forty-eight percent (48%) of stakeholder respondents indicated they were supportive (pooled *highly supportive* and *moderately supportive* responses) of using herbicides on Pelican Lake, whereas 27% were unsupportive (pooled *not supportive* and *moderately un-supportive* responses). Slightly higher support was garnered by respondents for mechanical harvesting (65% pooled *highly supportive* and *moderately supportive* responses), and even higher support for manual removal methods (78% pooled *highly supportive* and *moderately supportive* responses)

Queston 34: The Pelican Lake Association is in the process of assessing future techniques for the EWM population. What is your level of support for the future use of the following EWM management techniques in Pelican Lake?

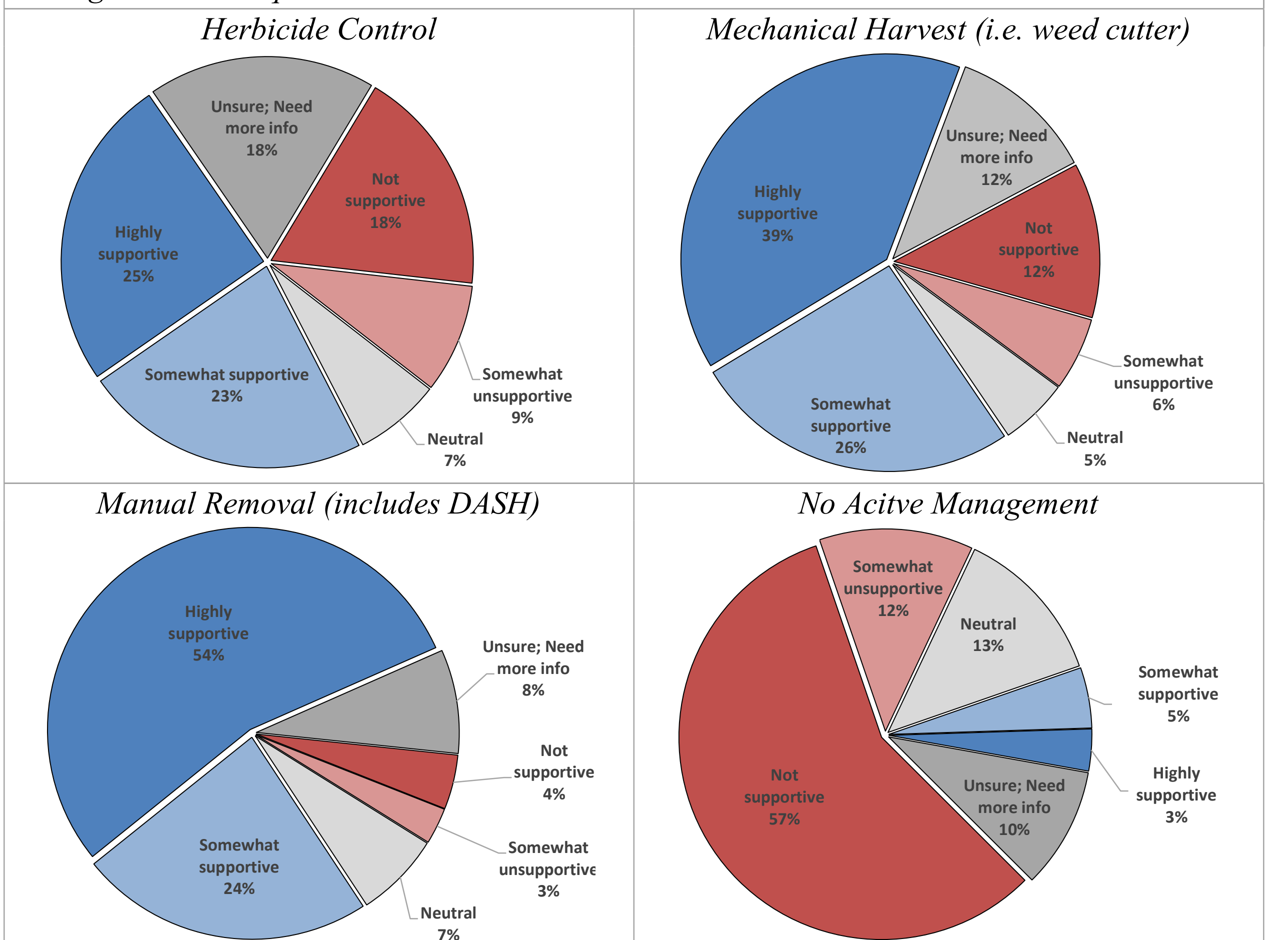


Figure 3.4-6. Select survey responses from the PLA stakeholder survey. Additional questions and response charts may be found in Appendix B.

Within the 2023 survey, stakeholders were also asked about their level of concern for active EWM management techniques (Figure 3.4-7). Respondents largely favored hand-harvesting with DASH as well as mechanical harvesting for the control of EWM but showed concerns with its potential cost as well as ineffectiveness of the technique strategy (Figure 3.4-7). The 2023 respondents also expressed concerns for herbicide use such as potential impacts to native aquatic plant species, fish, insects and potential impacts to human health (Figure 3.4-7). The largest number of concerns overall were indicated under the use of aquatic herbicides.

Queston 35: If you answered "Not supportive" or "Somewhat unsupportive" for Question #35, what is the reason(s) you oppose the future use of the management techniques to target EWM?

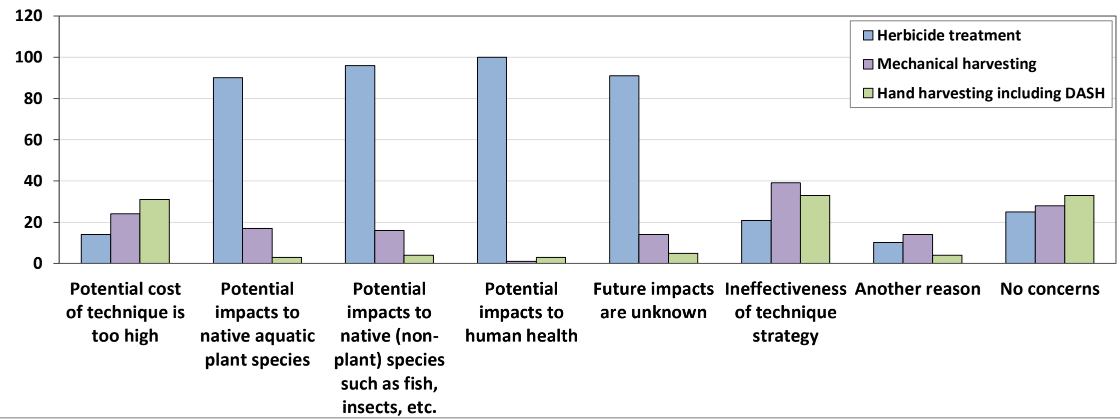


Figure 3.4-7. Select survey responses from PLA stakeholder survey. Additional questions and response charts may be found in Appendix B.

Pelican Lake Prevention & Containment

Pelican Lake is an extremely popular destination by recreationists and anglers, making the lake vulnerable to new infestations of exotic species. Figure 3.4-6 shows the three main landings on Pelican Lake where the PLA focuses their prevention and containment strategies. The intent of a watercraft inspection program is not only be to prevent additional invasive species from entering the system through its public access locations, but also to prevent the infestation of other waterways with invasive species that originated in the system. The goal is typically to cover the 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. While CBCW watercraft monitoring has been at all of the landings on Pelican Lake, the PLA has prioritized the State Landing near County HWY G as high priority for their coverage, with Keelers Landing as a secondary.

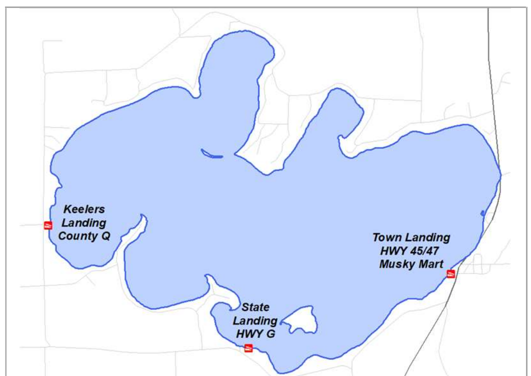
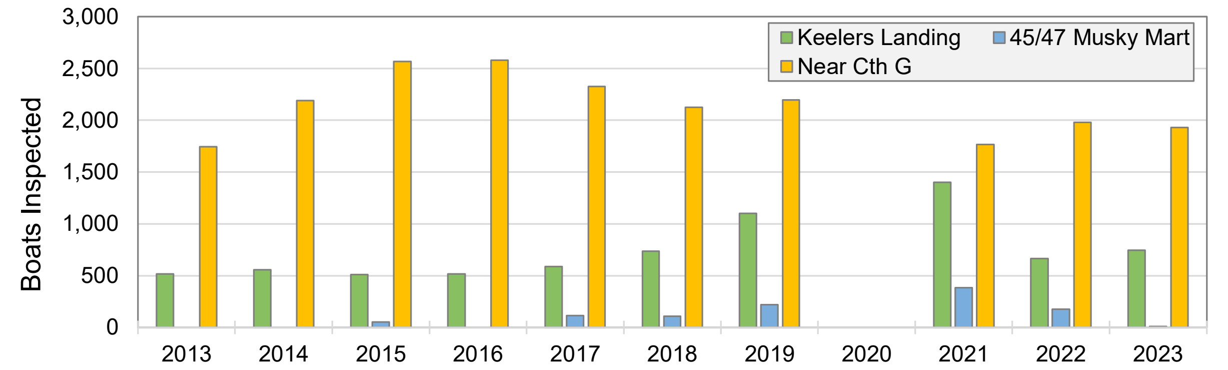


Figure 3.4-8. Pelican Lake boat launch locations with CBCW coverage.

The PLA utilizes WDNR grant funding to sponsor watercraft inspections through the WDNR's Clean Boats Clean Waters (CBCW) program at the public boat launch. The PLA's Clean Boats Clean Waters program has been well organized, with numerous watercraft inspections occurring annually. Any given year, an average of 2,500 boats are inspected at the Pelican Lake boat launches (Figure 3.3-8).



All Landings Combined	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Boats Inspected	2,262	2,745	3,129	3,098	3,029	2,965	3,520		3,552	2,821	2,687
Hours Spent	751	924	860	768	1145	1326	1692		1724	1352	913
Boats Inspected/Hrs Spen	3.01	2.97	3.64	4.03	2.65	2.24	2.08		2.06	2.09	2.94

Figure 3.4-9. Watercraft inspections completed on Pelican Lake boat launch from 2013 to 2023. Data from WDNR, SWIMS.

Based upon modeling by the University of Wisconsin Center for Limnology, Pelican Lake is on the state's list of top 300 AIS Prevention Priority Waterbodies. The lakes included in this list experience a significant influx of boats from lakes with AIS (receiving) and witness a substantial number of boats leaving from Pelican Lake to uncontaminated waters (sending). Therefore, the WDNR encourages additional supplemental prevention efforts above just watercraft inspections, offering additional grant funds for these activities for applicable lakes. Supplemental prevention efforts such as decontamination stations (e.g., pressure washer), water-less cleaning stations (e.g. CD3 systems), and remote video surveillance (e.g., I-Lids).

An internet-based video surveillance camera (I-LIDS), using funds from a state grant program (described above) and the PLA, was purchased for HWY G landing in 2020 and a second one was installed at the Town (Keelers) Landing in June 2023. During the process of launching a boat (using motion detection), an educational audio message plays and short video clips are obtained. These clips are reviewed for any possible violations of transporting aquatic plants into Pelican Lake. When Pelican Lake riparians and PLA members were asked about their support for the I-LID program, 16% of respondents did not support the effort, 44% supported the program at multiple landings, and 27% supported only the HWY G landing.

38. Which option best describes your viewpoint on the use of I-LIDS at boat launches on Pelican Lake?

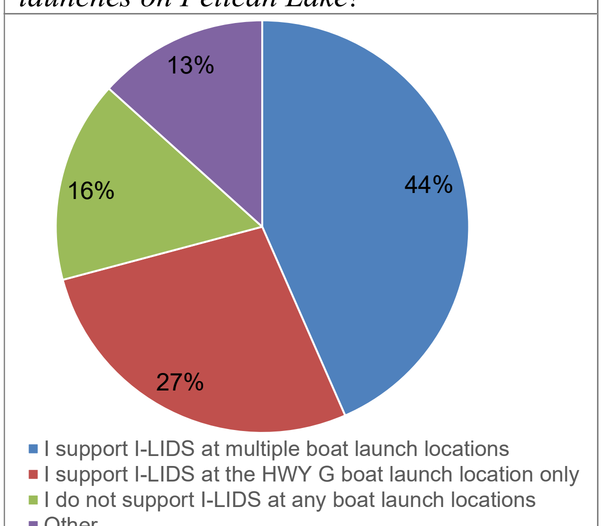


Figure 3.4-10. Select survey responses from the PLA stakeholder survey. Additional questions and response charts may be found in Appendix B.

3.5 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 Pelican Lake. 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 Nathaniel Lederman and DNR Treaty Data Coordinator Tom Cichosz (WDNR 2023 & 2024).

Pelican Lake 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 supplying its mass and composition. The gamefish in Pelican Lake are supported by a complex underlying food chain. Although each lake's food chain is unique, here is a basic food chain to help show the potential complexity and size of Pelican Lake's biotic community.

At the bottom of this food chain are algae and plants that require nutrients such as phosphorus and nitrogen and gather energy from sunlight via photosynthesis. The next tier in the food chain belongs to insects and zooplankton (tiny crustations) that feed upon algae and plants. Small fish are generally planktivorous and feed upon zooplankton and insects, and in turn become food for larger fish. The species at the top of the food chain are primarily piscivorous (they eat other fish) and are the larger gamefish that are often sought after by anglers, such as muskellunge and walleye.

Through energy flow in a lake, the available algae and plant matter generally describes how much biomass of large fish is in a lake. Since 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 insects and zooplankton to support a large planktivorous fish community. And finally, there must be a large planktivorous fish community to support a large piscivorous fish community.

Studies have shown that in natural aquatic 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 3.5-1.

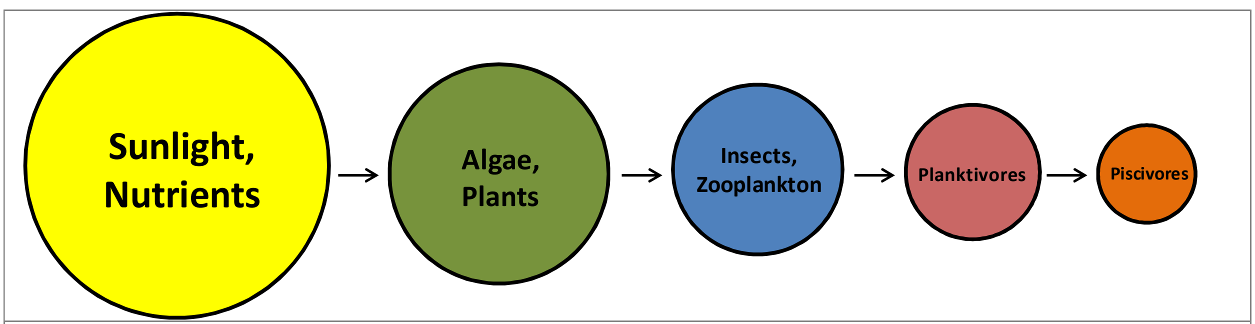


Figure 3.5-1. Aquatic food chain. Adapted from (Carpenter et al. 1985)

As discussed in the Water Quality section, Pelican Lake is a eutrophic system, meaning it has high nutrient content and thus relatively high primary productivity. Simply put, this means Pelican Lake should be able to support sizable populations of piscivorous fishes because the supporting food chain is relatively robust. Table 3.5-1 shows the popular game fishes present in the system.

Table 3.5-1. Gamefish present in Pelican Lake with corresponding biological information (Becker 1983).

Common Name (*Scientific Name*)	Spawning Period	Spawning Habitat Requirements	Food Source
Black Bullhead (Ameiurus melas)	April - June	Matted vegetation, woody debris, overhanging banks	Amphipods, insect larvae and adults, fish, detritus, algae
Black Crappie (Pomoxis nigromaculatu	May - June	Near Chara or other vegetation, over sand or fine gravel	Fish, cladocera, insect larvae, other invertebrates
Bluegill (Lepomis macrochirus)	Late May - Early August	Shallow water with sand or gravel bottom	Fish, crayfish, aquatic insects and other invertebrates
Largemouth Bass (Micropterus salmoi	Late April - Early July	Shallow, quiet bays with emergent vegetation	Fish, amphipods, algae, crayfish and other invertebrates
Muskellunge (Esox masquinongy)	Mid April - Mid May	Shallow bays over muck bottom with dead vegetation, 6 - 30 in.	Fish including other muskies, small mammals, shore birds, frogs
Northern Pike (Esox lucius)	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)	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)	Late May - Early June	Bottom of course sand or gravel, 1 cm - 1 m deep	Crustaceans, insect larvae, and other invertebrates
Smallmouth Bass (Micropterus dolomi	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)	Mid April - Early May	Rocky, wavewashed shallows, inlet streams on gravel bottoms	Fish, fly and other insect larvae, crayfish
White Bass (Morone chrysops)	Late April - June	Running water of streams, windswept shorelines, sand, gravel, or rock	Crustaceans, insect larvae and other invertebrates, and fish
Yellow Bullhead (Ameiurus natalis)	May - July	Heavy weeded banks, beneath logs or tree roots	Crustaceans, insect larvae, small fish, some algae
Yellow Perch (Perca flavescens)	April - Early May	Stream or lake, over hard bottom in tailwaters of streams	Small crustaceans, fish, leeches

Survey Methods

To keep the fishery of a lake healthy and stable, fisheries biologists conduct surveys to assess fish populations, size structures, and other aspects of the fishery. This information can help estimate the annual safe harvest, set size and bag limits for different species, and determine other relevant applications of fisheries management. To begin this process, there are a few methods of fish capture that fisheries biologists can choose from.

There are multiple fish capture methods that are used by fisheries experts. One commonly used passive trap is a fyke net (Photograph 3.5-1). Fish swimming towards this net along the shore or bottom will encounter the lead of the net, be diverted into the trap, and then move through a series of funnels which direct the fish further into the net. The net is often set overnight to allow time for fish to move in. Another commonly used sampling method is electrofishing (Photograph 3.5-1). This is done by using a specialized boat fit with a generator that powers two submerged electrodes near the bow that send electricity through the water. The electroshocking boat cruises at an idol speed to cover an area of the lake. Once a fish comes in contact with the electrical current produced, the fish are stunned, making them easier to capture by a handheld net. Contrary to what some may believe, electrofishing is not intended to kill the fish that are shocked, they generally recover within minutes. Both methods of capture allow similar biological measurements to be taken.

Some biological measurements can help find population estimates, abundances, size structures, and age classes of fishes. A population estimate can be conducted by using the mark and recapture method. This method involves marking a number of a target fish species by fin clip, tag, or other marking technique during a catchment survey. The marked fish are then released back into the body of water. After time allows the tagged and non-tagged fish in the lake to distribute evenly, a second catchment is then conducted. The ratio of marked to non-marked fish is then placed into a statistical model to calculate a population estimate of the fish species. Abundance is also commonly analyzed by these catchment surveys. A fyke net survey can give an experienced fisheries biologist a general idea of how abundant a species is in a lake based on the number of individuals caught. The average number of a fish species caught in the fyke nets in a 24-hour period from a survey is referred to as the number of individuals caught “per net night”. Unlike a population estimate, abundance is a quantity of individuals, not the estimated number of individuals in an area. A size structure analysis may also be studied from these catchment surveys by taking measurements of each fish to find the abundance of certain size groups. These size groups can then be analyzed for age by taking several scale or spine samples to age in a lab. Fisheries biologists can then use this data to make recommendations and informed decisions on managing the future of the fishery.

Photograph 3.5-1. Fyke net (left) and an electroshocking boat (right).

Fish Stocking


Photograph 3.5-2. Muskellunge fingerling.

To assist in meeting fisheries management goals, the WDNR may permit the stocking of fingerling or adult fish in a waterbody that are raised in permitted hatcheries. 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. Pelican Lake has been stocked with Muskellunge (Photograph 3.5-2), Walleye, Smallmouth Bass, Largemouth Bass, Bluegill, Yellow Perch, and White Bass. The White Bass present in Pelican Lake are believed to be present as a result from stocking efforts that occurred from 1891 and 1914 to lakes with resorts in Northern Wisconsin to enhance tourism opportunities. There is no data for 1909 and after but on May 13, 1889 it was noted that 500 adult white bass were stocked in Pelican Lake (Wisconsin Fish Commission 1914). A 2005 panfish assessment was done on Pelican Lake to find abundance and to also analyze the impacts that the 2004 bluegill stocking effort had on the population. Only 0.27% of the bluegills were recaptured on this assessment which led the fisheries biologist to believe that the stocking effort had little impact to helping the population. There were no stocking efforts for bluegill after that conclusion was made. Muskellunge appears to be the most consistently stocked species in pelican. Large efforts occurred in the 70s, through the 90's, a bit of a gap in years, and now have been stocked every three years since 2012. If the trend continues, the next stocking will occur in 2024. Walleye stocking was discontinued due to natural reproduction providing a sustainable amount of regeneration for the amount of harvest occurring.

Table 3.5-2. Stocking data available for Walleye in Pelican Lake (1972-2023).

Year	Species	Age Class	# Fish Stocked	Avg Fish Length (in)
1972	Walleye	Fingerling	46,600	4
1975	Walleye	Fingerling	20,000	3
1976	Walleye	Fingerling	20,000	3
1984	Walleye	Fry	3,000,000	1
1991	Walleye	Fry	400,000	1
1999	Walleye	Fry	440,000	1
2000	Walleye	Fry	460,000	1

Table 3.5-3. Stocking data available for Muskellunge in Pelican Lake (1972-2023).

Year	Species	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1974	Muskellunge	Unspecified	Fingerling	2850	9
1976	Muskellunge	Unspecified	Fingerling	1395	9
1977	Muskellunge	Unspecified	Fingerling	2369	11
1980	Muskellunge	Unspecified	Fingerling	2500	8
1981	Muskellunge	Unspecified	Fingerling	890	12
1982	Muskellunge	Unspecified	Fingerling	2500	11.5
1984	Muskellunge	Unspecified	Fingerling	1186	10
1985	Muskellunge	Unspecified	Fingerling	2500	12
1986	Muskellunge	Unspecified	Fingerling	1176	9
1988	Muskellunge	Unspecified	Fingerling	2500	10.33
1989	Muskellunge	Unspecified	Fingerling	2210	10
1991	Muskellunge	Unspecified	Fingerling	1750	10
1992	Muskellunge	Unspecified	Fingerling	2500	11
1993	Muskellunge	Unspecified	Fingerling	2500	12.4
1996	Muskellunge	Unspecified	Fingerling	2500	10.8
1996	Muskellunge	Unspecified	Fry	100000	0.5
1998	Muskellunge	Unspecified	Large Fingerling	2500	12.35
2012	Muskellunge	Upper Wisconsin River	Large Fingerling	3611	11.5
2015	Muskellunge	Upper Wisconsin River	Large Fingerling	1772	11.8
2018	Muskellunge	Upper Wisconsin River	Large Fingerling	1793	11.8
2021	Muskellunge	Upper Wisconsin River	Large Fingerling	1772	12.3

Table 3.5-4. Stocking data available for bass and panfish in Pelican Lake (1972-2023).

Year	Species	Age Class	# Fish Stocked	Avg Fish Length (in)
2000	Largemouth Bass	Large Fingerling	250	N/A
2000	Smallmouth bass	Large Fingerling	250	N/A
2001	Yellow Perch	Adult	12000	N/A
2002	Yellow Perch	Adult	20000	N/A
2003	Yellow Perch	Large Fingerling	33250	5.5
2004	Bluegill	Adult (Broodstock)	34,671	4.2

Fishing Activity

Based on data collected from the stakeholder survey (Appendix B), fishing open-water was the second most important activity for property owners on or near Pelican Lake (Question #9). Figure 3.5-2 displays the fish that Pelican Lake stakeholders enjoy catching the most, with yellow perch, walleye, and bluegill/sunfish being the most popular. Approximately 75% of the respondents believed that the quality of fishing on the lake was either good or fair (Figure 3.5-3). Approximately 60% of respondents who fish Pelican Lake believe the quality of fishing has gotten much worse or somewhat worse since they first started to fish the lake (Figure 3.5-4).

Question 11: What species of fish do you try to catch on Pelican Lake?

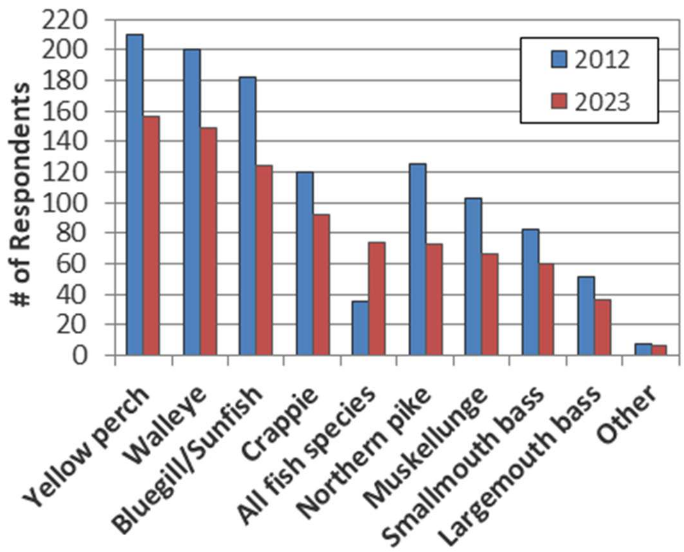


Figure 3.5-2. Select stakeholder survey responses regarding the Pelican Lake fishery.

Question 12: How would you describe the current quality of fishing on Pelican Lake?

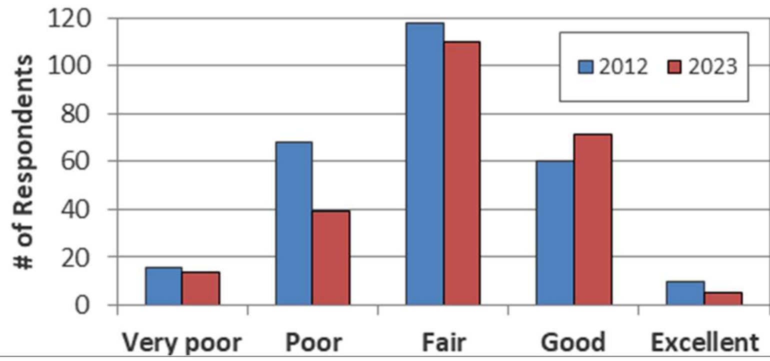


Figure 3.5-3. Select stakeholder survey responses regarding the Pelican Lake fishery.

Question 13: How has the quality of fishing changed on Pelican Lake since you have started fishing the lake?

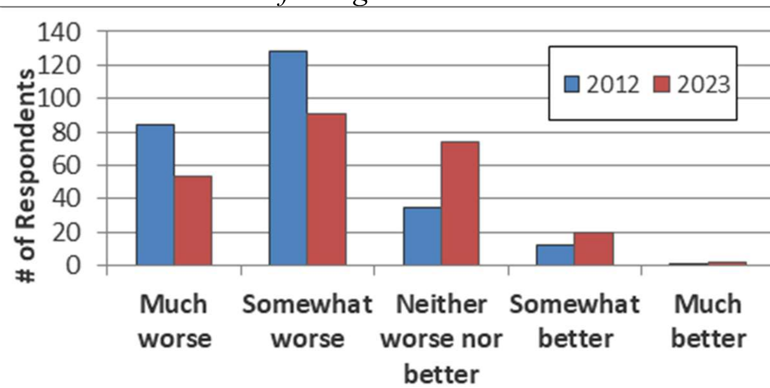


Figure 3.5-4. Select stakeholder survey responses regarding the Pelican Lake fishery.

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 fished that 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 Pelican Lake during the 1990-1991 and 2011-2012 fishing seasons (Table 3.5-5). Anglers directed the largest amount of effort towards yellow perch and walleye during both the 2011-12 and 1990-91 fishing seasons (Table 3.5-5).

Table 3.5-5. Creel Survey from 1990 and 2011

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
Walleye	1990	78430	21.01%	11324	7.3	1356	57.8	16.7
	2011	52019	18.43%	13479	4.3	3915	13.9	17.8
Muskellunge	1990	40736	10.91%	1261	38.9	146	277.8	37.8
	2011	17447	6.18%	217	116.3	0		
Northern Pike	1990	63832	17.10%	10918	6.7	6023	11	21.9
	2011	36946	13.09%	14976	4	6032	7.2	22.5
Smallmouth Bass	1990	1114	0.30%	891	3.6	80	25.3	13.6
	2011	14541	5.15%	9066	2.5	149	122	18.8
Largemouth Bass	1990	6325	1.69%	1337	5.9	584	12.3	13.5
	2011	13329	4.72%	8633	1.7	30		18.2
Yellow Perch	1990	84468	22.63%	109607	0.8	98455	0.9	7.7
	2011	68286	24.19%	131000	0.5	40141	1.7	8.9
Bluegill	1990	52917	14.17%	58624	0.9	37188	1.5	6.5
	2011	48537	17.20%	104476	0.5	30093	1.7	7
Pumpkinseed	1990	1976	0.53%	1655	1.7	1017	2.7	6.5
	2011	11595	4.11%	9220	2.3	1830	8	6.6
Black Crappie	1990	39103	10.47%	22891	1.8	20028	2	8.9
	2011	18847	6.68%	9730	2.2	5682	3.8	10.1
Rock Bass	1990	636	0.17%	1238	1.3	216	3	8.2
	2011	236	0.08%	4269	0.6	403	1.2	8
White Bass	1990	3796	1.02%	3681	1.3	2198	2.2	11.6
	2011	449	0.16%	699	1.3	468	1.4	12.5

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 in many ways by fisheries biologists to better understand the fishery and how it should be managed.

Gamefish

The gamefish present on Pelican Lake represent different population dynamics depending on the species. The results for the stakeholder survey show that yellow perch and walleye were species most fished for on Pelican Lake (Figure 3.5-2). Brief summaries of gamefish with fishable populations in Pelican Lake are provided based off two reports conducted by the DNR. Retired WDNR fisheries biologist John Kubisiak submitted the fisheries surveys completed in 2011, which was the last time any population estimates were conducted on Pelican Lake. The most recent size structure analysis was from a report submitted by Current Fisheries Biologist Nathan Lederman following the fisheries surveys completed in 2022.

Walleyes have been stocked in Pelican Lake in the past, but stocking efforts were discontinued due to natural reproduction occurring. The last population estimate conducted was in 2011 which estimated 2.4 adult walleyes/acre in 2011 which is lower than expected due to the size of the lake and the fact that natural reproduction was observed. The survey in 2022 observed length of walleyes between 4.2 and 23.5 inches. The average length found was 9.6 inches. Only 12% of the individuals were over 15 inches.

Largemouth Bass had an estimated abundance at 0.53 adults/acre in the 2011 survey. This is a low density for largemouth bass in a eutrophic system. The size structure observed in 2022 was between 2.9 and 20.2 inches. Average length was 12.4 inches. Based upon surveys, Pelican Lake is considered to have trophy class largemouth bass.

Northern Pike population was estimated at 1.5 adults/acre in 2011, which is a low to moderate density for a northern pike population. Sizes observed in the 2022 survey were between 7.5 and 31.6 inches. The average size captured in the 2011 survey was 24.2 inches. 88% of the individuals observed were 21 inches or larger. Lymphosarcoma is a disease that was confirmed present in the 2011 survey. It affects muskellunge and northern pike and is sometimes fatal. The disease is evident by skin sores or lesions. Multiple northern pike were observed with this disease in the 2011 survey.

Muskellunge are considered common in Pelican Lake. The 2011 survey estimated 241 muskellunge to be in the lake. There is evidence of natural reproduction from the 2011 survey of 2010 and 2011 year classes. Although there is natural reproduction, stocking had still occurred every three years since 2012. If this trend continues, there will be stocking in 2024. Size structure observed in the 2022 survey were fish between 13.1 and 48.5 inches, the average being 31.1 inches.

Smallmouth Bass are present in Pelican Lake but too little were handled to estimate a population in the 2011 survey. Average length in the 2022 survey was 14.5 inches. Fish ranged from 2.5 to 21.7 inches. Like the largemouth bass, Pelican Lake is considered to have trophy smallmouth bass.

White Bass are present in Pelican Lake, but not present in other lakes in the area. The 2011 survey captured fish of a narrow length range of 13.4 to 15.7 with an average size of 14.6 inches. None were observed in the 2022 survey.

Panfish

The panfish present on Pelican Lake represent different population dynamics depending on the species. The results for the stakeholder survey show yellow perch is the most targeted species on Pelican Lake (Figure 3.5-2). Brief summaries of panfish abundance and size are provided based on the WDNR fisheries surveys completed in 2005 survey submitted by retired DNR Fisheries Biologist John Kubisiak and the 2011 and 2022 surveys mentioned above.

From the 2005 survey, when evaluating the contribution of stocked bluegill from the 2004 stocking effort, only 0.27% of the catch had fin clips, suggesting a minimal impact from stocking efforts, which fell short of the expected benchmark of 10% contribution to the population. Bluegill abundance assessment found 60 bluegills per net night.

In the 2011 survey, there were no population estimates conducted for panfish. However, bluegill abundance was analyzed. 155 bluegills were captured per net night. It was noted that this large increase from the previous 2005 survey could have been partially due to the warming temperature and potential effects on fish movement that occurred during the 2011 survey, but it also shows there was a high population.

The 2022 report showed the size structures of panfish species caught. Black crappie averaged 9.0 inches and ranged from 4.4 to 15.1 inches. Bluegill averaged 5.1 inches and ranged from 1.4 to 9.1 inches. Pumpkinseed averaged 4.9 inches and ranged from 2.9 to 7.8 inches. Rock bass averaged 6.9 inches and ranged from 3.4 to 9.8 inches. Lastly, yellow Perch averaged 5.6 inches and ranged from 2.3 to 10.8 inches.

Pelican Lake Spear Harvest Records

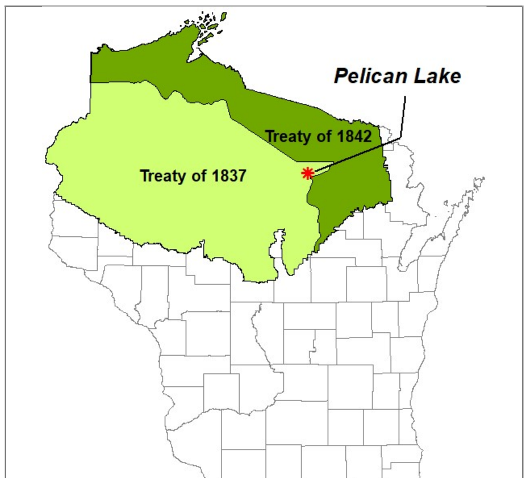


Figure 3.5-5. Location of Pelican Lake within the Native American Ceded Territory (GLIFWC 2017). This map was digitized by Onterra; therefore, it is a representation and not legally binding.

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 3.5-5). Pelican Lake falls within the ceded territory based on the Treaty of 1837. 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 by tribal 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 represents the number of fish that can be harvested by tribal members through the use of high efficiency gear such as spearing or netting without influencing the sustainability of the population. This does not apply to angling harvest which is considered a low-efficiency harvest regulated statewide by season length, size and bag limits. 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 high efficiency methods. By March 15th of each year the relevant Native American communities may declare a proportion of the total safe harvest on each lake; this declaration represents the maximum number of fish that can be harvested by tribal members 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 statewide 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).

Tribal members may 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 2017). 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 (GLIFWC 2017). This regulation limits the harvest of the larger, spawning female walleyes. An updated nightly declaration is determined each morning by 9 a.m. based on the data collected from the successful spearers. Spearfishing of a particular species ends once the declared harvest is reached in a given lake

Mole Lake Sokaogon Chippewa Community has historically exercised their treaty rights for open-water spear harvest on Pelican Lake. Walleye open water spear harvest records are provided in Figure 3.5-6 from 1986 to 2023. As many as 2,473 walleye have been harvested from the lake in the past (2017), but the average harvest is roughly 850 fish in a given year. Spear harvesters on average have taken 92% of the declared quota.

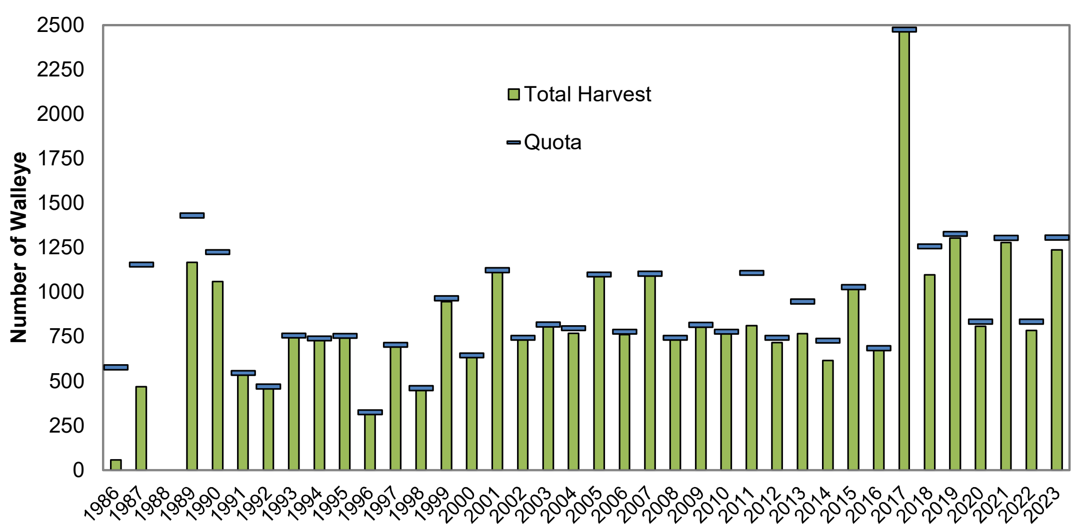


Figure 3.5-6. Pelican Lake walleye spear harvest data. (GLIFWC 1998-2023).

Muskellunge open water spear harvest records are provided in Figure 3.5-7 from 1998-2023. As many as 24 muskellunge have been harvested from the lake in the past (2003), however the average harvest is 19 fish in a given year. Spear harvesters on average have taken 53% of the declared quota.

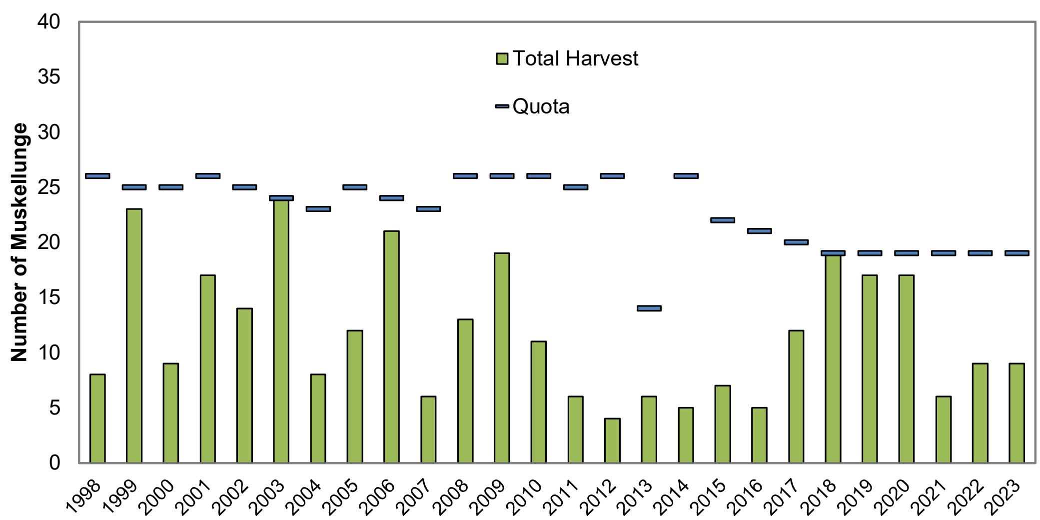


Figure 3.5-7. Pelican Lake muskellunge spear harvest data. (GLIFWC 1998-2023).

The spearing harvest numbers can be compared to the estimated hook and line angler harvest data collected by creel surveys in 1990 and 2011 (Figure 3.5-8, Figure 2.5-9). These charts show that the hook and line angler harvest resulted in a higher annual harvest of walleye in both years and muskellunge in 1990. The estimated annual muskellunge harvest in 2011 by hook and line angler was zero fish which is presumed to be a result of the publicity of practicing catch and release with Muskellunge in Wisconsin fishing culture in the past couple decades.

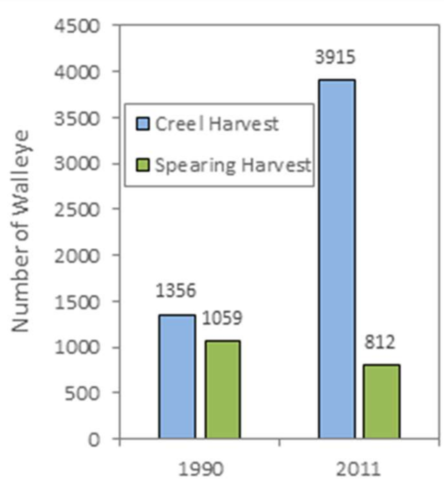


Figure 3.5-8. Pelican Lake Walleye creel and spear harvest observations for 1990 and 2011.

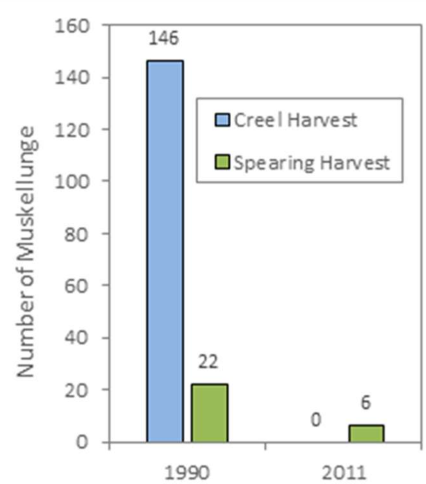


Figure 3.5-9. Pelican Lake Muskellunge creel and spear harvest observations for 1990 and 2011.

Pelican Lake 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 2023, 30% of the substrate sampled in the littoral zone of Pelican Lake were sand sediments, 20% was composed of rock and 50% were composed of soft sediments.

Woody Habitat

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 2009). The local fisheries biologist may be able to determine if adding wood structure would be beneficial for Pelican Lake.

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 3.5-3). 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 3.5-3. 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.

Half-logs are another form of fish spawning habitat placed on the bottom of the lakebed (Photograph 3.5-3). Smallmouth bass specifically have shown an affinity for overhead cover when creating spawning nests, which half-logs provide (Wills et al. 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 (Neuswanger and Bozek 2004).

Placement of a fish habitat structure in a lake may be exempt from needing a permit if the project meets certain conditions outlined by the WDNR's checklists available online:

(https://dnr.wi.gov/topic/waterways/Permits/Exemptions.html)

If a project does not meet all of the conditions listed on the checklist, a permit application may be sent in to the WDNR and an exemption requested.

Volunteers from the PLA as well as community members with oversight from the WDNR constructed and placed 41 wooden fish cribs in at least 8 different locations in Pelican Lake in 2021-2022. Local suppliers provided materials and the association contracted at a reduced rate for Pelican Piers to carry cribs to site and lower w crane.

Fishing Regulations

Regulations for Pelican Lake fish species for the 2023-2024 fishing season are displayed in Table 3.5-4. From 1997 to 2005, Pelican Lake had a daily bag limit of 5 Walleye with no minimum length limit except for one fish larger than 14 inches. This aimed to manage high-density populations with slow growth. However, in 2006, they reverted to the statewide 15-inch minimum length limit. This was due to the moderate adult densities and average to above-average growth rates observed during surveys (Kubisiak 2012). The current regulation special regulations for Pelican Lake are larger muskellunge, largemouth bass, and smallmouth bass size limits and a lower largemouth bass and smallmouth bass bag limit than the state's general fishing regulations. This regulation is aimed to manage these species for trophy size potential.

Regulations for Pelican Lake fish species for the 2023-2024 fishing season are displayed in Table 3.5-6. 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 3.5-6. WDNR fishing regulations for Pelican Lake (2023-2024).

Species	Daily bag limit	Length Restrictions	Season
Panfish (Bluegill, Pumpkinseed, Sunfish, Crappie and Yellow Perch)	25 Total	None	Open All Year
Largemouth Bass and Smallmouth Bass	1 Total	18"	June 17, 2023 to March 3, 2024 May 6, 2023 to March 3, 2024
Muskellunge (Includes hybrids)	1 Total	50"	May 26, 2023 to November 30, 2024
Northern Pike	5	None	May 6, 2023 to March 3, 2024
Walleye	3 Total	The minimum length is 15", but walleye from 20" to 24" may not be kept, and only 1 fish over 24" is allowed.	May 6, 2023 to March 3, 2024
Bullheads and rough fish	Unlimited	None	Open All Year
Rock Bass and White Bass	Unlimited	None	Open All Year

General Waterbody Restrictions: Motor Trolling is allowed with 1 hook, bait, or lure per angler, and 3 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 can 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 3.5-10. 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 3.5-10. 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

Pelican Lake boasts a diverse fishery with balanced gamefish species, including walleye, northern pike, largemouth bass, smallmouth bass, and muskellunge. There are multiple species of panfish present, bluegill are most abundant, but perch are more commonly targeted by anglers. Forage and non-game species also contribute to the ecosystem. Humans play a role in the fishery by both hook and line harvest and spear harvest. The lake is managed as a mixed fishery, emphasizing trophy muskellunge and quality size abundance potential for other species. In 2024, the WDNR is scheduled to conduct creel and capture surveys, aiming to acquire current data crucial for enhancing fisheries management practices.

3.6 Swimmers Itch

Cercarea dermatitis or swimmer's itch is a type of skin reaction that is caused when the larval stage of a shistosome flatworm accidentally burrows into a human's skin when that person is spending time in the water (Figure 3.6-1).

The skin reaction varies from one individual to another, but is usually accompanied by intense itching and a rash of small red bumps that look similar to insect bites. Each of the red bumps is caused by localized, inflammatory immune response to an individual parasite which will die within hours of entering into the skin. The allergic reaction can greatly compromise the recreational value for those who enjoy spending time in the water. For some individuals, the reaction can be so severe they may require medical attention (due to the intense inflammatory response or a secondary skin infection). Young children seem to be more affected by this condition; as they typically spend more time in the water, have more sensitive skin, and have a tendency to spend more time in near-shore areas of the lake where the flatworms may be more concentrated.

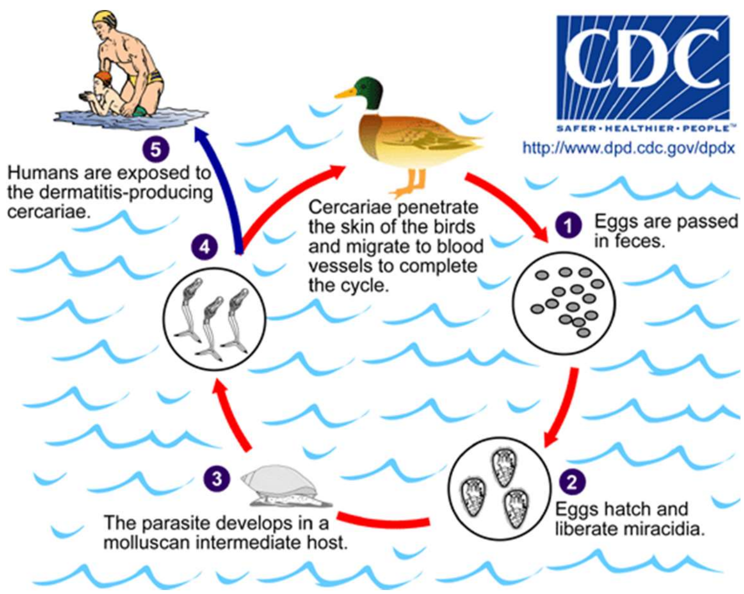


Figure 3.6-1. Swimmer's itch life cycle. Obtained directly from the Centers for Disease Control & Prevention website (CDC 2012).

The larval stage (cercariae) of this group of flatworms needs to burrow into the skin of certain bird species to complete its lifecycle ❹. While the primary hosts are ducks, gulls, geese, swans, and red-winged blackbirds, other non-bird species (e.g. muskrats, mice) have also been shown to complete this parasite's life cycle. Mergansers have been known to have some of the highest infection rates of this group of parasites. After the flatworm matures in the bird host, it produces eggs that are released into the water through the bird's feces ❶. The eggs hatch ❷ and the immature life stage (miracidia) of the parasite seeks out a snail host to continue maturation ❸. While not all snail species will suffice as intermediate hosts for the flatworms, nine or more species have been known to host flatworm species associated with swimmer's itch. Once the flatworm matures the larval cercaria emerges and seeks out a definitive host to complete the lifecycle. However, sometimes the cercariae accidently encounter a human and attempt to burrow into the skin ❺, causing the skin reaction discussed above.

Historically, molluscicides have been used to combat swimmer's itch by targeting the intermediate host, snails. The pesticides are non-selective towards snails, mussels, and other mollusks that play an integral part of the aquatic ecosystem. For that reason, along with the high expense and uncertain long-term consequences of applying these metal-based pesticides, this management technique has gone out of favor and typically is not permitted in Wisconsin.

Below are the following steps that can be taken to prevent or reduce the discomfort caused by swimmer's itch. The following summary list is based off information available on the WDNR's website:

- Avoid spending time in shallow water, especially if swimmer's itch has been known to be a problem in the area.
- Avoid spending time in the water between noon and 2 p.m, during which cercariae are most prevalent.
- Towel off immediately after getting out of the water. Cercariae will not penetrate the skin until after the person leaves the water. There may be an opportunity to remove the parasite before this occurs.
- Discourage ducks and other waterfowl from congregating in or near swimming areas by keeping near-shore areas vegetated, and by avoiding feeding the birds.

Avoid using riprap or seawalls along the shoreline, as this provides an excellent substrate for many snail species. Host snails are known to live on all types of substrate (sand, rock, mulch, vegetation) with an increased preference for sandy beaches.

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 Pelican Lake ecosystem.
2) Collect detailed information regarding invasive plant species within the lake, with the primary emphasis on Eurasian water milfoil.
3) Collect sociological information from Pelican Lake stakeholders regarding their use of the lake and their thoughts pertaining to the past and current condition of the lake and its management.

These were largely the same objectives from the 2013 *Comprehensive Management Plan,* although there was not a lot of data on these topics at this time. Following a decade of the PLA implementing data collection and management activities, this 2024 *Comprehensive Management Plan* is able to provide a better picture of the Pelican Lake ecosystem and develop ways to protect and enhance it.

As a shallow lowland drainage lake, Pelican Lake as relative small watershed compared to its size. The majority of Pelican Lake's surficial watershed is forest and forested wetlands, two landcover types that export the least amount of phosphorus to the lake. Actually, watershed modeling predicted about half of the phosphorus entering Pelican Lake comes into the lake from rain falling on the lake itself. The largest controllable source of phosphorus comes from the developed lakeshore properties from runoff and septic systems.

Phosphorus is the limiting nutrient in Pelican Lake, meaning added phosphorus means added plants and algae in the lake. Pelican Lake is on the EPA's 303(d) list of impaired waters because it often has high free-floating algae content. A sediment core indicated that Pelican Lake has historically had high nutrient levels. This investigation noted that phosphorus levels were higher prior to European settlement than they are currently. The study indicated less overall aquatic plants in the lake, as the lake was algae dominated.

Legacy phosphorus has built up on Pelican Lake, and may periodically be released from its sediments during the summer when the bottom waters become void of oxygen. There is only limited data that supports this likelihood, but not enough to understand is actual role or magnitude in influencing Pelican Lake's water quality. Increases in the frequency of large rain events has been documented, which can flush wetlands and increase nutrient loads to lakes compared to the same amount of rain spread out in smaller increments.

The occurrence of potentially dangerous blue-green algae blooms has also thought to be increasing on Pelican Lake. This is a reality on many lakes throughout the world, with scientists eagerly trying to find ways to limit them. Implementing nutrient management practices, especially on riparian properties, is the best way to reduce the severity and periodicity of blue-green algae blooms.

Pelican Lake has an exceptional aquatic plant community, with about 60 different species confirmed within and along the margins of the lake. With many different habitat and substrate types, a wide range of species do well in Pelican Lake. These plants are important for utilizing the phosphorus before algae does, keeping the lake in a clear-water condition. The plants are important drivers of the lake's fishery, providing the proper amount of habitat for foraging, spawning, and protection. Changes in aquatic plant biomass, and where that biomass is situated in the water column, could cause shifts in fish populations.

Eurasian water milfoil populations remained relatively low in Pelican Lake from 2011 to 2020, with minimal management intervention. It is unknown what conditions changed, but the EWM footprint and density greatly expanded from 2021-2024. As a large lake, management intervention is incredibly expensive. The PLA was one of the most proactive lake organizations as it implemented manual removal methods, including those using Diver-Assisted Suction Harvest (DASH) techniques. Unfortunately, the rate of removal was outpaced by the rate of increase. In 2023 and 2024, the PLA also incorporated mechanical harvesting into their aquatic plant management strategy.

The PLA is hesitant to adopt chemical methodologies until all other options are exhausted. The PLA believes the known and unknown risks of using herbicides are not commensurate with a lowered EWM population for 4-5 years (at best case scenario). If ramped up mechanical harvesting and DASH efforts can be implemented to allow sufficient navigation and recreation, the PLA would continue that path. If that goal cannot be achieved, additional investigations in the potential for herbicide options would be made. Based upon Onterra's experience, large and basin-wide treatment strategies will produce longer reductions compared to small spot treatments.

Some PLA members are also concerned with the mucky sediment contained in some of the bays, some of which may be unnaturally deposited as part of prior logging and milling operations. Increased sedimentation concerns are shared by many lake groups, driving technological advances in this field. The PLA intends to continue to explore novel approaches to sediment reduction strategies.

Through the process of this lake management planning effort, the PLA has learned much about their system, both in terms of its positive and negative attributes. It is particularly important to protect high quality aspects of the Pelican Lake ecosystem. The PLA has built and plans to implement an ambitious set of management activities, potentially one of the largest and most detailed that Onterra has worked on.

5.0 IMPLEMENTATION PLAN

The Pelican Lake Association's Mission statement:

> *The purpose of the corporation is to preserve, protect, and enhance the waters of Pelican Lake and its surroundings through the undertaking of various activities, including advocating and facilitating communication through sharing of information among individuals, environmental organizations, and state and local governmental bodies. This also includes involvement in various educational and special projects aimed at good stewardship and wise use of the lake to enhance the water quality, fishery, boating safety, natural wildlife habitats, and aesthetic values of Pelican Lake as a public recreational facility for today and future generations.*

The Implementation Plan presented below was created through the collaborative efforts of the PLA Planning Committee and ecologist/planners from Onterra in an effort to fulfil the PLA's mission. It represents the path the PLA will follow in order to meet their lake management goals. The goals detailed within the plan are realistic and based upon the findings of the studies completed in conjunction with this planning project and the needs of the Pelican Lake stakeholders as portrayed by the members of the Planning Committee, the returned stakeholder surveys, and numerous communications between Planning Committee members and the lake stakeholders. The Implementation Plan is a living document in that it will be under constant review and adjustment depending on the condition of the lake, the availability of funds, level of volunteer involvement, and the needs of the stakeholders.

The PLA operates with nine standing committees, each with a chair and a vice-chair Planning Committee believes that assigning a facilitating committee to each of the following management actions will communicate a stronger level of commitment to the management actions. The PLA acknowledges that facilitators may change as the plan ages, with the PLA Board of Directors being responsible for updating as appropriate.

Fish and Wildlife	Land Use	Financial Review
Water Quality	Public Relations/Marketing	Membership
Boating Safety	Finance	Bylaws

Management Goal 1: Ensure the PLA has a Functioning and Up-to-Date Management Plan

Management Action:	Periodically update lake management plan
Timeframe:	Continuation of current effort; periodic
Facilitator:	Board of Directors
Description:	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. ***Comprehensive Management Plan*** The WDNR recommends *Comprehensive Lake Management Plans (CLMP)* generally get updated every 10 years. Implementation projects require a completion data of "**no more than 10 years** prior to the year in which an implementation grant application is submitted." This allows a review of the available data from the lake, as well as to consider changing BMPs for water quality, watershed, and shoreland management. ***Aquatic Plant Management Plan*** BMPs for aquatic plant management change rapidly, as new information about effectiveness, non-target impacts, and risk assessment emerges. To be eligible to apply for grants that provide cost share for AIS control and monitoring, "a current plan has a completion date of **no more than 5 years** prior to submittal of the recommendation for approval. The department may determine that a longer lifespan is appropriate for a given management plan if the applicant can demonstrate it has been actively implemented and updated during its lifespan. However, a [whole-lake] point-intercept survey of the aquatic plant community conducted within 5 years of the year an applicant applies for a grant is required." It is important to work with the regional WDNR Lakes Biologist to understand what is required at this time, as it is more subjective in comparison to the requirements of a *CLMP* as it relates to the specific management actions being considered. ***Annual Control & Monitoring Plan*** It is important to note that the management plan provides a framework to guide the management action, but does not include the specific control plan for a given year. If the action being considered does not fall within the framework of the overall management plan, it is likely that an updated plan is needed regardless of its relative age. If the PLA intends to conduct active management towards aquatic plants, a preceding control and monitoring plan, consistent with the *Management Plan*,

	would be produced typically January-March prior to its implementation. At a minimum this would include a map of the preliminary strategy (harvest, DASH, or treatment areas) and discussion of associated efficacy monitoring activities. If herbicide treatment strategies are to be implemented, a formal distributable written report would likely be created. The control plan is useful for WDNR and other regulators when considering approval of the action, as well as to convey the control plan to PLA members for their understanding.

Management Goal 2: Increase the PLA's Capacity to Communicate with Lake Stakeholders and Facilitate Partnerships with Other Management Entities

Management Action:	Maintain communication abilities with PLA membership
Timeframe:	In Progress
Facilitator:	Public Relations/Marketing Committee
Description:	Education represents an effective tool to address many lake issues. The PLA has an elaborate communication network, with this management action largely being a documentation of that current effort. The PLA sends out an annual newsletter with reports from each standing committee. The newsletter also hosts advertisements from local businesses. The PLA maintains a website (https://pelicanlakeassociation.org/), consistently updating it and serving as a repository of information. The PLA has made it a priority to build a complete an updated email list, which will allows rapid and cost-effective means of providing information to association members. The association currently employs a Constant Contact email marketing campaign to track email engagement. The PLA is in the process of updating our current directory to foster a sense of community between PLA members that wish to. The PLA hosts a number of community fundraising events, with largest being the annual *Pelican Lake FunRaiser*. In recent years, the PLA has also hosted a Ski Show, Meat Raffle, and a Membership Appreciate Event. The PLA invests in the local community, sponsoring highway cleanup projects and promoting the local Red Cross Blood Drive. The PLA promotes lake steward practices, educational articles, community events and fundraising opportunities via social media platforms and many

	Northwoods free public outlets, such as through local radio stations, newspapers, and television (WJFW-12 and WSAW-7) through both their calendar of events and occasional live reporting opportunities.

Management Action:	Routinely educate and communicate with all lake stakeholders
Timeframe:	In progress
Facilitator:	Board of Directors, pertinent committees
Description:	The PLA will make the education of lake-related issues a priority. One of the first tasks would be to disseminate the information contained within this *Comprehensive Management Plan*, allowing it to be better understood by association members. To accomplish this task, each committee will highlight key topics from the plan that are relevant to their committee, sharing educational materials on the subjects over time. The PLA believes that creating smaller modules of information and spreading out the delivery over time will be an effective educational initiative. As a part of the planning process, the PLA identified key topics which they believe the association members would appreciate additional educational opportunities. These may include educational materials, awareness events, and demonstrations for lake users as well as activities which solicit local and state government support. *Example Educational Topics* • Pelican Lake water levels and WVIC • Aquatic Plant Decomposition/Muck Impacts/Management • Development of a courtesy code for boating safety • Vacation rentals, capacity, and impacts on Pelican Lake • Importance of natural landscapes • Shoreline habitat restoration and protection • Minimize disturbance of nesting loons, eagles, and osprey • General lake ecology • Aquatic invasive species identification • Septic system maintenance • Noise and light pollution • Fishing regulations and overfishing • Minimizing disturbance to spawning fish • Shoreline erosion • Bluegreen algae • Swimmers itch

Management Action:	Conduct Periodic Riparian Stakeholder Surveys
Timeframe:	Every 5-6 years
Facilitator:	Board of Directors
Description:	Formal riparian stakeholder user surveys have been performed by the association in 2012 and 2023. Approximately once every 5-6 years, likely during a management plan update, an updated stakeholder survey would be distributed to the Pelican Lake riparians. 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. All survey results would be fully shared with the membership. The stakeholder survey could partially replicate the design and administration methodology conducted during 2023, 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.

Management Action:	Continue PLA's involvement with other entities that have responsibilities in managing (management units) Pelican Lake
Timeframe:	Continuation of current efforts
Facilitator:	Board of Directors
Description:	The purpose of the PLA is to maintain, protect, and improve the quality of lakes for the landowners and those that use the lake for recreation purposes. 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 other organizations rely on voluntary participation. It is important that the PLA 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 following table:

Partner	Contact Person	Role	Contact Frequency	Contact Basis
Wisconsin Department of Natural Resources	Fisheries Biologist (Nathan Lederman – 715. 525.2898)	Manages the fishery of the system.	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.	Once a year, or more as necessary.	Information on updating a lake management plans, submitting grants r permits, and to seek advice on other lake issues.
	Warden (Curt Butler – 715.416.0068)	Oversees regulations handed down by the state.	As needed.	Suspected violations pertaining to recreational activity, including fishing, boating safety, ordinance violations, etc.
	CLMN Director (Sandra Wickman – 715.365.8951)	Training and assistance on CLMN activities.	Twice a year or more as needed.	Contact to arrange for training as needed, in addition to planning out monitoring and reporting of data.
	AIS Regional Coordinator (Alan Wirt – 715.365.8905)	Oversees AIS monitoring and prevention activities locally.	Twice a year or more as issues arise.	AIS training and ID, AIS monitoring techniques
Mole Lake Sokaogon Chippewa Community	Fish Biologist (Mike Preul– 715.528.4400) Environmental Director (Tina Van Zile – 715.478.7605)	Active in fisheries and habitat management programs.	As needed:	Tribe enacts conservation efforts through research, documentation, education, and outreach.
Oneida County Land & Water Conservation Department	AIS Coordinator (Steph Boismenue – sboismenue@co.oneida.wi.us)	Oversees AIS monitoring and prevention activities locally.	Twice a year or more as issues arise.	Spring: AIS training and ID, AIS monitoring techniques Summer: Report activities to Ms. Boismenue.
	County Conservationist (Michele Sadauskas - msadauskas@co.oneida.wi.us)	Oversees conservation efforts for land and water projects.	Twice a year or more as needed.	Can provide assistance with shoreland restorations and habitat improvements.
Town of Enterprise	Town Clerk (Jonathan Sommer - 715.360.0336)	Local government	As needed:	Building and zoning, municipal sewer, funding opportunities, grant applications, CBCW, I-Lids events, ordinances etc.
Town of Schoepke	Town Clerk (Julie Taylor- (715.487.6155)		As needed:	
Oneida County Lakes & Rivers Association	General email: oclra100@gmail.com	Organization facilitating discussion and education.	Twice a year or as needed. (oclra.org)	Training or education opportunities, partnering in special projects, or networking.
UW-Extension	Program Coordinator (Erin McFarlane – 715.346.4978)	Clean Boats Clean Waters Program	As needed.	May be contacted to set up CBCW training sessions, report data, etc.
Wisconsin Lakes	General staff (800.542.5253)	Facilitates education, networking and assistance on lake issues.	As needed. May check website (wisconsinlakes.org) often for updates.	May attend WL's annual conference to keep up-to-date on lake issues. WL reps can assist on grant issues, training, habitat enhancement techniques, etc.

Partner	Contact Person	Role	Contact Frequency	Contact Basis
Wisconsin Valley Improvement Company	WVIC President: Thomas Kipp WVIC Operations and Safety Exec: Peter Hansen WVIC Strategy & Regulatory Exec: Ben Niffenegger	Within the confines of their FERC license, operates the dam on Pelican Lake.	Once a year, or more as issues arise.	For issues related to lake water levels and dam management practices
Wisconsin Department of Natural Resources	Statewide FERC Coordinator: Cheryl Laatsch	Coordinates state oversight of federally regulated dams	Once a year, or more as issues arise.	For issues related to lake water levels and dam management practices

Management Action:	Participate in annual Wisconsin Lakes and Rivers Convention & other local information sharing opportunities
Timeframe:	Annually
Facilitator:	Board of Directors
Description:	Wisconsin is unique in that there is a long-standing partnership between a governmental body, a citizen-based lake lobbying and protection association, and the state's primary educational outreach program. That unique group is the Wisconsin Lakes Partnership and its three members, the Wisconsin Dept. of Natural Resources, Wisconsin Lakes, and the UW-Extension Lakes Program, facilitate many lake-related events throughout the state. The primary event is the Wisconsin Lakes Partnership Convention held each spring in Stevens Point. This is the largest citizen-based lakes conference in the nation and is specifically suited to the needs of lake associations and associations. It is an exceptional opportunity for lake group members to learn about lake management and monitoring; network with other lake groups, agency staff, and lake management contractors; and learn how to effectively operate a lake association/association. The PLA will continue to sponsor the attendance of 1-3 association members annually at the convention. Following the attendance of the convention, the members will report specifics to the board of directors regarding topics that may be applicable to the management of Pelican Lake and operations of the PLA. The attendees will also create a summary in the form of a newsletter article and if appropriate, update the association membership at the annual meeting. In addition to the state-wide conference, local counties occasionally hold more focused conferences where PLA would attempt to have representation present. The PLA has attended the Northwoods Six-County Lakes Meeting at Nicolet Collect that last two years. The PLA is an active participant in the Oneida County Lakes and Rivers Association (OCLRA), currently with representation on the Board of Directors.

	The PLA regularly attends Oneida County Conservation and UW Education Committee meetings of possible impacts or feedback, and well as attends the Oneida County Planning and Development Meetings when shoreline ordinance modifications are on the agenda. The PLA has been involved with the current conservation policy changes that are occurring as part of the rewrite/update to the Oneida County Comprehensive Plan.

Management Action:	Engage with other lake organizations about swimmer's itch issues
Timeframe:	Annually
Facilitator:	Water Quality Committee
Description:	53% of stakeholder survey respondents indicated that someone from their household has experienced swimmer's itch as a result of participating in water activities in Pelican Lake. As discussed in Section 3.6, swimmers itch can greatly impact the enjoyment of time on the water. While there is no standardly accepted method for managing swimmer's itch in a lake, some lake groups are considering more aggressive strategies. The PLA intends to reach out to these lake groups, such as the North & South Twin Lake Protection & Rehabilitation District in Vilas County, to pool knowledge and experience in dealing with swimmer's itch. If deemed appropriate by the PLA board, act on addressing swimmers itch in Pelican Lake.

Management Goal 3: Maintain or Enhance Water Quality Conditions

Management Action:	Monitor water quality through WDNR Citizens Lake Monitoring Network
Timeframe:	Continuation of current effort.
Facilitator:	Water Quality Committee
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. Water quality data is collected by the Wisconsin Valley Improvement Corporation (WVIC) for a 3-year period, once every 10 years. The next sampling period will be conducted in 2030-2033. Pelican Lake is also part of the WDNR Long-term Trends sampling program, with the WDNR annually collecting a suite of water quality data.

	Volunteer water quality monitoring should be completed annually by Pelican Lake 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. In addition to Secchi disk water transparency data, the PLA is enrolled in the advanced CLMN program where water chemistry samples are also collected (chlorophyll-*a*, and total phosphorus). Samples are collected three times during the summer and once during the spring. As a part of the program, these data collected are automatically added to the WDNR database and available through their Surface Water Integrated Monitoring System (SWIMS) by the volunteer. CLMN volunteer and/or PLA Board would facilitate new volunteer(s) as needed to ensure consistency of data collection over time. As a part of this management planning process, the data suggest that internal nutrient loading is likely occurring, with the severity of impacts possibly being tied to the interval of destratification events. The PLA is encouraged to conduct temperature and dissolved oxygen profiles as often as possible (weekly would be best), but especially in conjunction with the CLMN monitoring schedule. It is recommended that the PLA purchase a probe to make available for this sampling. The WDNR recommends: YSI ProSolo ODO – Optical Dissolved Oxygen Meter. WDNR grant opportunities are available for this type of sampling equipment purchase. It also must be noted that the CLMN program may be changing in the near future, as enrollment in the program is currently capped. If there is not an ability for the PLA to participate in the advanced CLMN program, they are open to considering self-funding the analysis of these samples on an annual or semi-annual basis.

Management Action:	Educational initiative aimed at raising awareness of blue-green algae blooms on Pelican Lake
Timeframe:	Continuation of current effort.
Facilitator:	Water Quality Committee
Description:	Determining the causes of algal blooms are difficult and at times impossible. Nutrient levels and sunlight availability, while important in all cases, are not the only factors controlling the growth rates of algae. Temperature, inter-species competition, iron availability, lake stratification, and many other factors can cumulate to produce conditions allowing one or more algae types to proliferate and create a bloom. In general, reducing nutrient inputs to the lake from the watershed can reduce the frequency and severity of algal blooms, including blue-green algal blooms. Like 'true' algae, cyanobacteria or blue-green algae are able to convert sunlight into energy through the process of photosynthesis. Many species of blue-green algae can naturally be found in Wisconsin waters, some of which can produce toxins potentially dangerous to people and animals. Exposure to these toxins

	occurs from ingestion of water, skin contact, and by inhaling aerosolized water droplets. The largest risk of exposure consists of swallowing water containing the toxins, usually during water-sporting activities. Symptoms include nausea, vomiting, diarrhea, and in severe cases, liver failure or paralysis. Skin contact with algae can produced blistering of the exposed skin. Allergy-like symptoms including coughing, watery eyes, and nose/throat irritation are most commonly associated when wind and motor boat activity cause the toxins to become aerosolized. Because dogs and other domestic animals actively drink water from lakes, these symptoms can be much more developed and can lead to death in some instances. If you suspect an illness, either from a human or an animal, the case should be reported to the Wisconsin Department of Health Services (www.dhs.wisconsin.gov/water/bg-algae/index.htm). Please note that this resource solely collects information for tracking blue-green algae outbreaks within the state. Individuals or animals experiencing severe symptoms should consult the appropriate medical attention immediately. The PLA will include educational information about blue-green algae and the potential risks related to their toxins within materials distributed to association members. If blue-green algae blooms are observed on Pelican Lake in the future, the PLA will attempt to have samples collected and immediately tested. Blue-green algae samples can be shipped to the Wisconsin State Laboratory of Hygiene for toxin analysis. The cost of the analysis is approximately $400 for each sample. Other testing options also exist if a larger sampling need arises, including microcystin dipsticks and BloomOptix specialized microscopes. Even if toxic blue-green algae are confirmed, there are no control measures that can be taken to remove the algae. Simply limiting exposure during an algae bloom and waiting for the bloom to dissipate is all that can be done. In this instance, the PLA would distribute information to association members informing them to limit their use of the lake during the bloom. Additional information relating to blue-green algae can be found on the WDNR's website: *https://dnr.wisconsin.gov/topic/lakes/bluegreenalgae*

Management Action:	Initiate stream monitoring of Pelican Lake inlets
Timeframe:	Ambition to start in 2025
Facilitator:	Water Quality Committee
Description:	Pelican Lake has a number of inlets, with 3 primary inlet creeks being considered as navigable waters by the WDNR. The PLA would like to better understand the relative concentrations of nutrients coming into Pelican from

	these two sources. The Water Action Volunteers (WAV) volunteer stream monitoring program is partially sponsored by the WDNR and has the purpose of gaining high-quality stream data to aid in natural resource management decisions. More information can be found here: *https://wateractionvolunteers.org* The PLA would solicit volunteers to learn about this program and start data collection. These data will help the PLA learn about these aspects of their overall ecosystem, and if future management actions are needed based upon the data collected.

Management Action:	Monitor chloride concentrations in Pelican Lake
Timeframe:	Spring 2025
Facilitator:	Water Quality Committee
Description:	In 2023, the HWY 45/47 corridor through Pelican Lake was rebuilt. There is a main culvert that drains water from the road into the lake shore and eventually into the lake. The PLA lobbied unsuccessfully to the WI Department of Transportation (DOT) for the runoff to be diverted to the east into existing wetlands. The DOT agreed to a shortened culvert that discharges into a rip-rap area to potentially filter contaminants and road salt before entering the lake (Photograph 5.0-1).  **Photograph 5.0-1. Runoff culvert from County Highway 45 to Pelican Lake.** Photo credit: PLA. Chloride levels in Pelican Lake have been monitored at the deep hole location in the early 1970s, during the 1990s, and during 2023. Chloride concentrations

	in Pelican Lake in the 1970s were near-normal but showed a moderate increase during the 1990s. In 2023, the values were slightly higher than in the 1990s, but well below levels that would cause lake-wide ecological impacts. Pelican Lake association members have expressed concerns over possible increases in chloride runoff into Pelican Lake from the adjacent and recently reconstructed HWY 45/47. The PLA would solicit a volunteer to collect samples in close proximity to the highway and at various times of the year, especially in late-winter/spring, to see if the levels are higher than being collected at the center of the lake location and may be of cause for concern. Chloride samples can be shipped to the Wisconsin State Laboratory of Hygiene for analysis. Discussion with the regional WDNR lake biologist on sampling locations and collection procedures is advised.

<table>
<tr><th><u>Management Action:</u></th><th>Facilitate connecting PLA members with Healthy Lakes & River Grants</th></tr>
<tr><td>Timeframe:</td><td>Ongoing</td></tr>
<tr><td>Facilitator:</td><td>Land Use Committee</td></tr>
<tr><td>Description:</td><td>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 5.0-1).

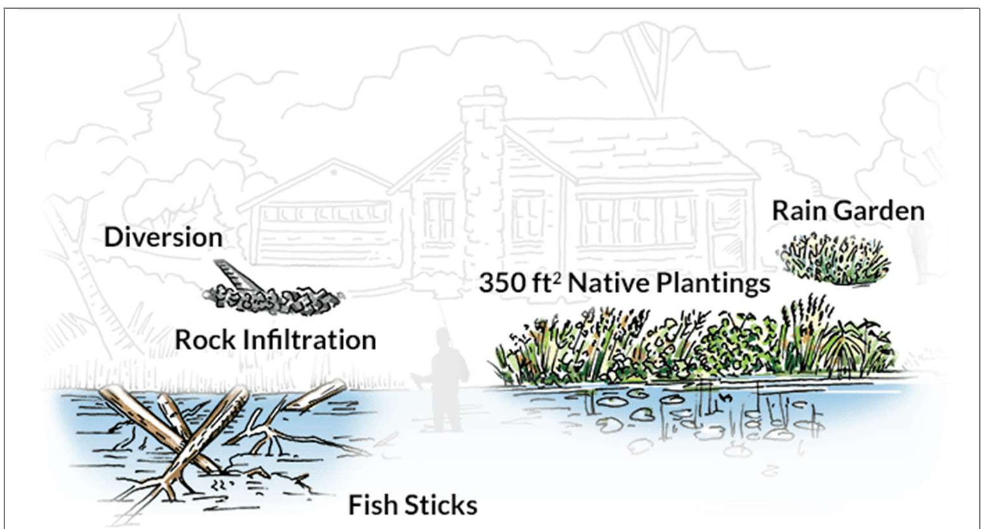


Figure 5.0-1. Healthy Lakes & Rivers 5 Best Practices. Illustration by Karen Engelbretson, extracted from healthylakeswi.com.</td></tr>
</table>

The Healthy Lakes & Rivers Grant program provides cost share for implementing the following best practices:

- Rain Garden
- Rock Infiltration
- Diversion
- Native Plantings (35 ft by 10 ft)
- Fish Sticks

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.

The above Healthy Lakes practices are important and applicable to all riparian properties except the addition of fish sticks. Fish stick projects must receive prior approval from the local WDNR fisheries biologist (Nathan Lederman) to ensure that the activity will be beneficial for the intended fish species. Once approved the fish stick project must be implemented in accordance with WDNR requirements and must comply with local shoreland zoning ordinances.

In June 2023, Michele Sadauskas from Oneida County Land & Water Conservation Department gave a presentation to the PLA membership and reviewed serval properties with guidance on what practices could be adopted to improve shoreline health. The PLA intends to continue to provide education to its membership on this topic with the goal of enlisting PLA members in this grant program. The PLA will gladly facilitate the grant program on behalf of interested landowners.

The PLA maintains a Shoreland Restoration Garden demonstration site at the Town of Schoepke Town Hall. Each year, native plants are added, and non-

	native plants are removed. The PLA intends to have informational brochures available at the demonstration site.

Management Action:	Work with applicable agencies and entities to adjust the procedures for managing the water level of Pelican Lake
Timeframe:	Ongoing
Facilitator:	Water Quality Committee
Description:	Pelican Lake is one of the natural lake reservoirs in the Wisconsin Valley Improvement Company (WVIC) system. Set by the Federal Energy Regulatory Commission (FERC), Pelican Lake has an operational range of 6 inches during the summer months and can be brought down two feet from full pool in the winter. Operationally, the dam is required to be open 1 inch at all times to maintain flow in the downstream system. The PLA has expressed concern in the “extreme and concerningly low” water levels in recent years that may be impacting water quality parameters, reducing availability of fish spawning habitat, exacerbating nuisance aquatic plant growth, and impacting the safety of watercraft and snowmobile use. The PLA organized an informational session in 2023 for riparian owners who have been concerned about low water levels and how the dam on Pelican influences those levels. There were at least 35 PLA members and nonmembers who listened and questioned Ben Niffenegger and Peter Hansen from WVIC. As a part of the 2026 FERC license review, the PLA would like to work with WVIC, WDNR, US Fish & Wildlife Service, and the towns of Schoepke and Enterprise in 1) adjusting the procedures of managing the water levels and 2) revalidate and adjust seasonal maximum/minimum water levels. The PLA has also requested an out-of-cycle review, but it is unclear if that will be granted since the re-registration is only in two years.

Management Goal 4: Enhance the Pelican Lake Fishery

Management Action:	Continue to work with WDNR fisheries managers to enhance the fishery of Pelican Lake
Timeframe:	Ongoing
Facilitator:	Fish and Wildlife Committee
Description:	Pelican Lake is a popular fishing destination for many anglers. The PLA has been proactive in the management of the fish population of Pelican Lake. The PLA has worked closely with the Mole Lake Sokaogon Chippewa Community (Mole Lake Tribe), Walleyes for Tomorrow, and WDNR in recent years on the following topics:

	• The PLA Fish & Wildlife Committee has proposed two new fishing regulations that were presented to the Conservation Congress Warm Water Fisheries Committee and were passed in 2023. • The PLA has completed their Fish Crib Habitat Reef Project, installing 41 wooden fish cribs in strategic locations in 12-15 feet of water on Pelican Lake. • In partnership with the WDNR and the Pelican Lake Muskie League, the PLA initiated a muskie tag reader program to help monitor the muskellunge population on the lake. • Approximately every-other-year, the PLA tours Mole Lake Tribe fish hatchery, spreading information and education to members about tribal spearing, population estimates, and rearing capacity especially relating to Pelican Lake. In 2023, approximately 12-15 participated in this event. • Current walleye population surveys are conducted by the WDNR approximately every 10 years. As discussed in Section 3.5, these population estimates ultimately determine spear harvest quotas. The PLA is encouraged by the potential of Mole Lake Tribe and the Great Lakes Indian Fish & Wildlife Commission (GLIFWC) to work with the PLA in collecting these data potentially on a 3-year cycle in the future. • The PLA has been in conversation with the Mole Lake Tribe Economic Development Team about scope development of a Fish & Aquatic Plant Research Facility on Pelican Lake. The PLA is investigating the feasibility of establishing a PLA data collection and research station in collaboration with the Mole Lake Tribe, Universities, and the WDNR to gather data and test theories to address issues impacting Wisconsin lakes. This issues may include but are not limited to; blue-green algae, water quality, swimmers itch, fish habitats, spawning ground research, impacts of water levels, muck/sediment, impacts on the lake heath and mitigation options (dredging/bio-dredging), and wild rice. • The PLA asks its members to monitor for spring fish kills, likely caused by columnaris disease. The PLA will continue to implement projects like those outlined above.

Management Goal 5: Monitor Aquatic Vegetation on Pelican Lake

Management Action:	Periodically monitor the Eurasian watermilfoil population
Timeframe:	Periodic: annually; Timing: during latter part of growing season
Facilitator:	Water Quality Committee
Description:	As the name implies, the Late-Season EWM Mapping Survey is a professionally contracted survey 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 the Pelican Lake, this survey would likely take

	place in late-August to the end of September, dependent on the growing conditions and management activities of the particular year. This survey would include a complete or focused meander survey of the system's littoral zone by professional ecologists and mapping using GPS technology (sub-meter accuracy is preferred). Late Season EWM Mapping Surveys have been conducted almost every year since EWM was first detected in 2011. These surveys have been focused on areas of the system known to contain aquatic plants. These data allow lake stakeholders to understand annual EWM populations in response to natural variation and directed management activities. The PLA plans to continue these surveys annually, but may vary the level of focus depending on the management activities that are taking place.

Management Action:	Coordinate periodic point-intercept aquatic plant surveys
Timeframe:	Periodic: at least once every 5 years, Timing: during July-August
Facilitator:	Water Quality Committee
Description:	The point-intercept aquatic plant monitoring methodology as described Wisconsin Department of Natural Resources Bureau of Science Services, PUB-SS-1068 2010 (Hauxwell et al. 2010) has been used on the Pelican Lake System during 2011 and 2023. This survey provides quantitative population estimates for all aquatic plant species within the lake and is designed to allow comparisons with past surveys in Pelican Lake as well as to other waterbodies throughout the state. 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. The PLA will ensure the point-intercept surveys is conducted at least once every five years. If the PLA is considering large-scale aquatic plant management such as significant herbicide treatments towards EWM, point-intercept surveys would occur surrounding that manipulation.

Management Action:	Consider periodic community mapping (floating-leaf and emergent) surveys
Timeframe:	Periodic: every 10 years or when prompted
Facilitator:	Water Quality Committee
Description:	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. Two community mapping surveys have been completed in 2011 and 2023 The lake currently contains a healthy population of floating-leaf and emergent plant communities as well, with bulrush expansion. Replicating this survey will help understand how these important plant communities are changing over time. The survey would also investigate for non-native shoreland emergent plants, such as purple loosestrife, narrow-leaved cattail, and phragmites grass.

Management Goal 6: Prevent Establishment of New Aquatic Invasive Species

Management Action:	Monitor Pelican Lake entry points for aquatic invasive species
Timeframe:	Ongoing
Facilitator:	Clean Boats Clean Water Coordinator
Description:	The intent of this program is not only to prevent additional invasive species from entering Pelican Lake, but also to prevent the infestation of other waterways with invasive species that originated in Pelican Lake. The PLA utilizes WDNR grant funding to sponsor watercraft inspections through the WDNR's Clean Boats Clean Waters (CBCW) program at its three public access points. While CBCW watercraft monitoring has been at all of the landings on Pelican Lake, the PLA has prioritized the State Landing near County HWY G as high priority for their coverage, with Keelers Landing as a secondary. The PLA recruits paid boat inspectors, sets up schedules, handles all payroll, and reports all the interns' hours to the WDNR"s online database (SWIMS). The PLA will continue to seek cost share assistance through the WDNR's streamline Clean Boats Clean Waters (CBCW) program, as well as welcome continued financial assistance from the Mole Lake Tribe: The PLA's Clean Boats Clean Waters program has been well organized, with over 2,500 boaters being contacted in 2023.

Management Action:	Continue to support supplemental aquatic invasive species prevention and containment methods
Timeframe:	Ongoing
Facilitator:	Water Quality Committee

Description:	Pelican Lake is an extremely popular regional destination, especially from anglers, making the lake vulnerable to new infestations of exotic species. In addition to its watercraft inspection program, the PLA has initiated supplemental prevention steps to protect Pelican Lake from new aquatic invasive species. As of 2023, the PLA has installed remote video surveillance at the State Landing (HWY G) and the Town Landing near the Musky Mart (HWY 45/47). The Internet Landing Installed Device Sensor (I-LIDS) play an audio message reminding boaters to remove vegetation from boats and trailers and drain live-wells. Their remote cameras record video that is later reviewed for potential violations of plant material. Suspect violations are referred to the PLA. If the PLA confirms a violation, they refer the instance to the County Sherrif for follow-up contact. In 2023, one citation was issued. The PLA intends to continue to partner with the Town of Schoepke to support the operation of these I-LIDS moving forward. Keelers Landing in the Town of Enterprise is the only landing without an I-LIDS. The PLA intends to continue discussions with the Town of Enterprise regarding the placement of an I-LIDS at that landing location.

Management Goal 7: Manage aquatic plants, including EWM, below levels that negatively impact recreation and navigation

This management goal outlines three management actions that when paired with the two previous management goals, for the PLA's Integrated Pest Management strategy on Pelican Lake. Integrated Pest Management (IPM) is an approach to manage an issue that utilizes a combination of methods that are more effective when applied collectively as part of defined strategy than when conducted separately. This long-term vision considers all available control practices such as it relates to Eurasian watermilfoil management:

Management Action:	Maintain recreational use in established and high/dense EWM population areas through mechanical harvesting
Timeframe:	Ongoing
Facilitator:	Water Quality Committee
Description:	Aquatic plants, especially increases in the EWM population in recent years, have negatively impacted navigation and recreational use in areas of Pelican Lake. At this time, Musky Bay and Outlet Bay have navigation impairment caused by a combination of EWM and native plants such as common waterweed and coontail. Building off of lessons learned in 2023, a more robust DASH and mechanical harvesting program will occur in 2024 and will implement up to $40,000. $28,500 will be used on DASH removal of plants in Treacherous, Mud, and Guths Bay (Map16) and $12,500 will be used for mechanical harvesting (cutting) in Lower Musky and Outlet Bay (Map 15). The PLA will use adaptive management principles, updating and tweaking the program in response to what is working, and discontinuing those actions not meeting riparian needs.

	Mechanical harvesting operations would have the following WDNR-imposed guidelines: • Harvesting locations are limited to areas on the permit map. A revised permit map may be produced annually. • The harvester would not be permitted in waters less than 3-feet to minimize sediment disturbance. • No harvesting shall occur before June 15 to avoid impacting valuable fish spawning habitat. • Harvesting operations shall not disturb spawning or nesting fish. Harvesting shall be done in a manner to minimize accidental capture of fish. An attempt would be made to return all gamefish, panfish, amphibians, and turtles to the water immediately. • Submerged plants, specifically EWM, are the target for this permit. Removal of emergent (e.g. bulrushes) and floating-leaf (e.g. water lilies) species needs to be avoided because of their ecological value and niche occupation. • Cut aquatic plants must be removed from the water. • Reports summarizing harvesting activities shall be given to the WDNR by November 30, each harvesting season. The report shall include a map showing the areas harvested, the total amount of plant material removed from each site, and amount of effort (time) spent at each site. The report shall also include a summary of the composition and quantity of plants removed by species (rough percent of each species from each operation).

Management Action:	Manage EWM populations that are in the process of establishing with manual removal methods
Timeframe:	Ongoing
Facilitator:	Water Quality Committee
Description:	The PLA intends to continue strategically targeting small and isolated populations with Diver Assisted Suction Harvest (DASH) technology, a form of manual-removal which involves divers removing EWM by hand and feeding the removed material into a suctioned hose for delivery to the deck of the harvesting vessel. The objective is to slow the establishment of EWM in these areas. As areas become too large and dense, they become no longer scale-appropriate or cost-effective for this technique. The 2024 strategy is shown on Map 16. Contracted hand-harvesting operations with DASH would adhere to the following bullet points in addition to WDNR permit conditions: • If a Diver Assisted Suction Harvest (DASH) component is utilized, the PLA and contracted firm would be responsible for the WDNR permit procedures. The contracted firm would be guided with GPS data from the

	consultant and would track their efforts (when, where, time spent, quantity removed) for post assessments. • The manual removal effort would occur from approximately mid-June to mid-September, but could be slightly extended earlier or later if climactic conditions allow in a given year. Generally conducting hand-harvesting earlier or later in the year can reduce the effectiveness of the strategy, as plants are more brittle and extraction of the roots more difficult. • As they occur, Late-Summer EWM Mapping Survey would be incorporated into success measurements, with the goal of at least maintaining current EWM populations from year to year where manual removal methods take place.

Management Action:	Potentially incorporate herbicide treatments toward EWM
Timeframe:	If prompted
Facilitator:	Water Quality Committee
Description:	As a part of this management planning process, the PLA Planning Committee spent many hours investigating the risks and benefits of using aquatic herbicides to manage EWM in Pelican Lake. This committee was most concerned with the unknown impacts of using herbicides on their lake. There was also concern about the potential impact to the fishery, either directly causing mortality to larval fish or indirectly from the reduction of plant habitat caused from the treatment. The committee also was underwhelmed by the length of EWM reductions gained from herbicide treatment, with anticipated rebound to pretreatment levels by 4-5 years after treatment. Based upon the riparian stakeholder survey, approximately 48% of respondents were supportive of conducting an herbicide treatment to manage EWM (pooled *moderately supportive* and *highly supportive*). The PLA Planning Committee agreed to develop an herbicide management action plan that may be implemented if other actions above do not reach management expectations of lake riparians. While some herbicide spot treatments have provided successful results, the unpredictability of spot treatments state-wide has resulted in less favorability of this strategy with WDNR regulators and lake managers. This is particularly true in areas of increased water exchange via flow, exposed and offshore EWM colonies, or small and isolated EWM populations. Due to the scale of the EWM populations in Musky Bay and Outlet Bay, whole-basin treatment strategies are the most likely to produce multi-year EWM control. In this scenario, herbicide would be applied directly over the dense EWM population. Studies have shown that the herbicide dissipates out from the application areas and becomes a uniform concentration with bays in 6-12 hours after treatment. Therefore, calculations would take place to understand the basin-

wide concentrations in the context of successful control throughout. An exploratory treatment scenario conducted as part of this project yielded targeting approximately 75 acres in Outlet Bay and 175 acres in Lower Musky Bay with ProcellaCOR™ EC at an application cost of $450,000 in addition to the associated monitoring costs.

EWM colonies that are *dominant, highly dominant*, or *surface matting* are those most likely impacting navigation and recreation in the lake. If the PLA considers implementing an herbicide treatment, they would target EWM colonies that meet these density triggers.

The PLA understands that herbicide treatments have financial costs and associated non-target environmental impacts. Therefore, they would only consider treatments that have a high likelihood of success. Emerging research shows that small spot treatments, especially those under 10 acres, are difficult to hold herbicide concentrations and exposure times (CETs) for effective EWM control. This research also confirms that intentionally designed basin-wide treatments have greater longevity of EWM reductions.

If the PLA decides to pursue future herbicide management of EWM, the following would occur:

- Early consultation with WDNR would occur. The PLA strives to work with the WDNR early in their planning stages to be alerted of any concerns that may be resolved or mitigated.
- The preceding annual *EWM Control & Monitoring Report*, produced in Jan-March would outline the precise control and monitoring strategy for regulators to review during the permit process.
- EWM efficacy would occur by comparing annual late-summer EWM mapping surveys. Specifically, these would be conducted during the *year prior to treatment*, *year of treatment*, and *year after treatment*.
- If grant funds are being used, large areas are being targeted, and/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://apps.dnr.wi.gov/swims/Documents/DownloadDocument?id=158140137

  This generally consists of collecting quantitative point-intercept data the *late-summer prior to treatment* (pre) and the summers following the treatment (*year of treatment and year after treatment*) within the application area. Basin-wide treatments would likely be monitored by using a sub-set of the whole-lake point-intercept data.
- Herbicide concentration monitoring may also occur surrounding the treatment if grant funds are being used or the PLA believes important information would be gained from the effort.
- An herbicide applicator firm would be selected in late-winter and a permit application would be applied to the WDNR as early in the

	calendar year as possible, allowing interested parties sufficient time to review the control plan outlined within the annual report as well as review the permit application. • Unless specified otherwise by the manufacturer of the herbicide, an early-season use-pattern would likely occur. This would consist of the herbicide treatment occurring towards the beginning of the growing season (typically in early- to mid-June), active growth tissue is confirmed on the target plants, and is after sensitive fish species of concern, like walleye, have outgrown their most-sensitive life stage to herbicide exposure (first 14 days after hatching). A focused pretreatment survey would take place approximately a week or so prior to treatment. 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. Additional aspects of the treatment may also be investigated, depending on the use pattern being considered, such as the role of stratification.

Management Goal 8: Understand and possibly remedy sedimentation issues in Bays of Pelican Lake

Management Action:	Conduct study to understand sediment characteristics in Bays of Pelican Lake
Timeframe:	Ongoing
Facilitator:	Water Quality Committee – likely initiate a study committee
Description:	During the 2023-2024 management planning project, concerns over increased and/or unnatural sedimentation in Musky Bay were raised. Thirty-nine percent (39%) of stakeholder respondents indicated that sedimentation is an issue in Musky Bay, with 53% being unsure if it is an issue (Figure 5.0-2). Most respondents linked the increase of mucky sediments to decay of vegetation, while some also mention that past logging efforts placed large amounts of sawdust in this part of the lake. Challenges with low water levels in recent years are thought to have exacerbated concerns in this part of the lake.

Question 27: Do you believe sedimentation is an issue in Musky Bay on Pelican Lake?

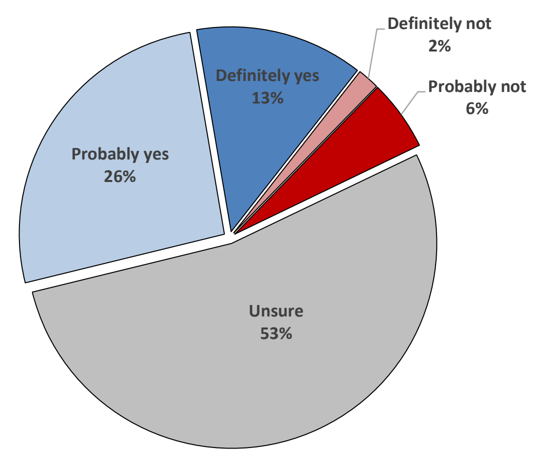


Figure 5.0-2. Select survey responses from the PLA stakeholder survey.

	Prior to initiating remediation techniques, a solid understanding of the sediment composition within Musky Bay would take place. The best way to understand sediment composition and sedimentation rates is conducting a *full sediment core* analysis. A full-core analysis refers to an approximate 5-foot deep sediment core that is divided into 1-2 cm sections for geochemical analysis, carbon dating, and paleoecological analysis. Nutrient concentrations, sedimentation rates, and inferred aquatic plant abundance, could be explored on roughly a decade-by-decade scale from the core. This would help quantify the amount of sediment that was deposited over a period of time, supporting or refuting claims regarding the magnitude of sedimentation. The collection, sectioning, and analysis of a full core may cost $15,000, so exploratory actions may be justified to help determine if a full-core analysis is warranted. Members of the PLA are currently conducting an exploratory approach in Lower Musky Bay to determine sediment characteristics. Specifically, they are looking at cross-sections of sediment samples and visually inspecting them to determine if a substantial band of woody material/sawdust can be located. This exploratory method alone may provide sufficient proof to the WDNR and other entities that the sediments have been unnaturally deposited and justify remediation. The PLA will continue to support these exploratory investigations.

Management Action:	Investigate and study alternative sediment management techniques
Timeframe:	If prompted by previous management action
Facilitator:	Water Quality Committee – likely initiate a study committee
Description:	If the investigations conducted as part of the previous management action confirm unnatural amounts of sediment and other materials (i.e. sawdust) exist in Musky Bay and/or other bays, the PLA will conduct a feasibility study to determine if remediation options are possible and/or beneficial for Pelican Lake. The PLA has already conducted some cursory investigations into hydraulic dredging, finding the cost of implementation to be outside of their capacity. One example prepared by Onterra during this planning project that would yield an increase of 2-feet over 50 acres would costs $3.8 to $4.6 million dollars, depending on the fate of the removed material (geotubes or sediment basin) The PLA will continue to investigate and study alternative sediment management techniques. Algae management, sedimentation management using aeration and/or additives, and emerging technologies are currently considered ineligible costs within the WDNR's Surface Water Grant program. This is a high cost investment without WDNR funding assistance that would

	only be made by the PLA if there is sound research into the procedure from unbiased sources. If the PLA believes there is a likelihood one of these novel approaches would meet their sediment management goals, they would enter into an official feasibility study for select bays of Pelican Lake. The PLA and chosen contractor would also need to work with the WDNR to determine the permitting process for implementing the sediment management technique, as this aspect is highly variable based upon the technology chosen.

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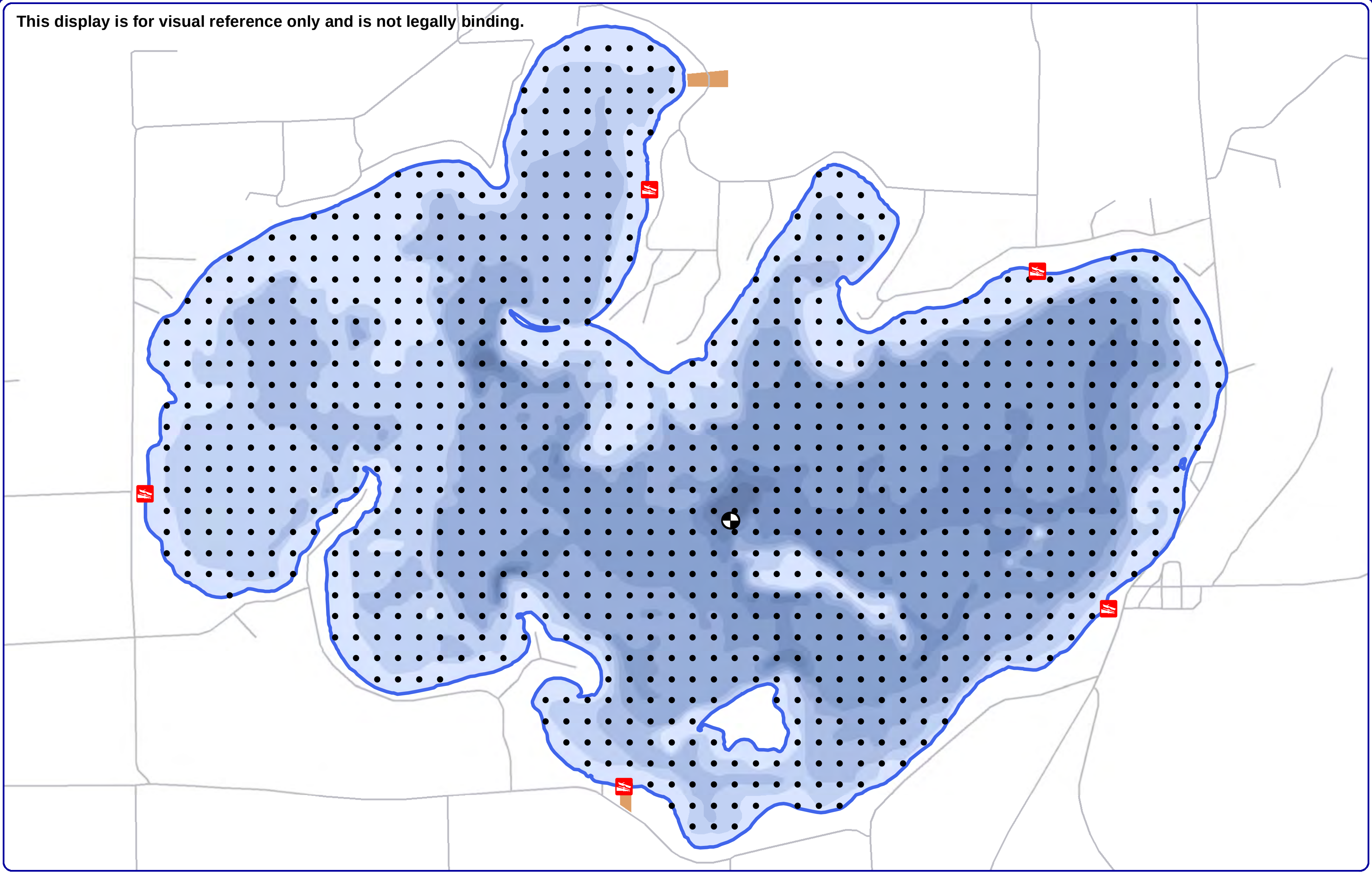

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Feet

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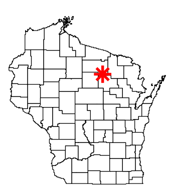
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: SOURCE
Public Lands: WDNR
Map Date: February 27, 2024 JMB
Filename: Map1_Pelican_Location.mxd



Project Location in Wisconsin

Legend

Pelican Lake ~ 3,551 acres
Onterra Definition

WDNR Managed Lands

Point-intercept Sample Location
115-meter spacing, 1,078 meter points

Public Access

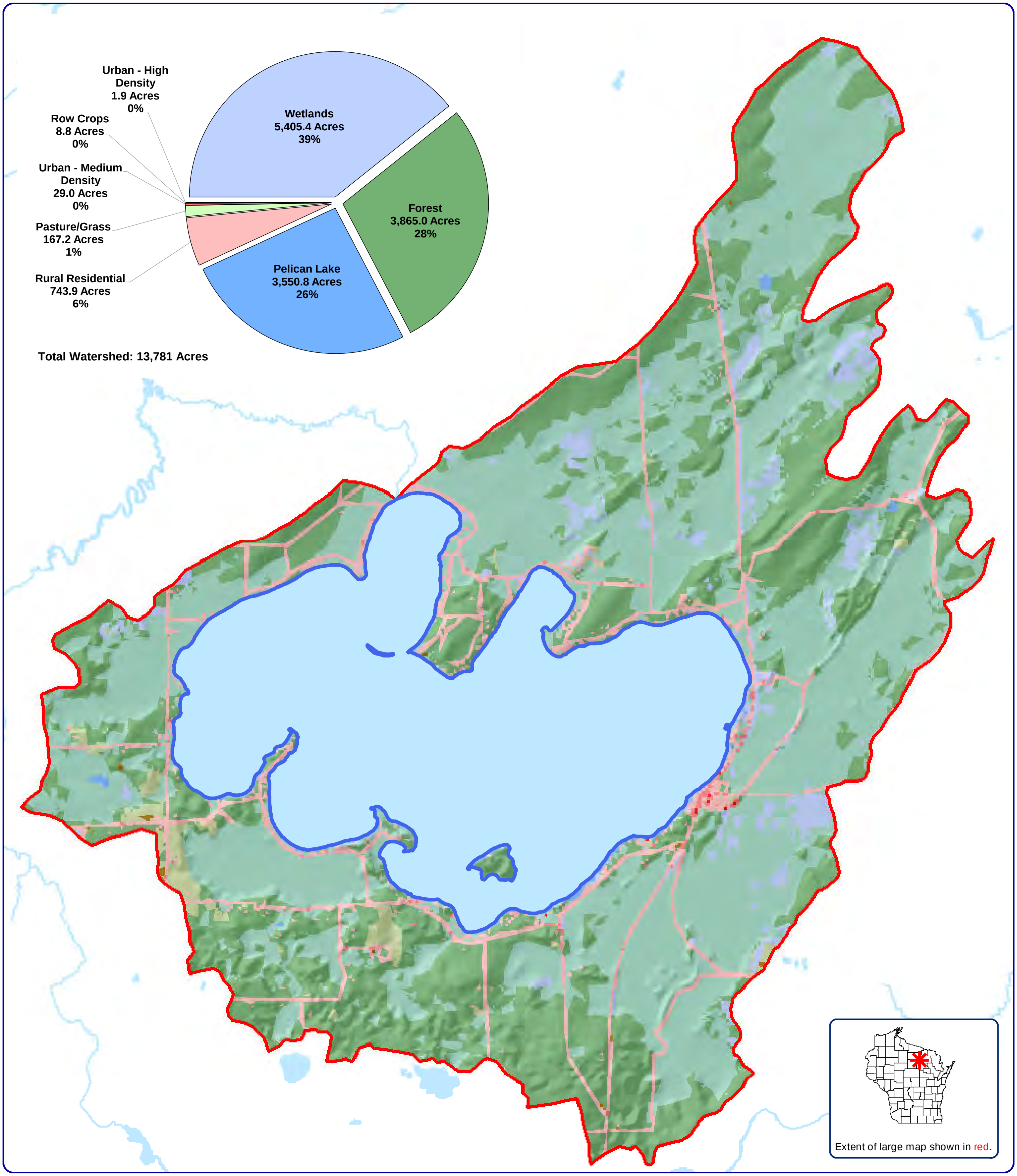
Water Quality
Sampling Location

Map 1

Pelican Lake

Oneida County, Wisconsin

Project Location & Lake Boundaries



4,250
Feet

Legend

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

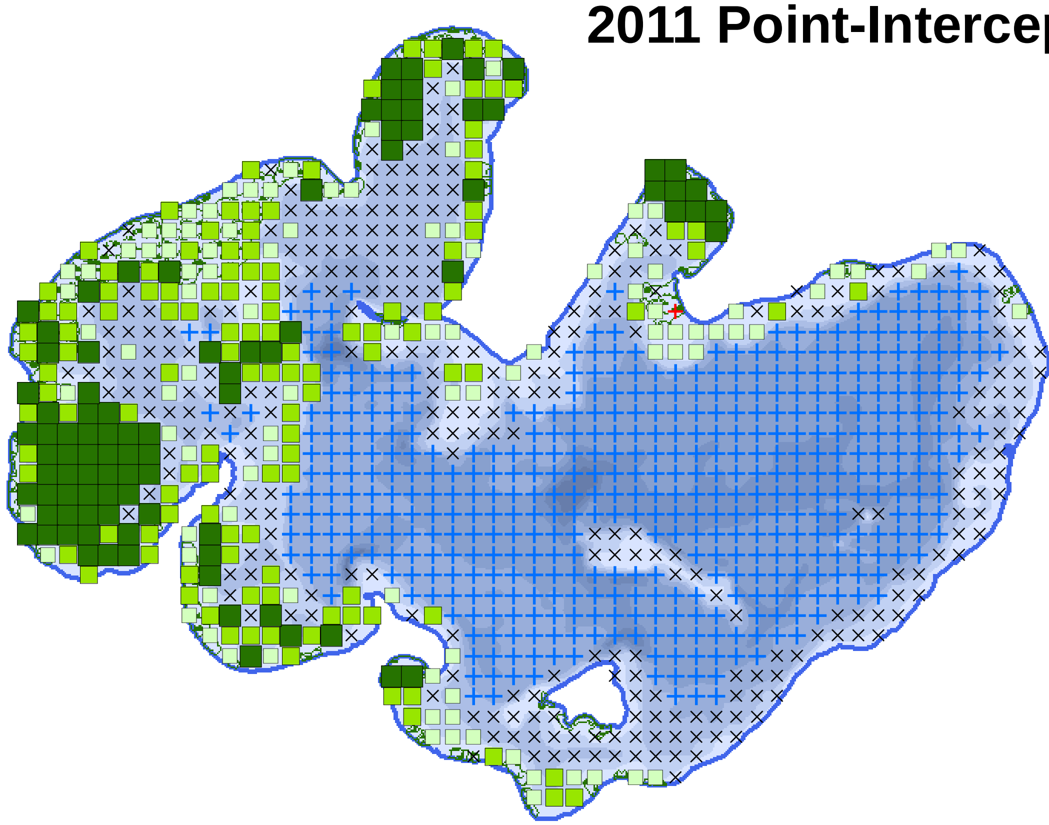
Map 2
Pelican Lake
Onieda County, Wisconsin
Watershed Boundaries & Land Cover Types

Onterra LLC
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

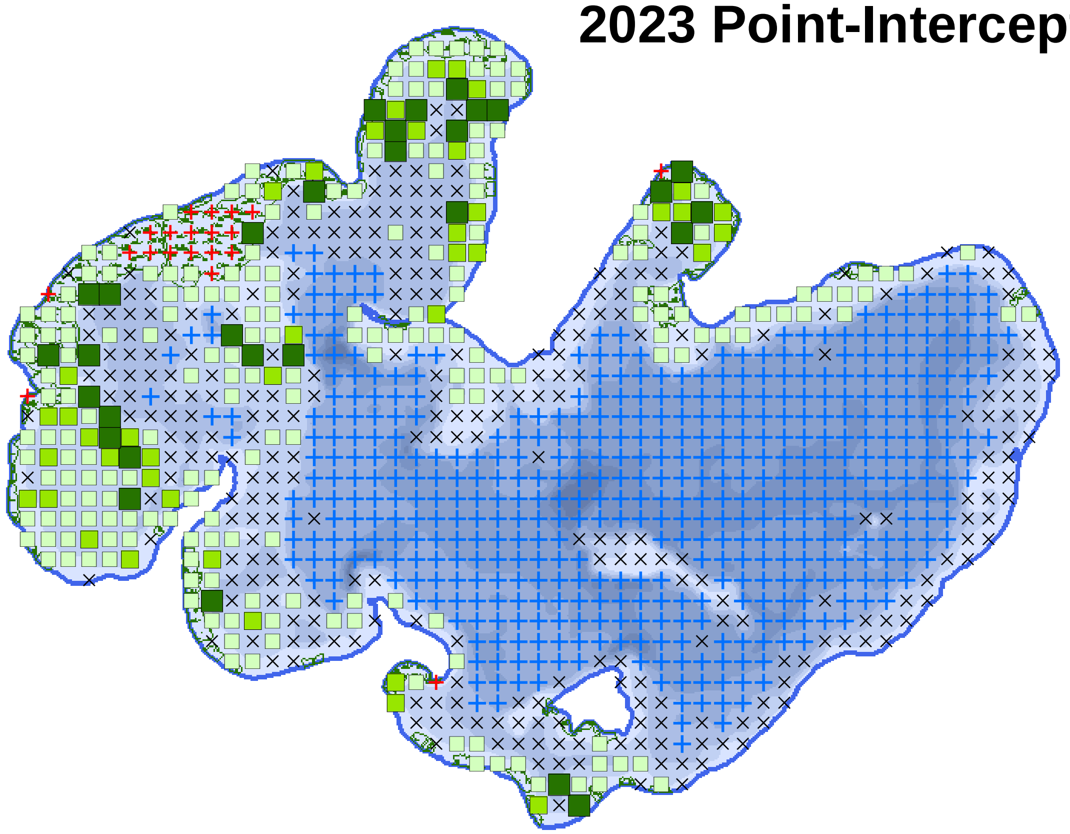
Sources:
Hydro: WDNR
Orthophotography: NAIP 2022
Land Cover: NLCD, 2021
Watershed Boundaries: Onterra, 2015

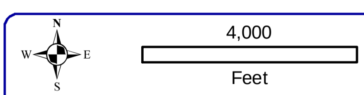
Map Date: April 9th, 2024 KLW
File Name: MapX_Pelican_WS_2023.mxd

2011 Point-Intercept Survey



2023 Point-Intercept Survey

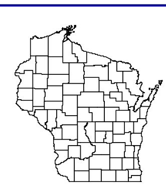




Onterra LLC
Lake Management Planning
815 Prosper Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources
Roads and Hydro: WDNR
Bathymetry: Digitized by Onterra
Aquatic Plants: Onterra, 2023

Map Date: March 11th, 2024 KLW
Filename: *Map4_Shawano_2023_EWM.mxd*



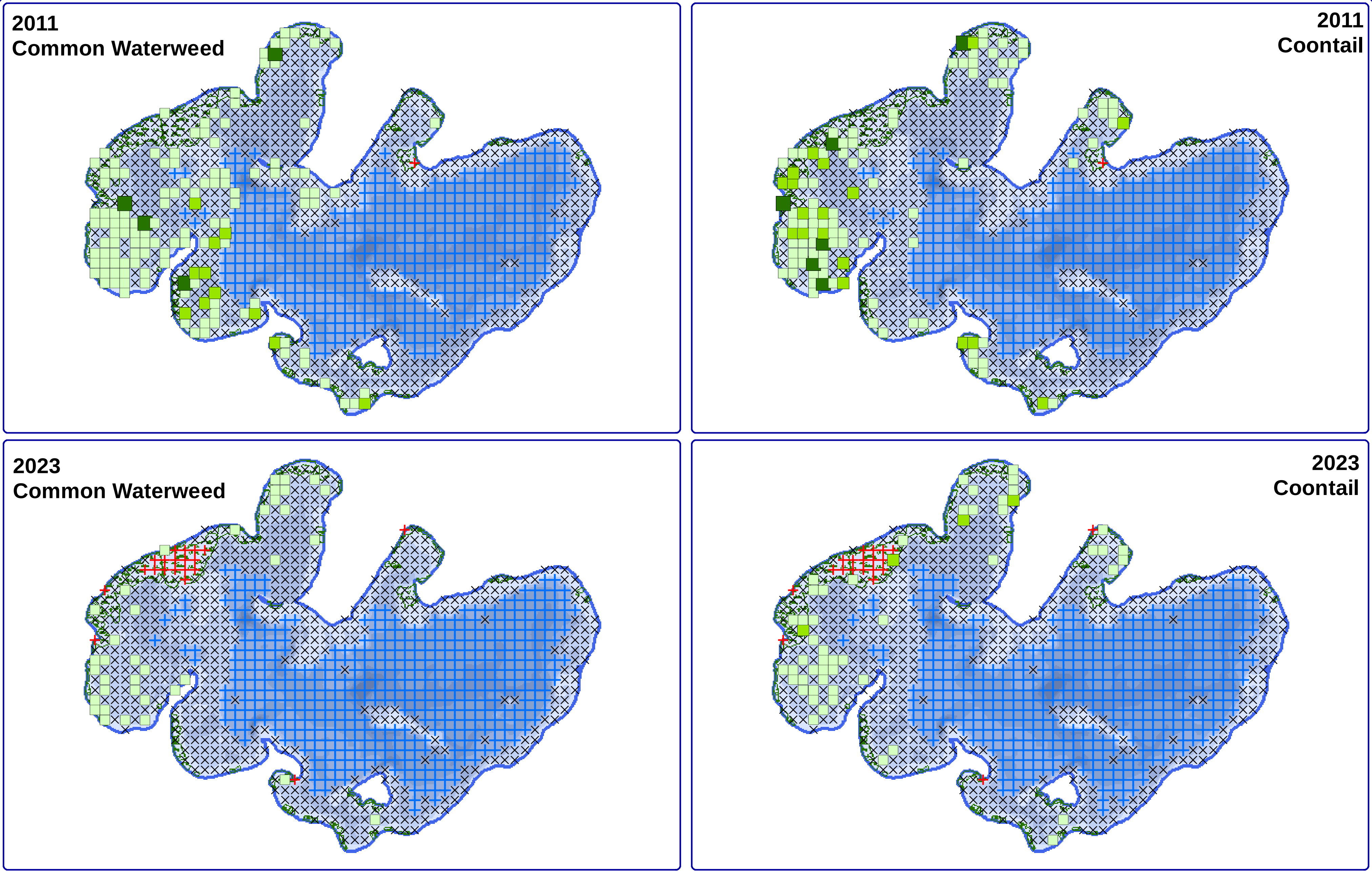
Project Location in Wisconsin

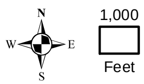
Legend

- Total Rake Fullness = 1
- Total Rake Fullness = 2
- Total Rake Fullness = 3

Map 3
Pelican Lake
Oneida County, Wisconsin

2011 vs 2023 PI: Total Rake Fullness





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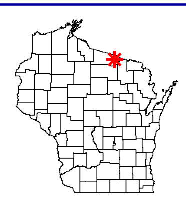
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plants: Onterra, 2014-2017

Map Date: October 3, 2017

Filename: STwin_EWMPB_2014-2017.mxd



Project Location in Wisconsin

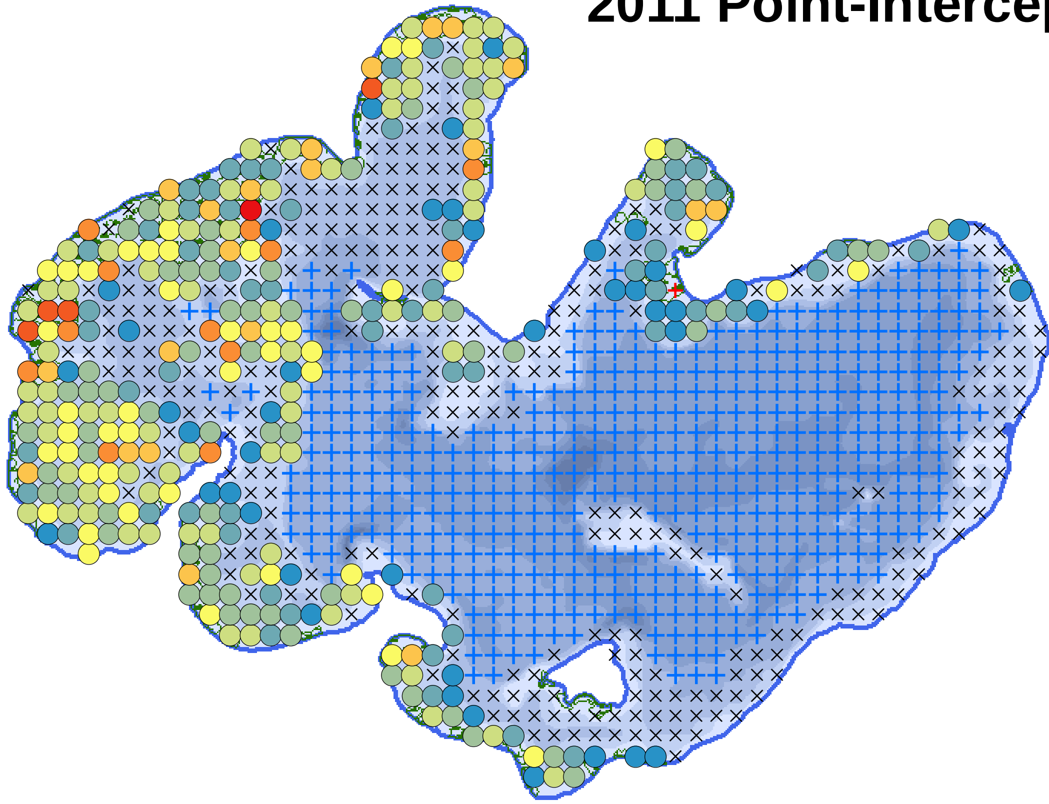
Legend

- Rake Fullness = 1
- Rake Fullness = 2
- Rake Fullness = 3

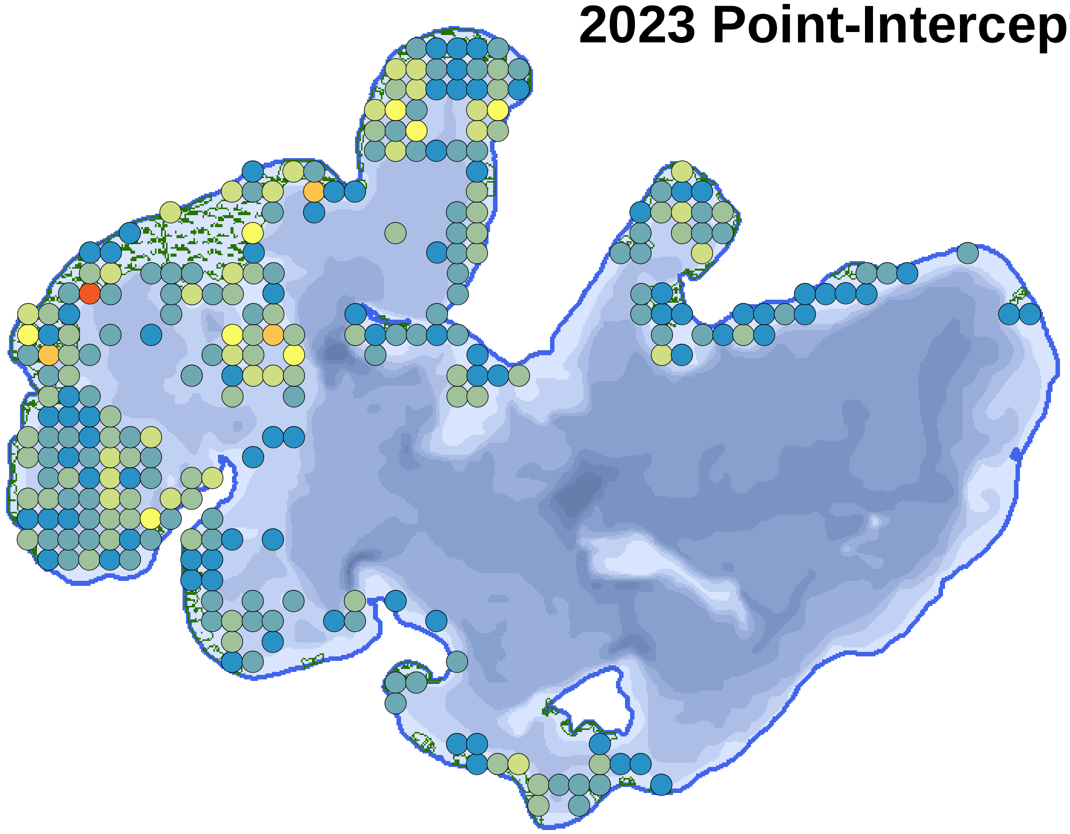
Map 4
Pelican Lake
Oneida County, Wisconsin

2011 vs 2023 PI: Coontail & Common Waterweed

2011 Point-Intercept Survey



2023 Point-Intercept Survey



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4,000

Feet

Onterra LLC
Lake Management Planning

815 Prosper Rd
De Pere, WI 54115
920.338.8860
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Sources
Roads and Hydro: WDNR
Bathymetry: Digitized by Onterra
Aquatic Plants: Onterra, 2023

Map Date: March 11th, 2024 KLW
Filename: *Map4_Shawano_2023_EWM.mxd*

Legend

Number of Native Species per Site

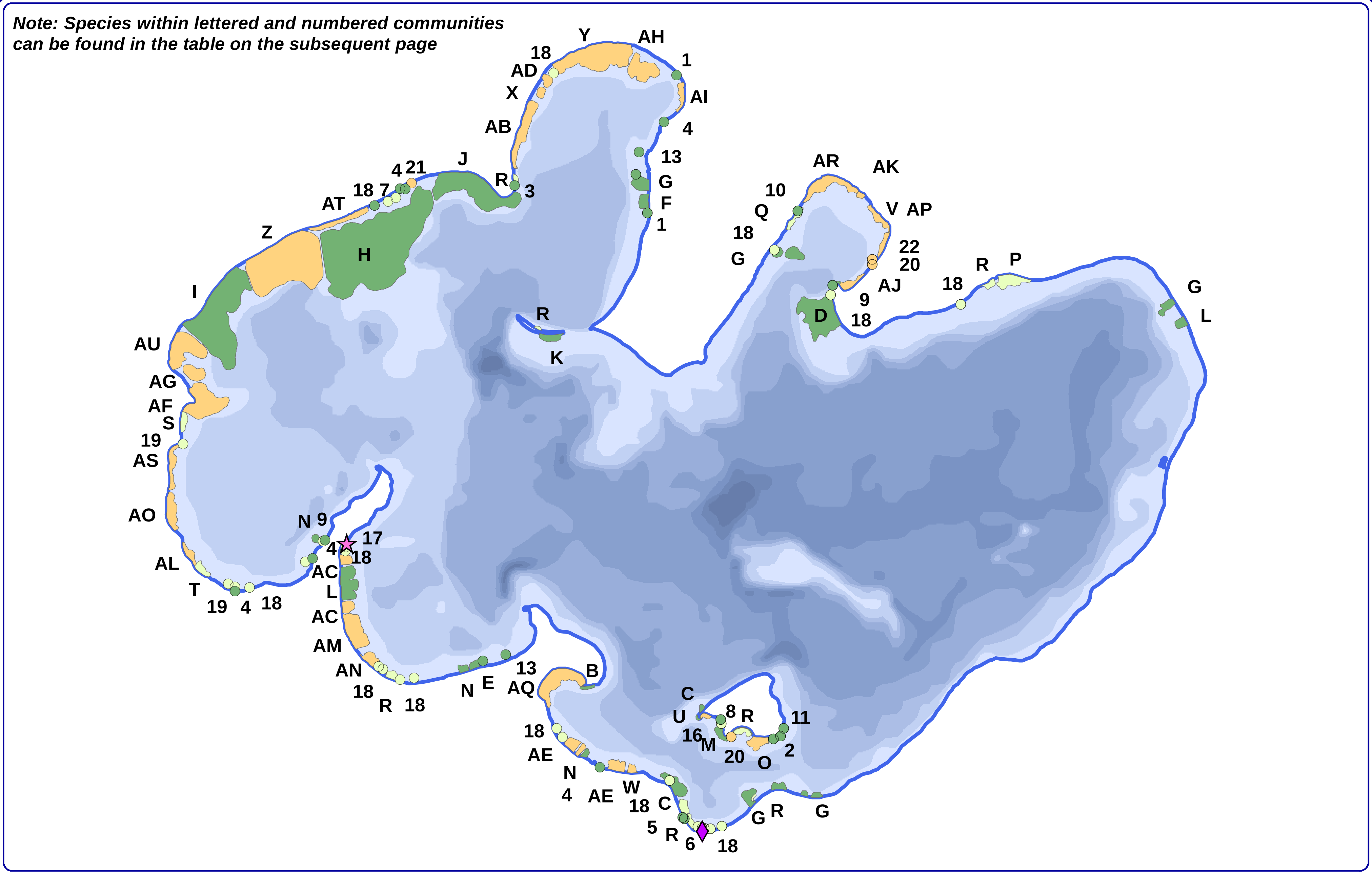
0 1 2 3 4 5 6 7 8 9

+ Too Deep

+ Non-navigable/Temporary Obstacle

Map 5
Pelican Lake
Oneida County, Wisconsin

2011 vs 2023 PI:
Total Rake Fullness



1,000
Feet

Onterra LLC
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources
Hydro: WDNR
Aquatic Plants: Onterra, 2023
Map date: November 9, 2023 JMB
Filename: Pelican_Comm_2023.mxd

Project Location in Wisconsin

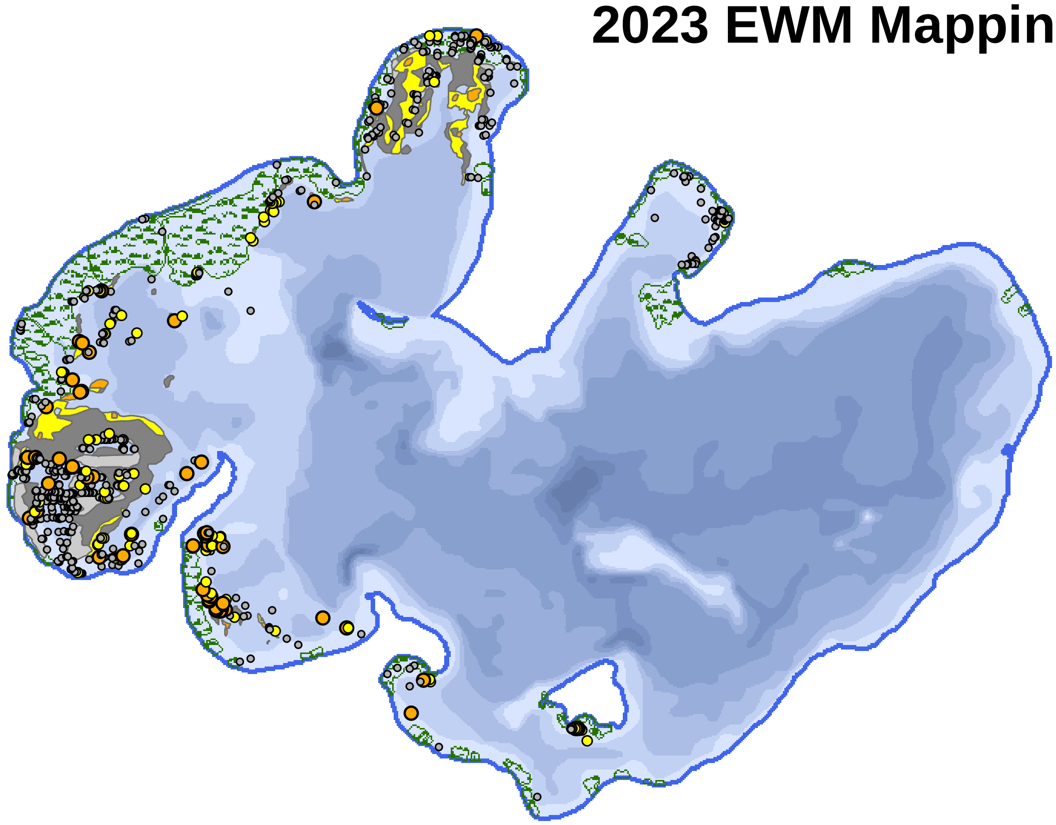
Legend

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- Purple Loosestrife
- Pink Water-lily

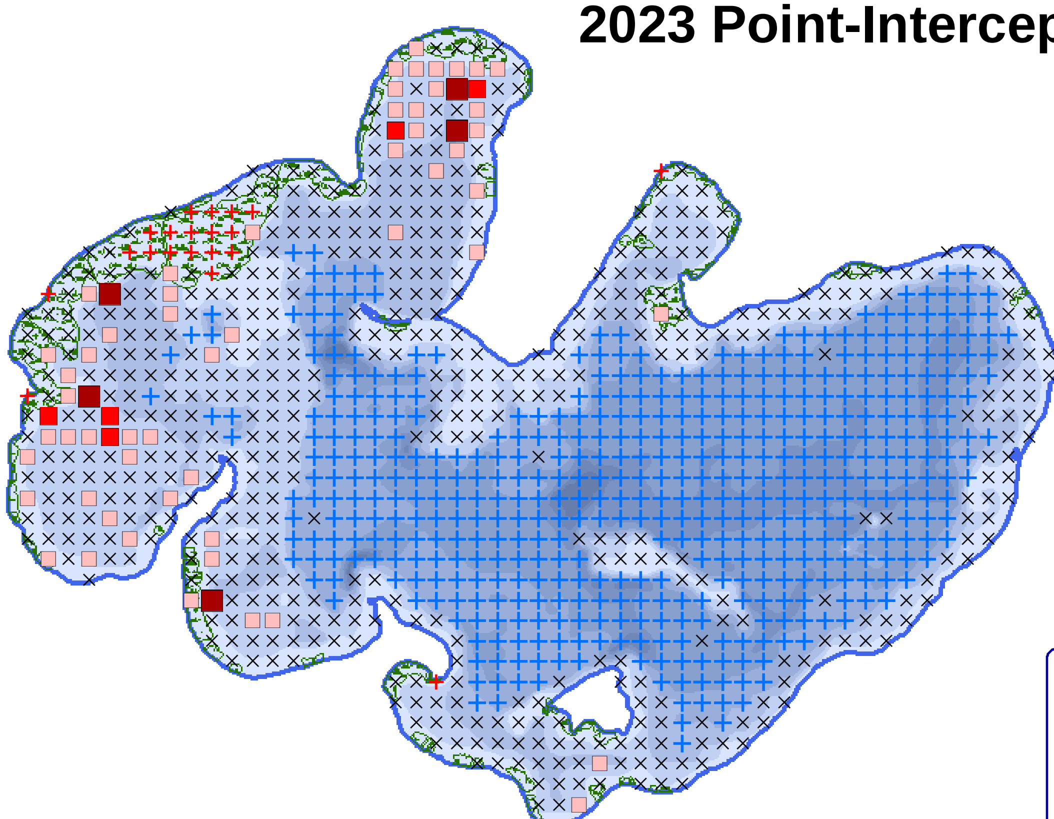
Large Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

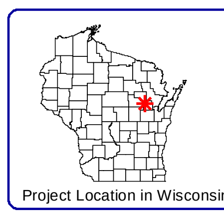
Map 6
Pelican Lake
Oneida Co, Wisconsin
2023 Aquatic Plant Communities

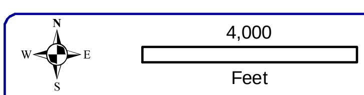
2023 EWM Mapping Survey



2023 Point-Intercept Survey







Onterra LLC
Lake Management Planning
815 Prosper Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources
Roads and Hydro: WDNR
Bathymetry: Digitized by Onterra
Aquatic Plants: Onterra, 2023

Map Date: March 11th, 2024 KLW
Filename: *Map4_Shawano_2023_EWM.mxd*

Legend

Top Frame

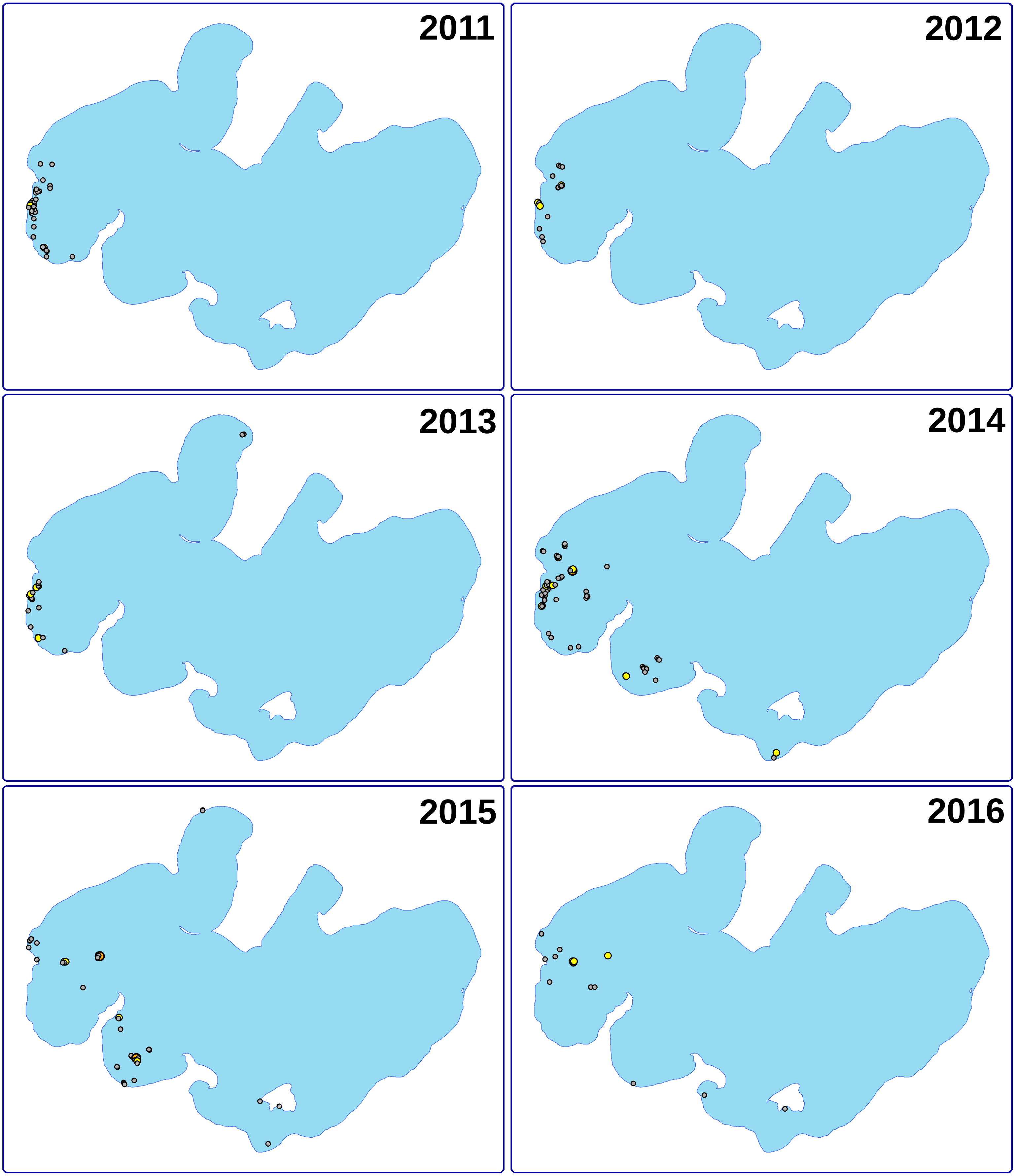
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting *(None)*
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony

Bottom Frame

- EWM Rake Fullness = 1
- EWM Rake Fullness = 2
- EWM Rake Fullness = 3

Map 7
Pelican Lake
Oneida County, Wisconsin

2023 Comparison EWM Mapping vs PI Survey



Legend

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

Map 8

Pelican Lake

Oneida County, Wisconsin

2011-2016 EWM Mapping Surveys

Onterra LLC
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815 Prosper Rd
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920.338.8860
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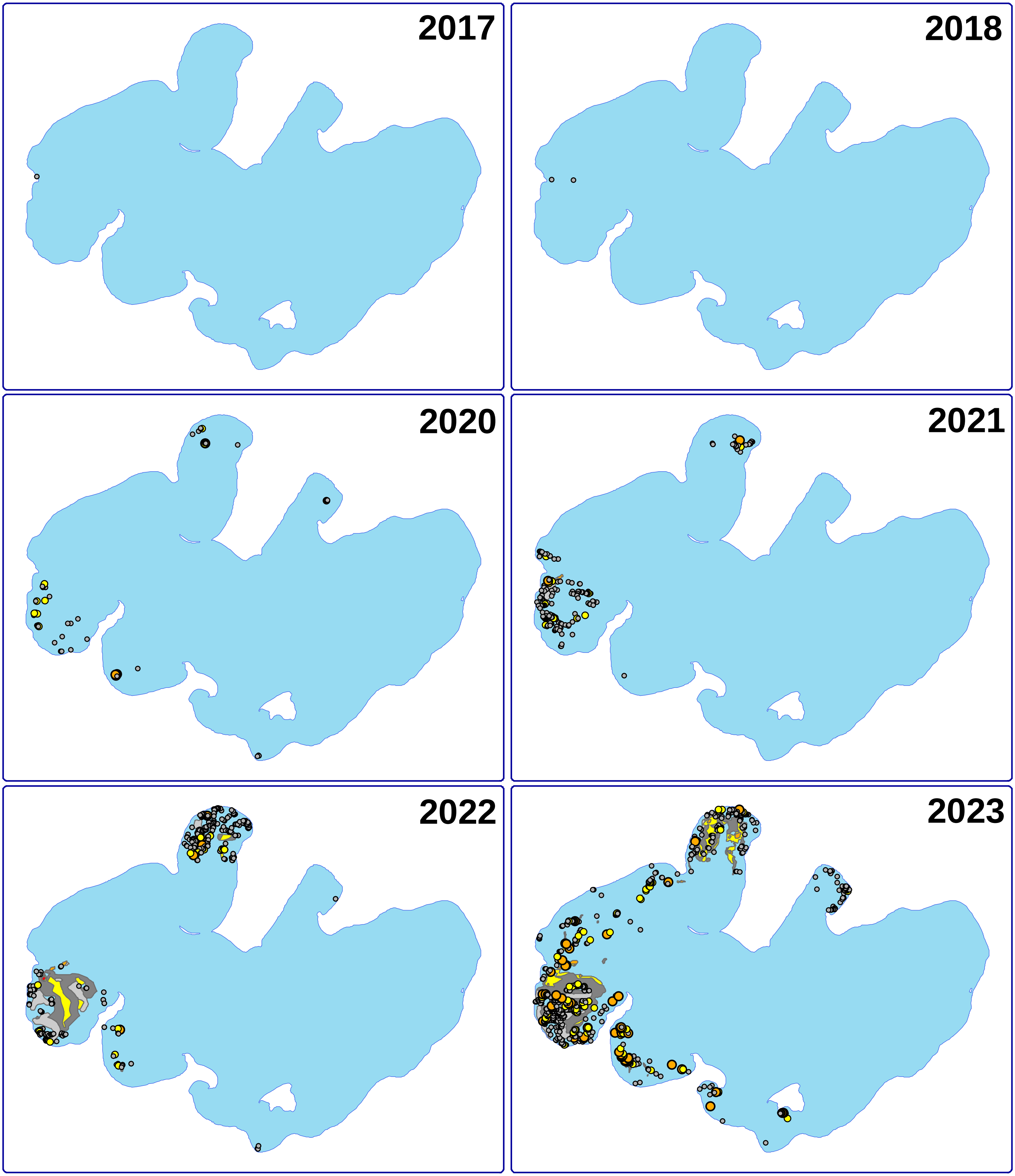
Sources
Roads and Hydro: WDNR
Bathymetry: Digitized by Onterra
Aquatic Plants: Onterra, 2023

Map Date: March 11th, 2024 KLW
Filename: *Map4_Shawano_2023_EWM.mxd*



Legend

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

Map 9

Pelican Lake

Oneida County, Wisconsin

2017-2023 EWM Mapping Surveys

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815 Prosper Rd
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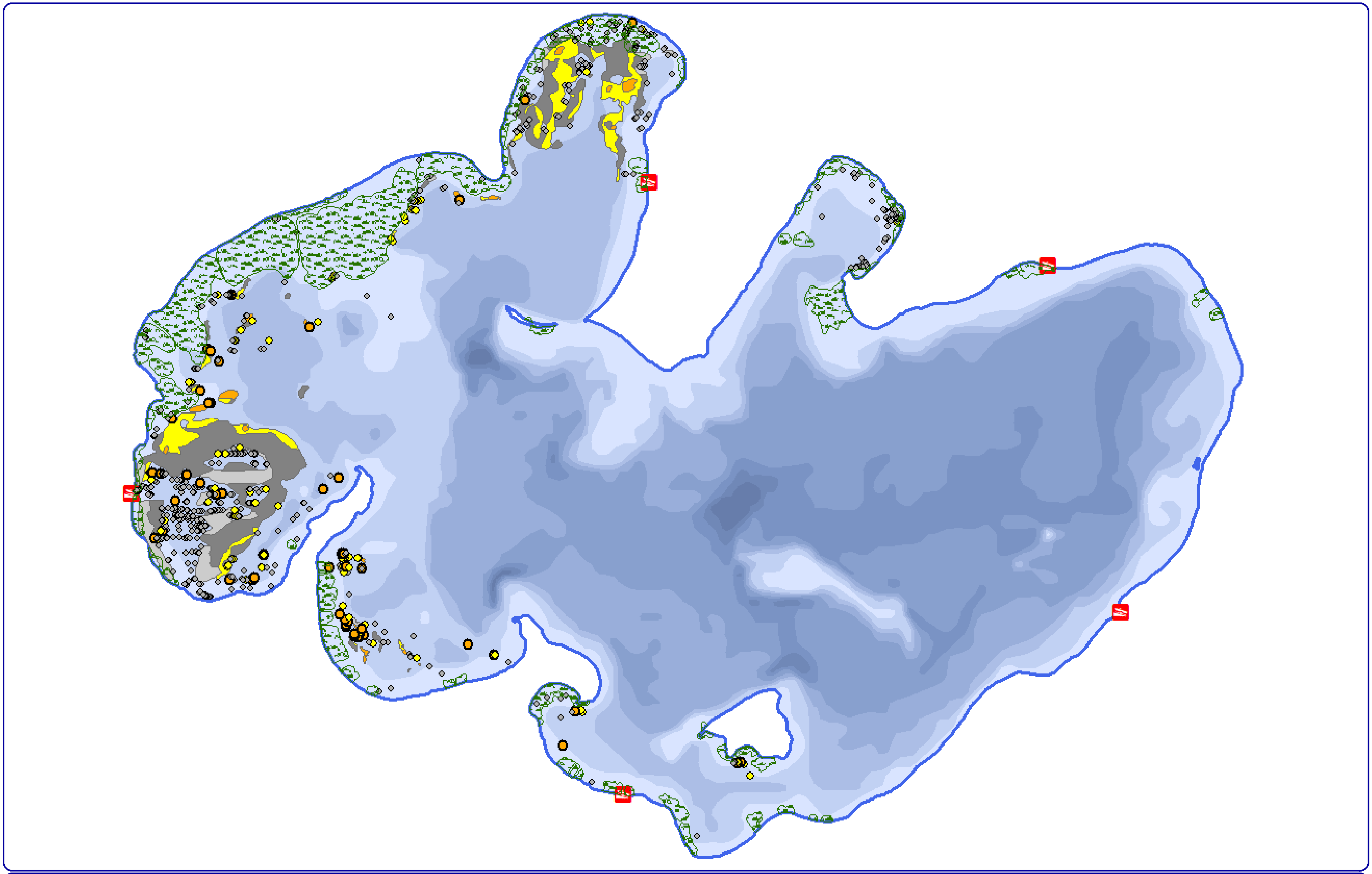
Sources
Roads and Hydro: WDNR
Bathymetry: Digitized by Onterra
Aquatic Plants: Onterra, 2023

Map Date: March 11th, 2024 KLW
Filename: *Map4_Shawano_2023_EWM.mxd*



N
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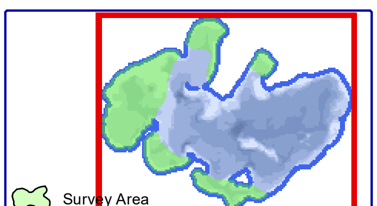
2,400
Feet

Onterra, LLC
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2023
Orthophotography: NAIP, 2022
Map Date: October 6, 2023 RMF/JMB



Legend

EWM Survey Results ***(August 28-31, 2023)***

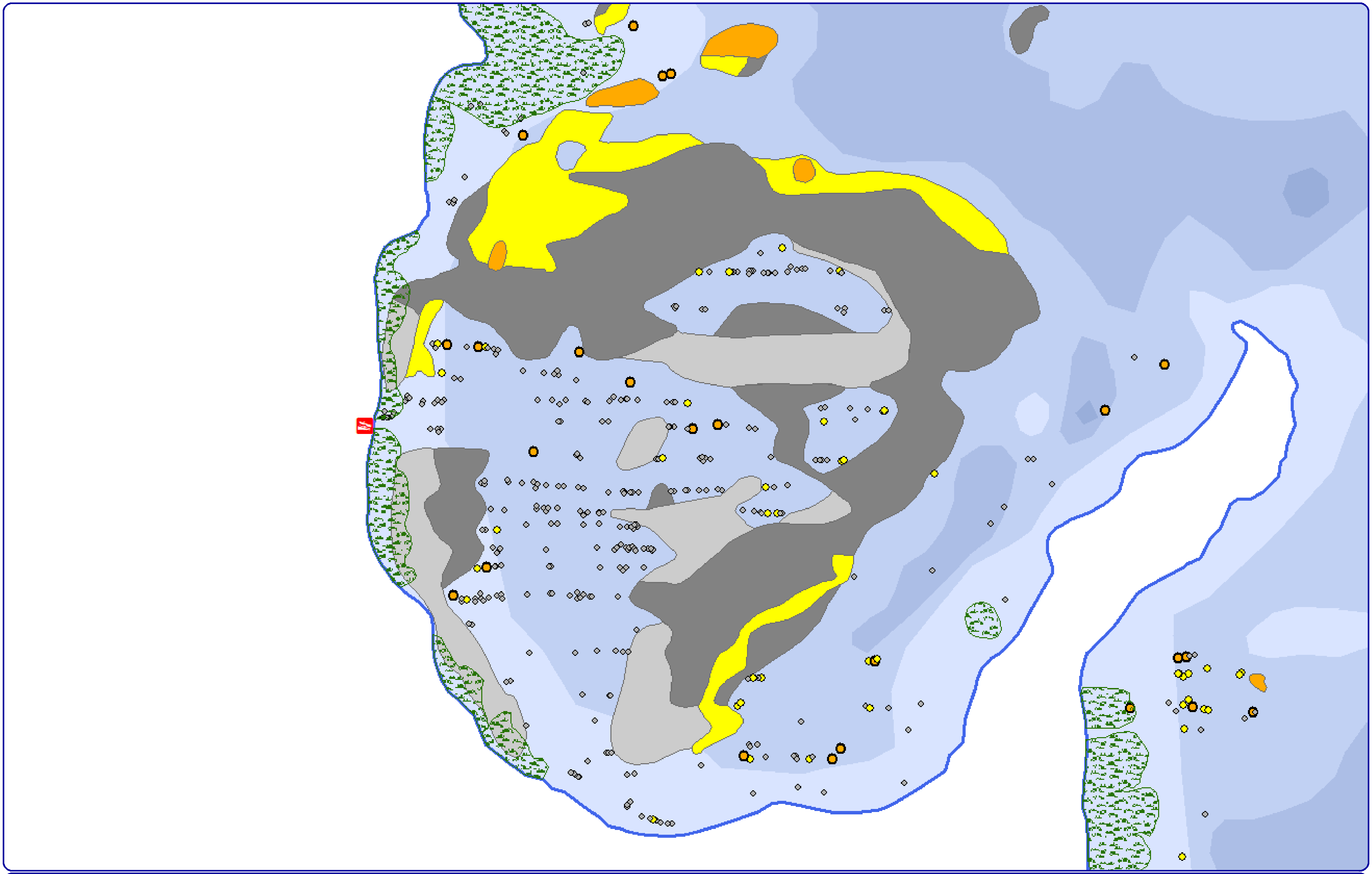
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- Emergent Plant Community *(Mapped in 2023)*

Map 10 (Overview)

Pelican Lake

Oneida County, Wisconsin

2023 Late-Season EWM Survey Results



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630
Feet

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815 Prosper Road
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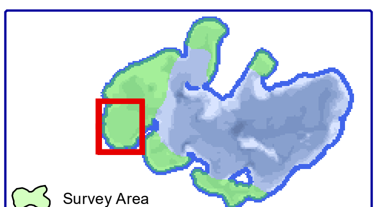
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2023
Orthophotography: NAIP, 2022
Map Date: October 6, 2023 RMF/JMB



Legend

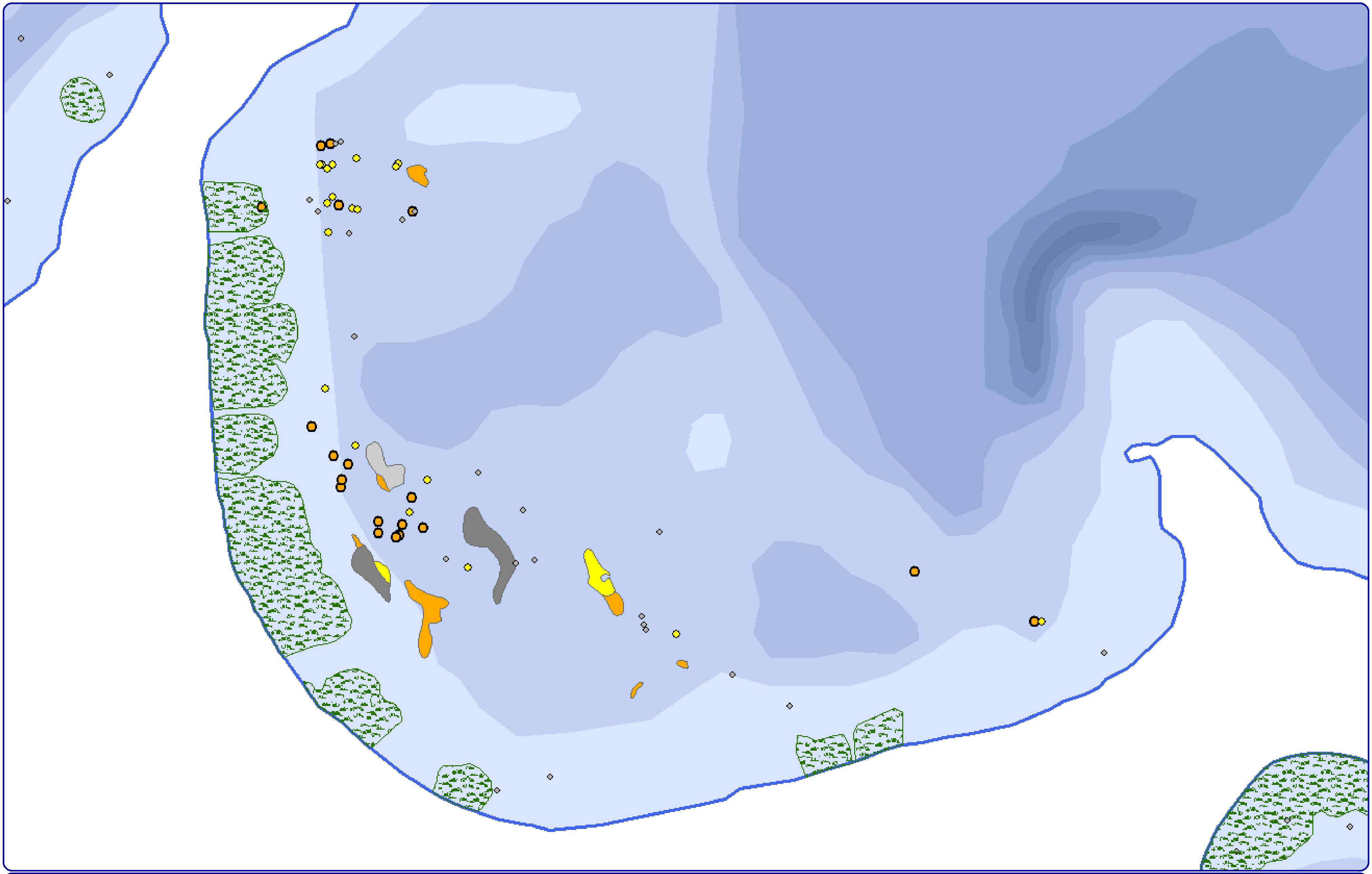
***EWM Survey Results** (August 28-31, 2023)*

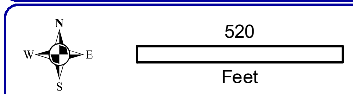
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- Emergent Plant Community *(Mapped in 2023)*

Map 11 (inset 1 of 7)

Lower Musky Bay
Oneida County, Wisconsin

2023 Late-Season EWM Survey Results





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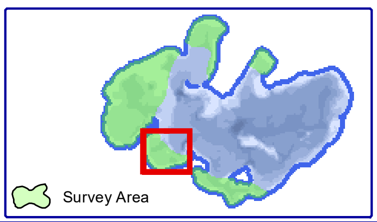
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2023
Orthophotography: NAIP, 2022
Map Date: October 6, 2023 RMF/JMB



Legend

EWM Survey Results ***(August 28-31, 2023)***

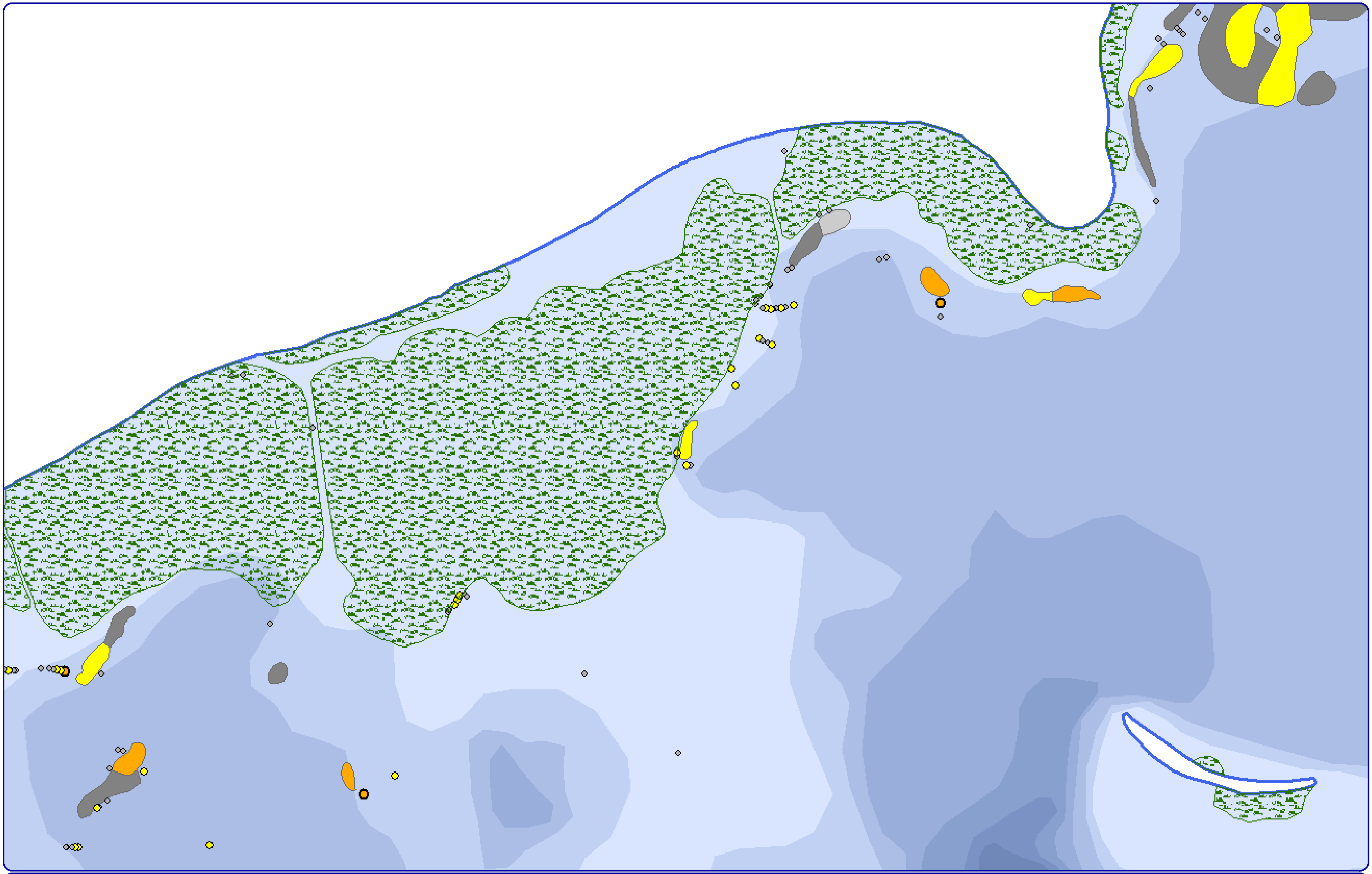
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clump of Plants
Small Plant Colony
Emergent Plant Community
(Mapped in 2023)

Map 12 (inset 2 of 7)

Treacherous Bay

Oneida County, Wisconsin

2023 Late-Season EWM Survey Results



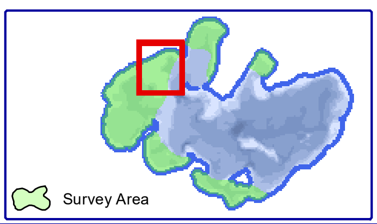
N W E S

630

Feet

Onterra LLC
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2023
Orthophotography: NAIP, 2022
Map Date: October 6, 2023 RMF/JMB



Legend

***EWM Survey Results** (August 28-31, 2023)*

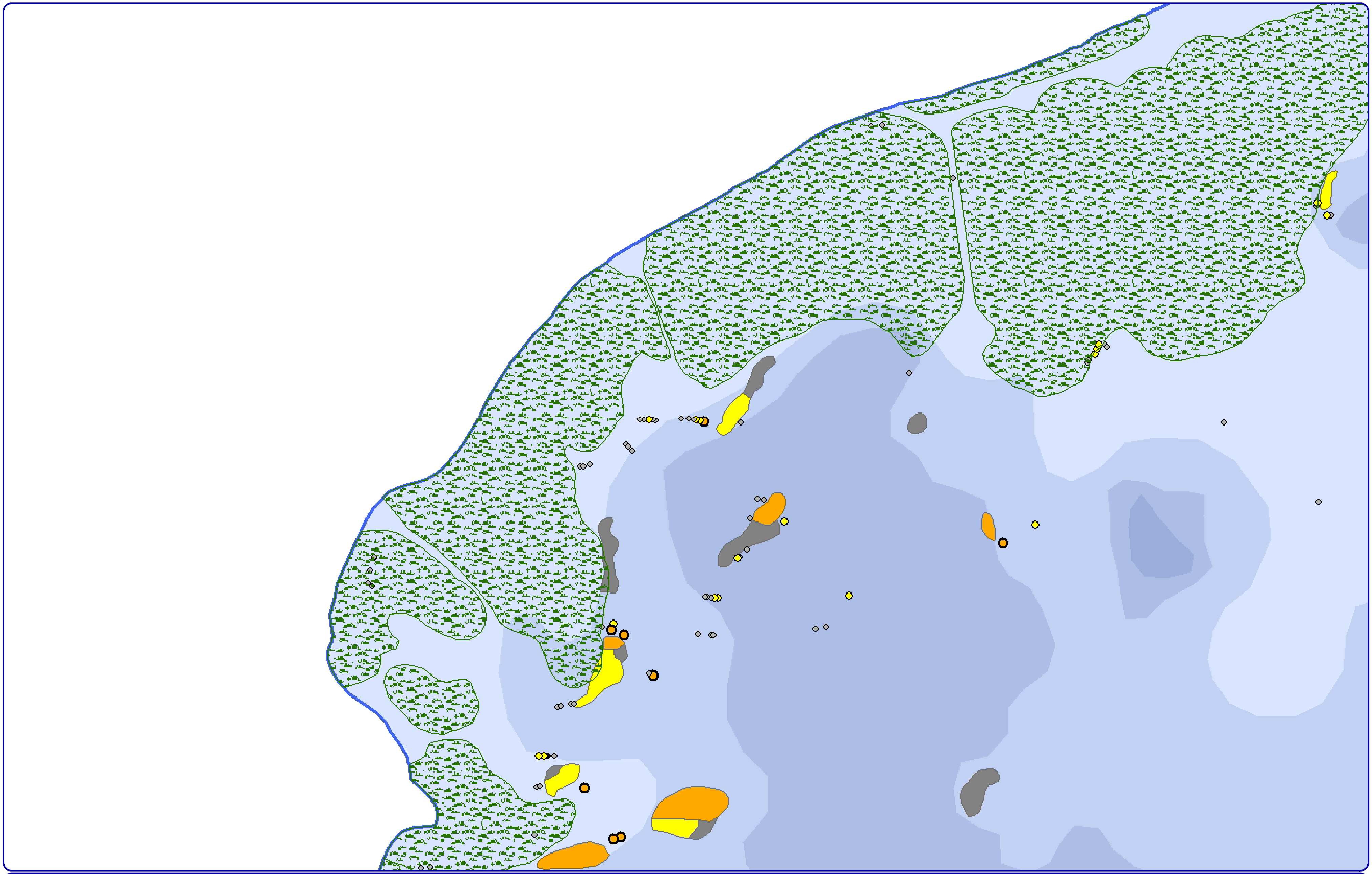
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- Emergent Plant Community *(Mapped in 2023)*

Map 13 (inset 3 of 7)

Upper Musky Bay

Oneida County, Wisconsin

2023 Late-Season EWM Survey Results



N
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630
Feet

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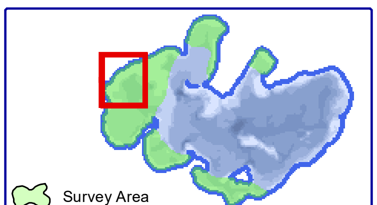
Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2023
Orthophotography: NAIP, 2022
Map Date: October 6, 2023 RMF/JMB



Legend

EWM Survey Results *(August 28-31, 2023)*

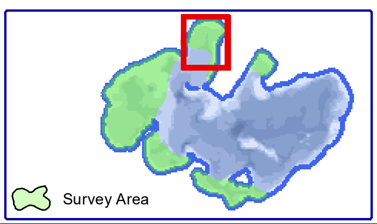
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- Emergent Plant Community *(Mapped in 2023)*

Map 14 (inset 4 of 7)

Mid Musky Bay
Oneida County, Wisconsin

2023 Late-Season EWM Survey Results

630
Feet



Legend

EWM Survey Results *(August 28-31, 2023)*

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- Emergent Plant Community *(Mapped in 2023)*

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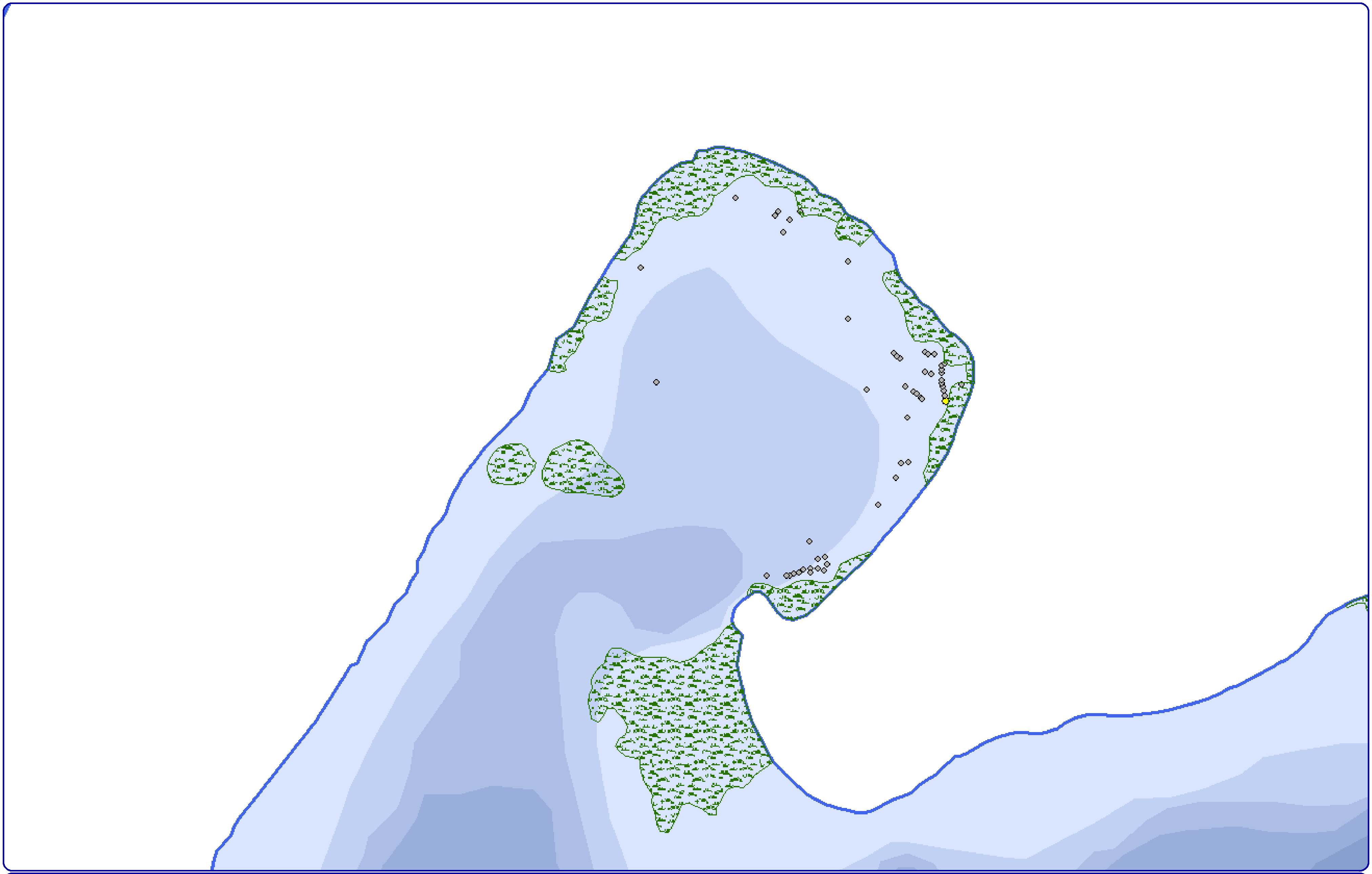
Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2023
Orthophotography: NAIP, 2022
Map Date: October 6, 2023 RMF/JMB

Map 15 (inset 5 of 7)

Outlet Bay

Oneida County, Wisconsin

2023 Late-Season EWM Survey Results



N
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630
Feet

Onterra, LLC
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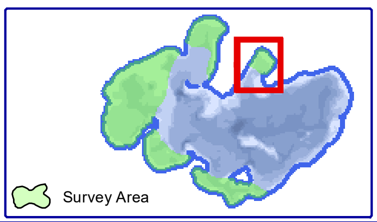
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2023
Orthophotography: NAIP, 2022
Map Date: October 6, 2023 RMF/JMB



Legend

EWM Survey Results ***(August 28-31, 2023)***

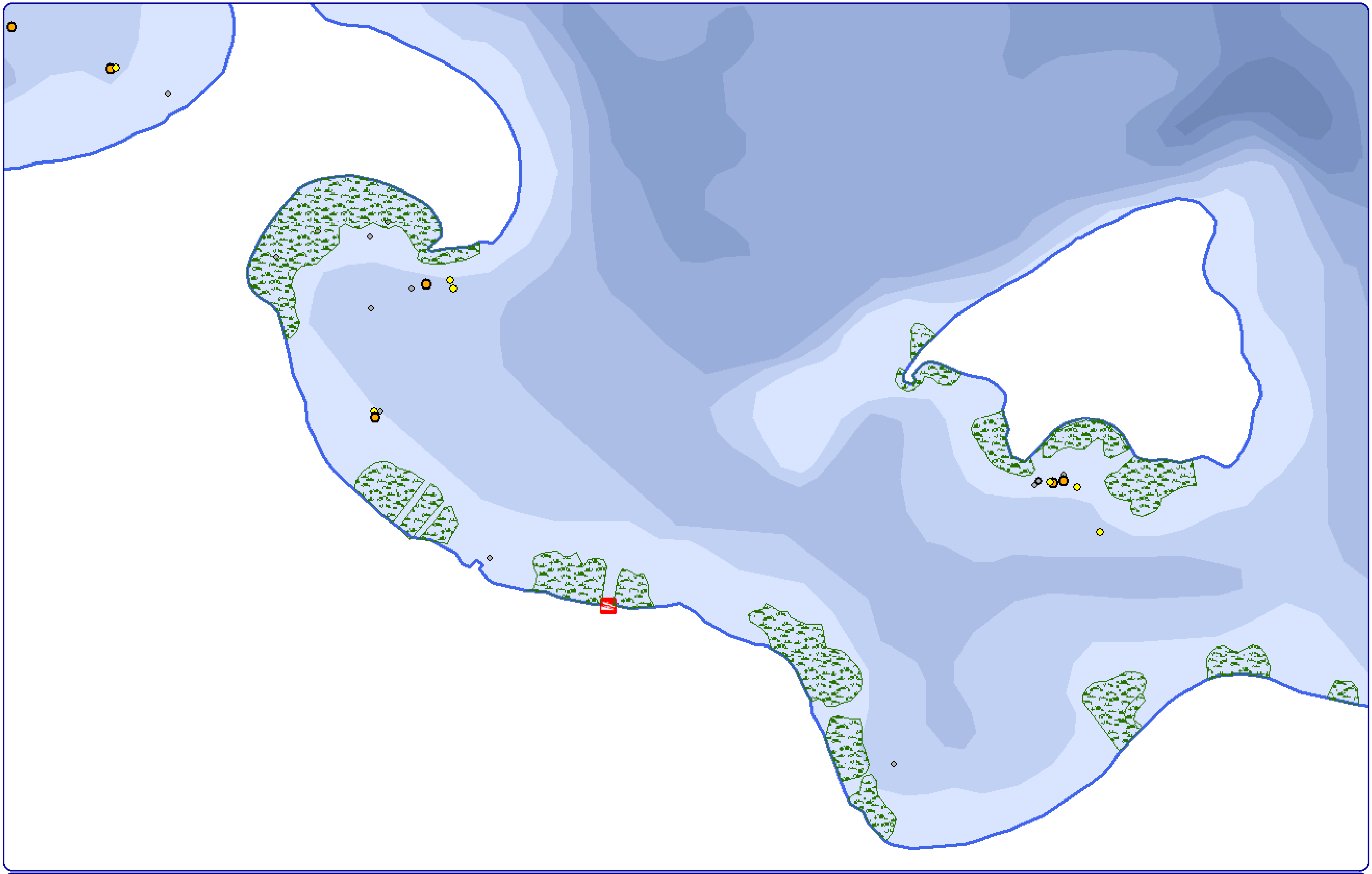
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- Emergent Plant Community *(Mapped in 2023)*

Map 16 (inset 6 of 7)

Mud Bay

Oneida County, Wisconsin

2023 Late-Season EWM Survey Results



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Feet

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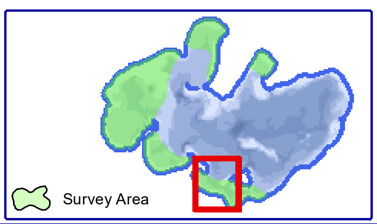
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2023
Orthophotography: NAIP, 2022
Map Date: October 6, 2023 RMF/JMB



Legend

EWM Survey Results ***(August 28-31, 2023)***

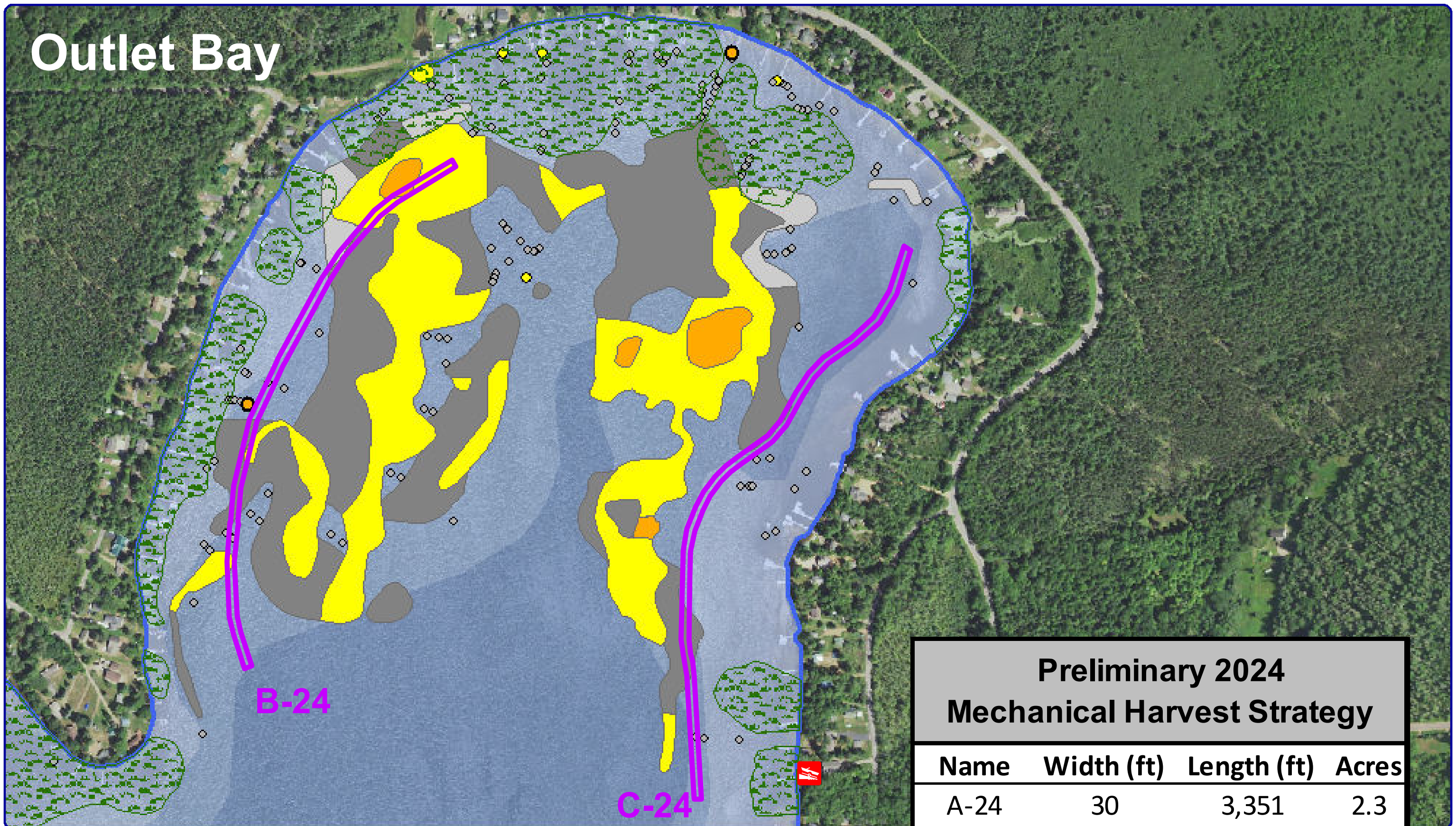
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- Emergent Plant Community *(Mapped in 2023)*

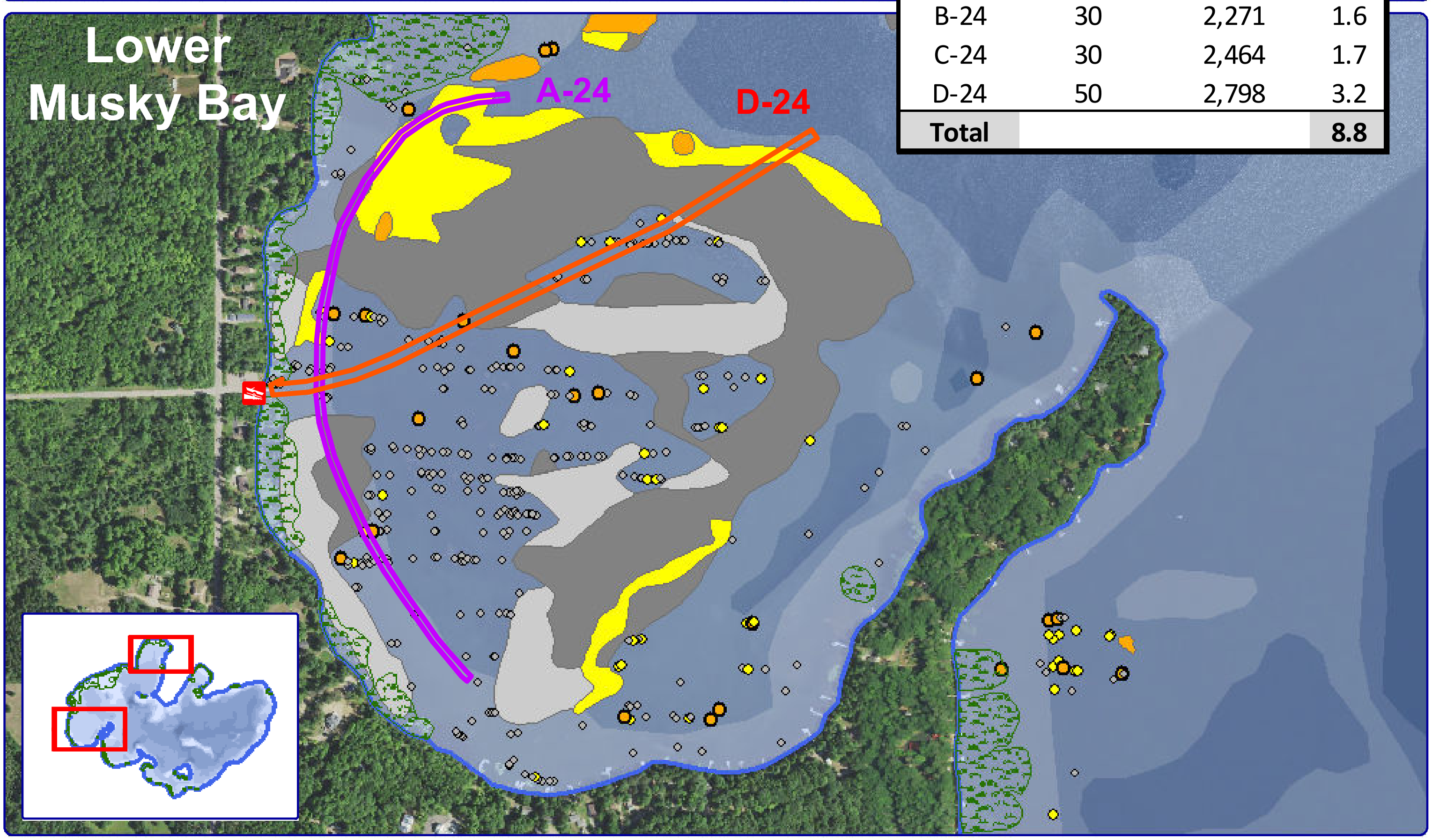
Map 17 (inset 7 of 7)

Guths Bay

Oneida County, Wisconsin

2023 Late-Season EWM Survey Results





Preliminary 2024 Mechanical Harvest Strategy			
Name	**Width (ft)**	**Length (ft)**	**Acres**
A-24	30	3,351	2.3
B-24	30	2,271	1.6
C-24	30	2,464	1.7
D-24	50	2,798	3.2
Total			**8.8**

Legend

EWM Survey Results *(August 28-31, 2023)*

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting *(None)*
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- Emergent Plant Community *(Mapped in 2023)*
- Mechanical Harvest Lane *(30 ft wide)*
- Mechanical Harvest Lane *(50 ft wide)*

Onterra LLC
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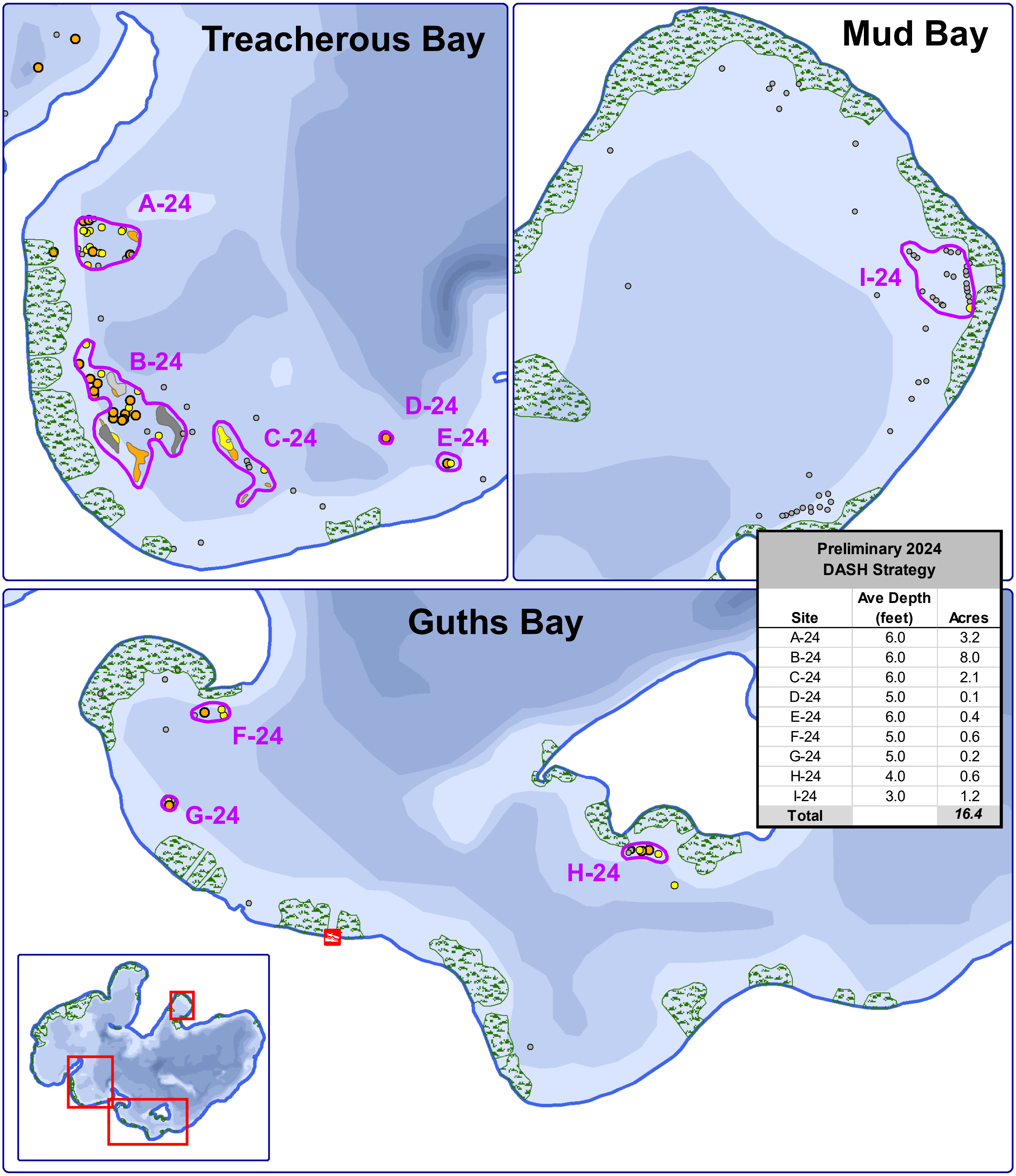
920.338.8860
www.onterra-eco.com

Sources
Roads and Hydro: WDNR
Bathymetry: Digitized by Onterra
Aquatic Plants: Onterra, 2023
Map Date: April 19, 2024 - RMF

Map 18
Pelican Lake
Oneida County, Wisconsin

Prelim 2024 Mechanical Harvest Strategy V2



Preliminary 2024 DASH Strategy		
Site	Ave Depth (feet)	Acres
A-24	6.0	3.2
B-24	6.0	8.0
C-24	6.0	2.1
D-24	5.0	0.1
E-24	6.0	0.4
F-24	5.0	0.6
G-24	5.0	0.2
H-24	4.0	0.6
I-24	3.0	1.2
Total		***16.4***

Legend

EWM Survey Results ***(August 28-31, 2023)***

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting *(None)*
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- Emergent Plant Community *(Mapped in 2023)*
- Hand Harvest Areas

Onterra LLC
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De Pere, WI 54115
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Sources
Roads and Hydro: WDNR
Bathymetry: Digitized by Onterra
Aquatic Plants: Onterra, 2023
Map Date: April 22, 2024 - RMF

Map 19
Pelican Lake
Oneida County, Wisconsin

Preliminary 2024 DASH Strategy V2