Lower Ninemile Lake

Vilas & Oneida Counties, Wisconsin

Comprehensive Management Plan

December 2013

Sponsored by:

Friends of Lower Ninemile Lake, Inc.

WDNR Grant Program

LPL-1398-11

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Onterra LLC
Lake Management Planning

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Comprehensive Management Plan

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Funded by: Friends of Lower Ninemile Lake, Inc.
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This management planning effort was truly a team-based project and could not have been completed without the input of the following individuals:

Lower Ninemile Lake Planning Committee

Connie Letts
Bob Dahl
Sam Moore
Gary Zajichek
Truman Gussick
Arlene Mugerauer
Steve Gilbert

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Kevin Gauthier
Tim Plude
Steve Gilbert

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Mike Peczynski

Data Resources

Data has been specifically provided for use in this report by the Wisconsin Department of Natural Resources, Great Lakes Indian Fish and Wildlife Commission, Wisconsin Valley Improvement Company, and US Forest Service.

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1.0 INTRODUCTION

Lower Ninemile Lake, Vilas and Oneida Counties, is a very shallow (six-foot maximum depth), 849-acre impoundment at the confluence of Ninemile and Sevenmile Creeks, and has a drainage basin covering approximately 29 square miles. Water levels are maintained via the Lower Ninemile Dam owned and operated by the Wisconsin Valley Improvement Company (WVIC). The lake's outlet, Ninemile Creek, flows to meet the Eagle River just above the Burnt Rollways Dam, which marks the divide between the Lower Eagle River Chain of Lakes and the Three Lakes Chain. Studies completed in 2011 indicate that Lower Ninemile Lake is a productive, mesotrophic-eutrophic system, and contains 49 native aquatic plant species of which fern pondweed was the most common. No non-native, invasive aquatic plants are known to exist in Lower Ninemile Lake, and none were located in 2011.

Field Survey Notes

Many cool plant and bird species were observed during our times on the lake, including a few trumpeter swans. With an abundance of floating-leaf and emergent plant communities, it took us more than a day longer than anticipated to finish our community mapping survey – but we didn't mind spending more time on such a great lake.

Photograph 1.0-1. Lower Ninemile Lake, Vilas & Oneida Counties.

Lake at a Glance - Lower Ninemile Lake

Morphology	
Acreage	849 (WDNR Definition)
Maximum Depth (ft)	6
Mean Depth (ft)	2
Shoreline Complexity	9.7
Vegetation	
Curly-leaf Survey Date	June 22, 2011
Comprehensive Survey Date	July 28-29, 2011
Number of Native Species	49
Natural Heritage Inventory Listed Species	0
Exotic Plant Species	0
Simpson's Diversity	0.89
Average Conservatism	6.6
Water Quality	
Trophic State	Mesotrophic-Eutrophic
Limiting Nutrient	Phosphorus
Water Acidity (pH)	7.4
Sensitivity to Acid Rain	Not Sensitive
Watershed to Lake Area Ratio	21:1

In 2007, Lower Ninemile Lake stakeholders organized to form the Friends of Lower Ninemile Lake (FLNML). The group was created over strife of an expanding northern wild rice population within the lake. The expansion of the wild rice has impacted navigation of some lake property owners. Some residents on the lake gained relief in 2009 by hand-removing wild rice under a special permit granted by the Wisconsin Department of Natural Resources (WDNR) with the cooperation of the Great Lakes Indian Fish and Wildlife Commission. .

The FLNML was interested in creating a lake management plan for three primary reasons. First, the FLNML wanted to learn gather the appropriate ecological and sociological data that would allow them to address the growing concerns about increased wild rice within the Lower Ninemile system. Secondly, they wanted to take a proactive approach and be prepared to react in the event that an aquatic invasive plant would become established in the lake. The FLNML understood that the Wisconsin Department of Natural Resources (WDNR) could respond more quickly and accurately to address an invasive species establishment if the lake had a management plan in place. The third primary reason for entering into a management planning project was that the FLNML recognized the value of gaining a better understanding of the Lower Ninemile Lake ecosystem and its current condition. The lake management planning project was funded through the WDNR grant program, which were secured during August 2010.

2.0 STAKEHOLDER PARTICIPATION

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

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

Kick-off Meeting
On July 9, 2011, a project kick-off meeting was held at the Franklin Lake Picnic Shelter to introduce the project to the general public. The meeting was announced through a mailing and personal contact by FLNML board members. The attendees observed a presentation given by Tim Hoyman, an aquatic ecologist with Onterra. Mr. Hoyman's presentation started with an educational component regarding general lake ecology and ended with a detailed description of the project including opportunities for stakeholders to be involved. The presentation was followed by a question and answer session.

Planning Committee Meeting I
On May 17th, 2012 Eddie Heath of Onterra met with five members of the Friends of Lower Ninemile Lake Planning Committee. In advance of this meeting, a draft copy of the Results & Discussion Sections (3.0) was provided to attendee, along with the results of the stakeholder survey (Appendix B). The primary focus of this meeting was the delivery of the study results and conclusions to the committee. All study components including, aquatic plant inventories, water quality analysis, and watershed modeling were presented and discussed.

Planning Committee Meeting II
On June 21st, 2012, Eddie Heath met with the same five members of the Planning Committee to begin developing management goals and actions for the Friends of Lower Ninemile Lake's Comprehensive Lake Management Plan. One of the major topics of discussion was related to wild rice and the perceived recreational impairment that it causes at times. Lisa David (Great Lakes Indian Fish and Wildlife Commission) and Kevin Gauthier (WDNR) were also in attendance at the meeting. Prior to the meeting, Ms. David and Mr. Gauthier were provided with copies of the presentation given at Planning Committee Meeting I, as well as the materials provided prior to the meeting (Results Sections and stakeholder survey results).

Project Wrap-up Meeting
Yet to occur

Management Plan Review and Adoption Process

In December 2012, a draft of the Implementation Plan Section (5.0) was provided to the Planning Committee for review. Comments were provided to Onterra and a second draft of the Implementation Plan Section was sent to the Planning Committee for Review in late-March 2013. The Implementation Plan Section of this report is based upon integration of the Planning Committee's comments of that draft.

Stakeholder Survey

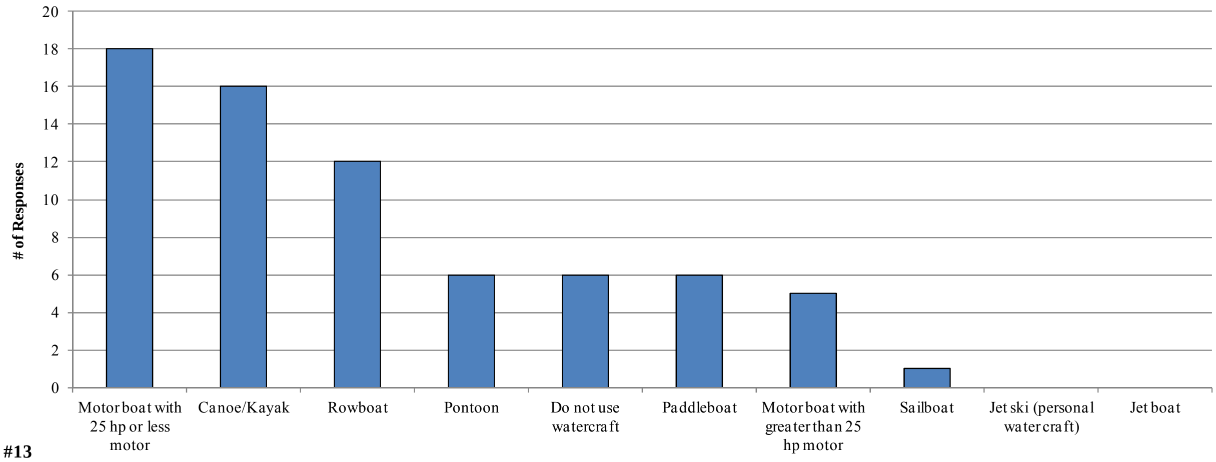
During November of 2011, an eight-page, 32-question survey was mailed to 49 riparian property owners in the Lower Ninemile Lake watershed. 71% of the surveys were returned and those results were entered into a spreadsheet by members of the Lower Ninemile Lake Planning Committee. The data were summarized and analyzed by Onterra for use at the planning meetings and within the management plan. The full survey and results can be found in Appendix B, while discussion of those results is integrated within the appropriate sections of the management plan and a general summary is discussed below.

Based upon the results of the Stakeholder Survey, much was learned about the people that use and care for Lower Ninemile Lake. 31% of the survey respondents own a seasonal residence (summer only) on Lower Ninemile Lake, while roughly 26% are year-round residents and 23% visit the lake on weekends throughout the year (Appendix B, Question #1). 69% of stakeholders have owned their property for over 15 years, and 51% have owned their property for over 25 years (Question #3).

The following sections (Water Quality, Watershed, Aquatic Plants and Fisheries Data Integration) discuss the stakeholder survey data with respect these particular topics. Figures 2.0-1 and 2.0-2 highlight several other questions found within this survey. When asked what types of watercraft they use on the lake, most survey respondents indicated use of a motor boat with 25hp or less motor or a canoe or kayak (Question #13). Rowboats, another passive type of vessel, were also a popular option. On a relatively shallow lake such as Lower Ninemile Lake, the importance of responsible boating activities is increased. The need for responsible boating increases during weekends, holidays, and during times of nice weather or good fishing conditions as well, due to potential increased traffic on the lake. As seen on Question #14, the top recreational activities that involve boat use are "passive" type of activities (e.g. open water fishing and canoeing/kayaking). Boat traffic was not listed as a factor potentially impacting Lower Ninemile Lake in a negative manner (Question #20) or as a top concern regarding the lake (Question #21).

A concern of stakeholders noted throughout the stakeholder survey (see Question #20, through #25 and survey comments – Appendix B) was excessive aquatic plant growth, primarily floating-leaf bur-reed and wild rice, within Lower Ninemile Lake. This topic is discussed in the Aquatic Plant Section and Summary & Conclusions section as well as within the Implementation Plan.

Question #13: What types of watercraft do you currently use on the lake?



Question #14: Please rank up to three activities that are important reasons for owning your property on or near the lake.

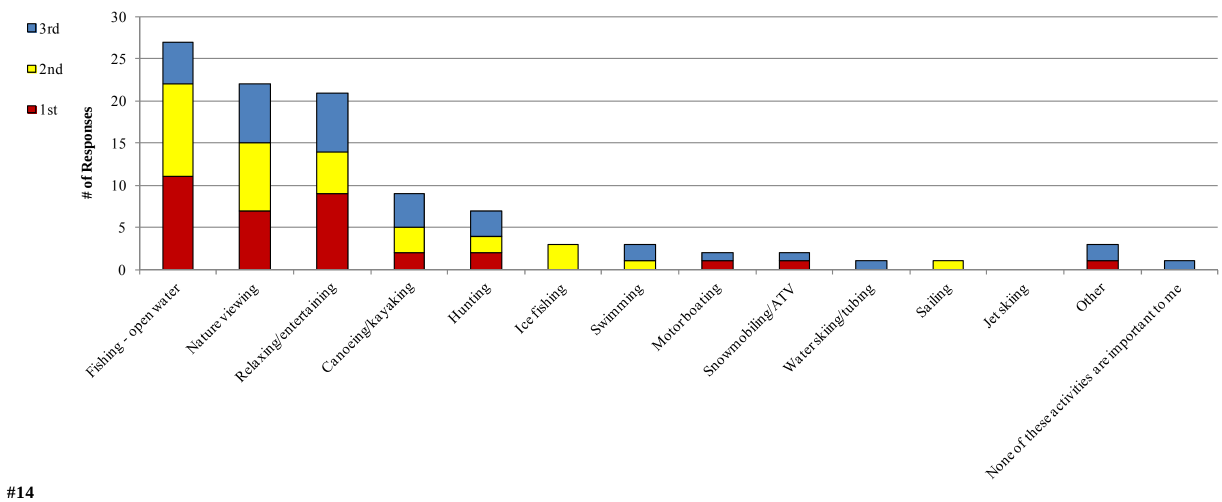
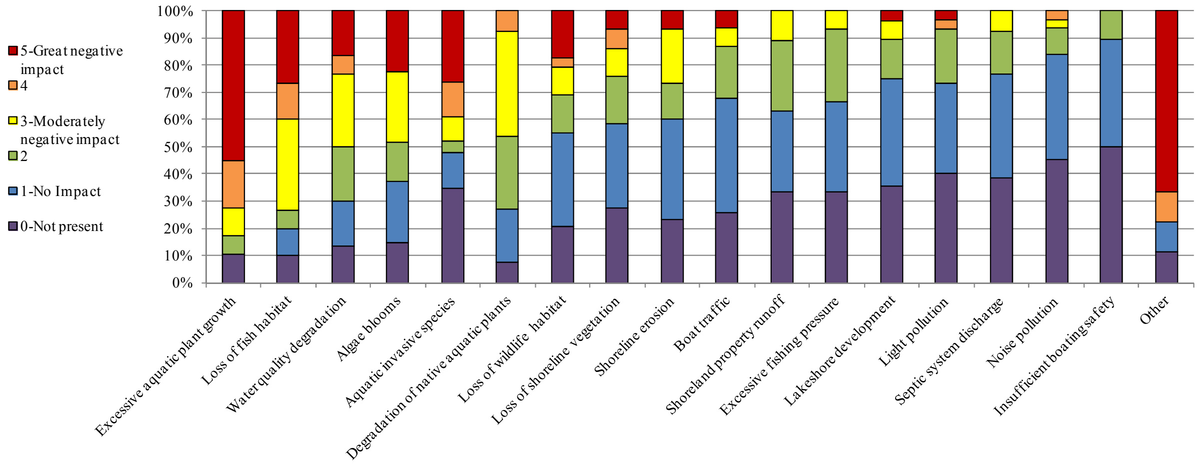


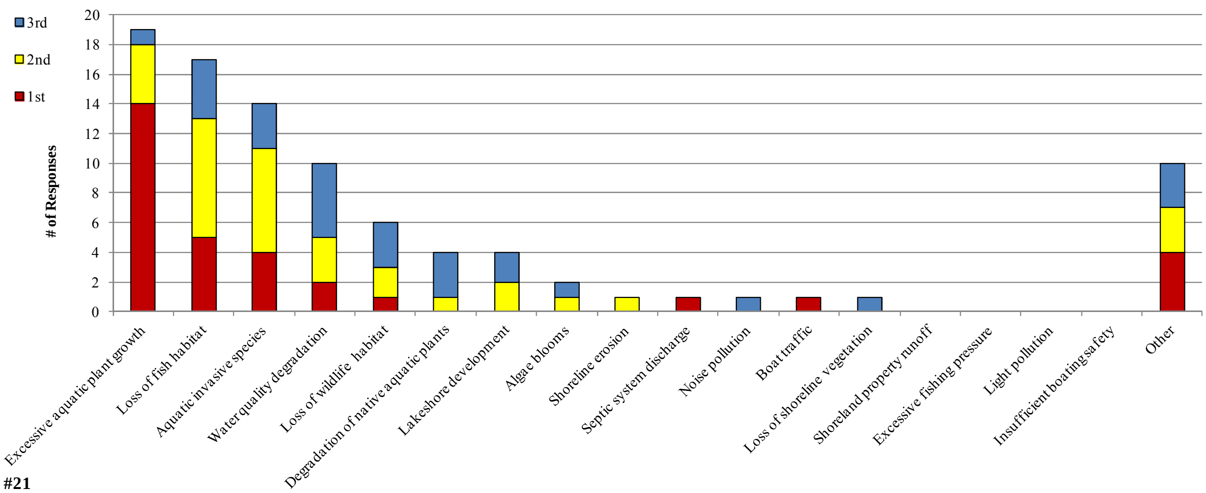
Figure 2.0-1. Select survey responses from the Lower Ninemile Lake Stakeholder Survey. Additional questions and response charts may be found in Appendix B.

Question #20: To what level do you believe these factors may be negatively impacting Lower Ninemile Lake?



#20

Question #21: Please rank your top three concerns regarding Lower Ninemile Lake.



#21

Figure 2.0-2. Select survey responses from the Lower Ninemile Lake Stakeholder Survey, continued. Additional questions and response charts may be found in Appendix B.

3.0 RESULTS & DISCUSSION

3.1 Lake Water Quality

Primer on 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 analysis 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 Lower Ninemile 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 Lower Ninemile Lake's 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 quadrates (a Secchi disk) into the water and recording the depth just before it disappears from sight.

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

Trophic State

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

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

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

Limiting Nutrient

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

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

Temperature and Dissolved Oxygen Profiles

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

> **Lake stratification** occurs when temperature gradients are developed with depth in a lake. During stratification the lake can be broken into three layers: The epiliminion 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, fishkills 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 strong stratification, 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 the spring and fall turnover events, these high concentrations of phosphorus are mixed within the lake and utilized by algae and some macrophytes. This cycle continues year after year and is termed "internal phosphorus loading"; a phenomenon that can support nuisance algae 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 screen non-candidate and candidate lakes following the general guidelines below:

Non-Candidate Lakes

- Lakes that do not experience hypolimnetic anoxia.
- Lakes that do not stratify for significant periods (i.e. months 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 publication *Implementation and Interpretation of Lakes Assessment Data for the Upper Midwest* (PUB-SS-1044 2008) 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 Lower Ninemile Lake will be compared to lakes in the state with similar physical characteristics. The WDNR groups Wisconsin's lakes into 6 classifications (Figure 3.1-1).

First, the lakes are classified into two main groups: **shallow (mixed)** or **deep (stratified)**. Shallow lakes tend to mix throughout or periodically during the growing season and as a result, remain well-oxygenated. Further, shallow lakes often support aquatic plant growth across most or the entire lake bottom. Deep lakes tend to stratify during the growing season and have the potential to have low oxygen levels in the bottom layer of water (hypolimnion). Aquatic plants are usually restricted to the shallower areas around the perimeter of the lake (littoral zone). An equation developed by Lathrop and Lillie (1980) incorporates the maximum depth of the lake and the lake's surface area and 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.

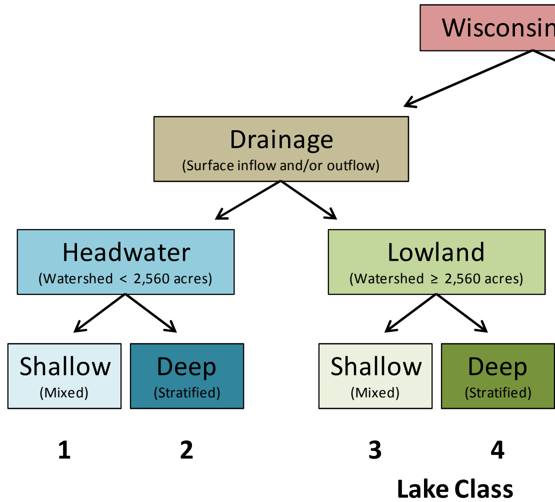


Figure 3.1-1. Wisconsin Lake Classifications. Lower Ninemile Lake is classified as a shallow (mixed), lowland drainage lake (Class 3). Adapted from WDNR PUB-SS-1044 2008.

While Lower Ninemile Lake is classified as a shallow, lowland drainage lake within this classification system, it is technically defined as a flowage or impoundment because it receives greater than 50% of its water volume from a control structure or dam. However, regional and state-wide water quality data sets for impounded waters are not yet available, and impoundments most closely resemble shallow, lowland drainage lakes. The WDNR developed state-wide median values for total phosphorus, chlorophyll-*a*, and Secchi disk transparency for each of the six 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. Lower Ninemile Lake is within the Northern Lakes and Forests ecoregion.

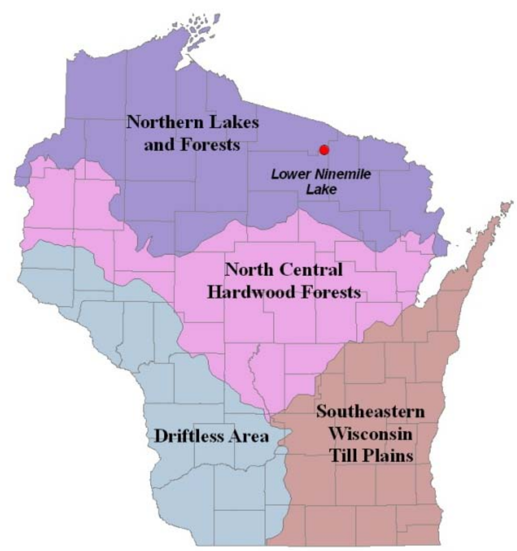


Figure 3.1-2. Location of Lower Ninemile Lake within the ecoregions of Wisconsin. After Nichols 1999.

The Wisconsin 2010 Consolidated Assessment and Listing Methodology (WisCALM), created by the WDNR, is another useful tool in helping lake stakeholders understand the health of their lake compared to others 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, they 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 Lower Ninemile 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.

Lower Ninemile Lake Water Quality Analysis

Lower Ninemile Lake Long-term Trends

The historic water quality data that exists for Lower Ninemile Lake is minimal, so it is impossible to complete a reliable long-term trend analysis. This is unfortunate because having an understanding of how the lake has changed over the years is always interesting and leads to sounder management decisions. It also provides a scientific basis behind anecdotal claims of a lake "getting worse" or "getting better". As part of this study, stakeholders in the Lower Ninemile Lake watershed were asked how they perceived the water quality of the lake to be. Over 74% of the respondents indicated they believed the current water quality of Lower Ninemile Lake was *Fair* or *Good* (Stakeholder Survey, Appendix B, Question #15). About 47% of respondents stated that they believe the water quality has not changed since they first visited the lake, while an equal amount (47%) feel the water quality has degraded either somewhat or severely (Question #16). Water quality degradation ranked third on a list of factors potentially negatively impacting the lake (Question #20).

Water column phosphorus and chlorophyll-*a* concentrations were sampled during 2000-2002, 2010 and 2011 on Lower Ninemile Lake. Average summer total phosphorus concentrations during this time rank mostly as *Excellent*, and a weighted average over all years falls below the median value for other shallow, lowland drainage lakes across the state (Figure 3.1-3). Similarly, chlorophyll-*a* values are low during this time as well (Figure 3.1-4). Average summer values rank as *Excellent*, and a weighted average falls below the median value for similar lakes state-wide.

In 2002, phosphorus and chlorophyll-*a* values, while still low, were slightly elevated from values observed in 2000-2001 and 2010-2011. These slightly higher values are of little concern, as they are fluctuations that can be attributed to differences in environmental variables (precipitation, temperature, etc.) during that year. It is not uncommon to see fluctuations in the water quality of a lake over a period of years, as these ecosystems are heavily influenced by environmental conditions.

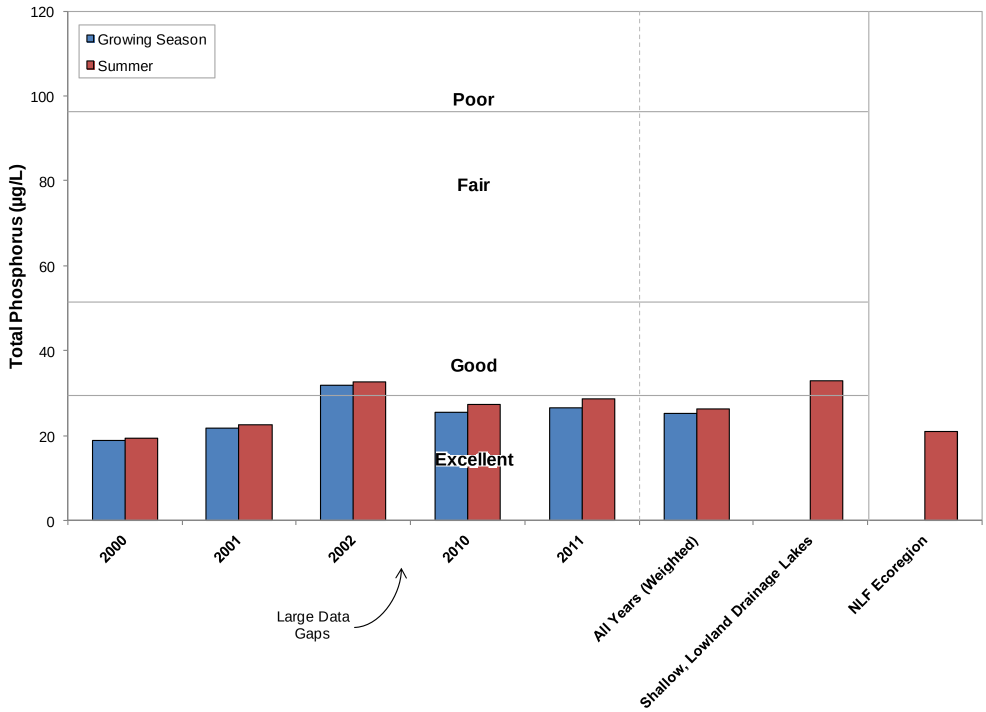


Figure 3.1-3. Lower Ninemile Lake, state-wide class 3 lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

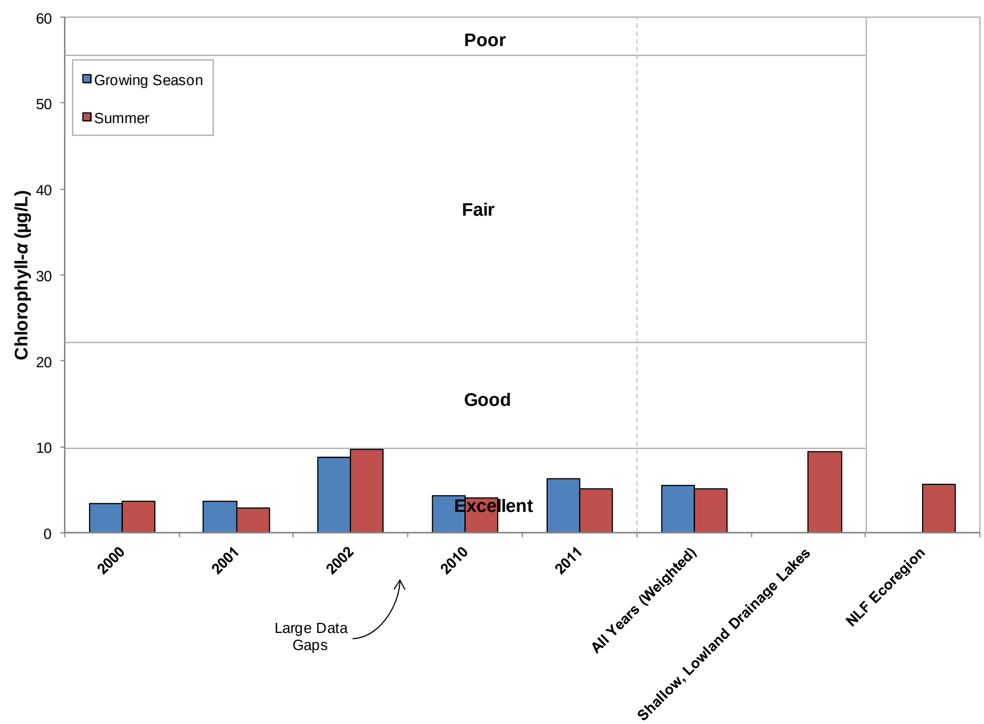


Figure 3.1-4. Lower Ninemile Lake, state-wide class 3 lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Secchi disc depth has been consistently measured between 4.5 and 6.5 feet over the few years in which data has been collected (Figure 3.1-5). These values rank as *Excellent* for shallow, lowland drainage lakes and a weighted average over all years is comparable to the median value for similar lakes statewide.

Flowages and drainage lakes within the Northwoods of Wisconsin may have slightly darker colored water than seepage lakes. This often occurs in situations where the lake has quite a large watershed, and has quite a bit of forested wetlands or wetlands within that watershed. Naturally occurring organic acids, a byproduct of decomposition in these environments, are washed out of the wetlands and into the lake. These dissolved acids, while harmless to humans and aquatic life, stain the water a darker color similar to how ground coffee beans stain hot water in a cup of coffee. The result is that the water in Lower Ninemile Lake has a slightly brown tint to it, and may reduce clarity somewhat from time to time.

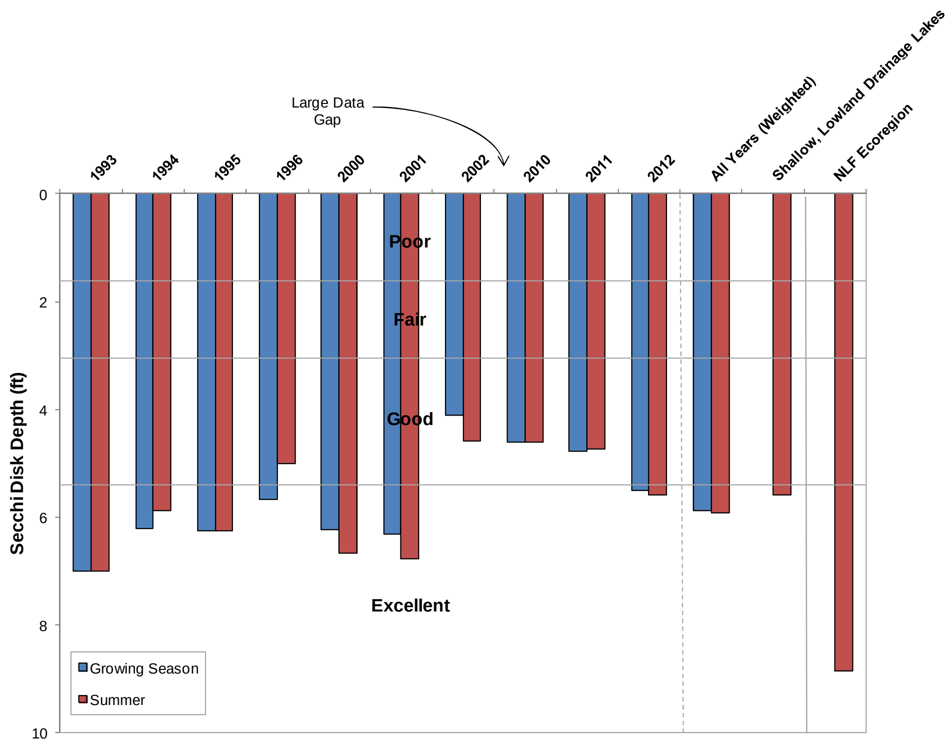


Figure 3.1-5. Lower Ninemile Lake, state-wide class 3 lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Limiting Plant Nutrient of Lower Ninemile Lake

Using midsummer nitrogen and phosphorus concentrations from Lower Ninemile Lake, a nitrogen:phosphorus ratio of 22:1 was calculated. This finding indicates that Lower Ninemile Lake is indeed phosphorus limited as are the vast majority of Wisconsin lakes. In general, this means that cutting phosphorus inputs may limit plant growth within the lake.

Lower Ninemile Lake Trophic State

Figure 3.1-6 contains the Trophic State Index (TSI) values for Lower Ninemile Lake. The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning from lower mesotrophic to lower eutrophic. In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on chlorophyll-*a* TSI values, it can be concluded that Lower Ninemile Lake is in a mesotrophic-eutrophic state. While the majority of chorlophyll-*a* levels fall within the mesotrophic level, much of Lower Ninemile Lake's production is located within the aquatic plant community and not free-floating algae. For this reason, the lake was classified as a mesotrophic-eutrophic system.

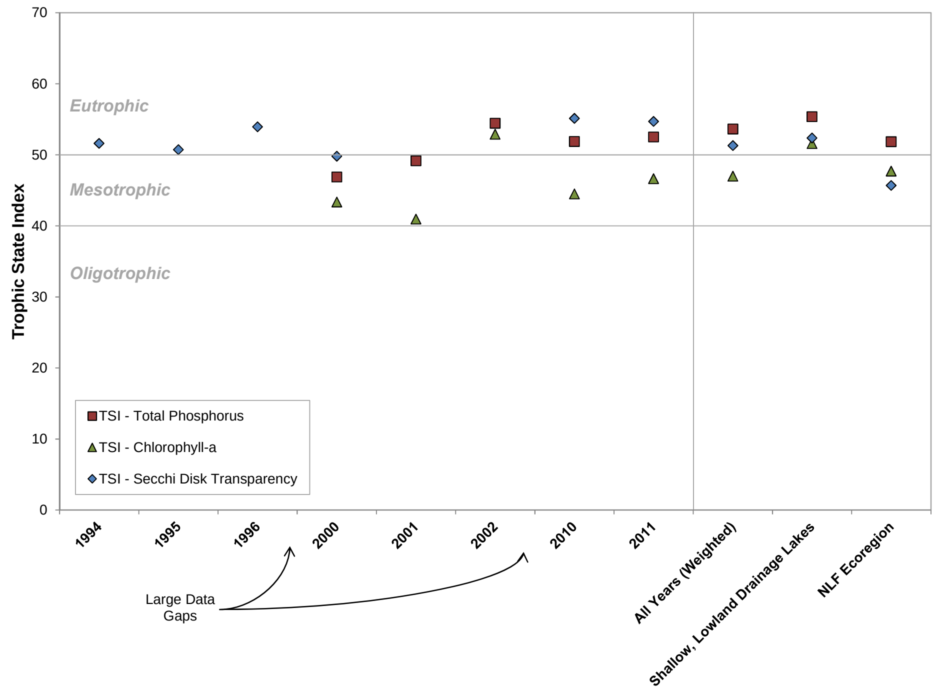


Figure 3.1-6. Lower Ninemile Lake, state-wide class 3 lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Lower Ninemile Lake

Dissolved oxygen and temperature were measured during water quality sampling visits to Lower Ninemile Lake by Onterra staff. Profiles depicting these data are displayed in Figure 3.1-7. Unfortunately, Onterra staff was unable to sample water during the winter months. When the sampling location was visited in 2011, a hole was drilled through the 2 ft. of ice covering the lake, and as soon as the ice hole was completed, the ice auger bit breached the soft bottom sediments of the lake. The ice filled much of the water column, in part due to the lower water levels created through WVIC dam operations but also from the thick ice that formed that winter.

As is expected within a shallow system such as Lower Ninemile Lake, the lake was found to be completely mixed during the entire course of the year in 2011. Dissolved oxygen concentrations were in excess of 10 mg/L during the windy spring and summer months, and were greater than 7 mg/L during the summer months. These levels are more than satisfactory for warm-water aquatic life in Wisconsin.

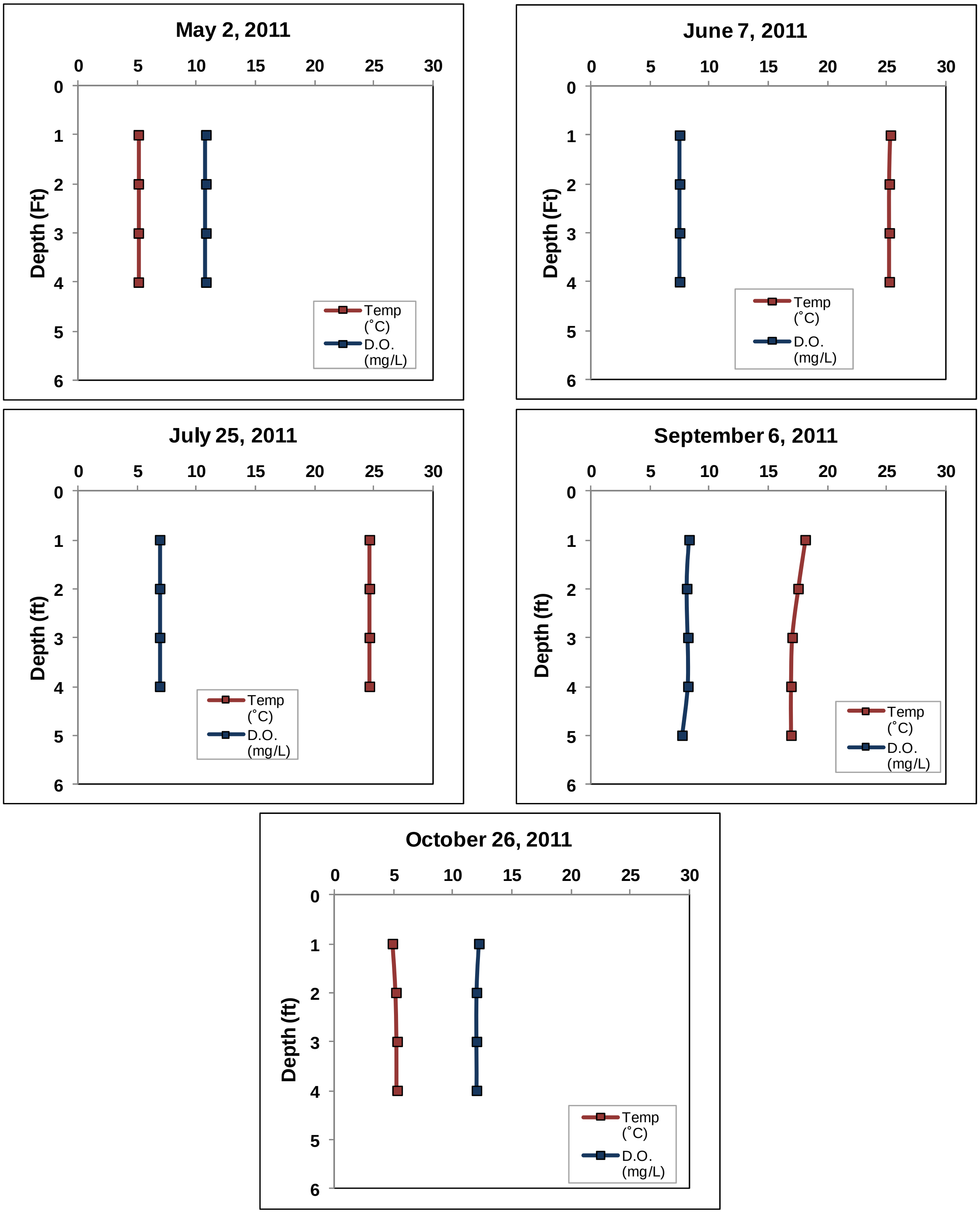


Figure 3.1-7. Lower Ninemile Lake dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected at Lower Ninemile Lake

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

The pH scale ranges from 0 to 14 and indicates the concentration of hydrogen ions (H^+) within the lake's water and is an index of the lake's acidity. Water with a pH value of 7 has equal amounts of hydrogen ions and hydroxide ions (OH^-), and is considered to be neutral. Water with a pH of less than 7 has higher concentrations of hydrogen ions and is considered to be acidic, while values greater than 7 have lower hydrogen ion concentrations and are considered basic or alkaline. The pH scale is logarithmic; meaning that for every 1.0 pH unit the hydrogen ion concentration changes tenfold. The normal range for lake water pH in Wisconsin is about 5.2 to 8.4, though values lower than 5.2 can be observed in some acid bog lakes and higher than 8.4 in some marl lakes. In lakes with a pH of 6.5 and lower, the spawning of certain fish species such as walleye becomes inhibited (Shaw and Nimphius 1985). The pH of the water in Lower Ninemile Lake was found to be near neutral with a value of 7.4, and falls within the normal range for Wisconsin Lakes.

Alkalinity is a lake's capacity to resist fluctuations in pH by neutralizing or buffering against inputs such as acid rain. The main compounds that contribute to a lake's alkalinity in Wisconsin are bicarbonate (HCO_3^-) and carbonate (CO_3^-), which neutralize hydrogen ions from acidic inputs. These compounds are present in a lake if the groundwater entering it comes into contact with minerals such as calcite ($CaCO_3$) and/or dolomite ($CaMgCO_3$). A lake's pH is primarily determined by the amount of alkalinity. Rainwater in northern Wisconsin is slightly acidic naturally due to dissolved carbon dioxide from the atmosphere with a pH of around 5.0. Consequently, lakes with low alkalinity have lower pH due to their inability to buffer against acid inputs. The alkalinity in Lower Ninemile Lake was measured at 25.1 (mg/L as $CaCO_3$), indicating that the lake has a substantial capacity to resist fluctuations in pH and has a low sensitivity to acid rain.

Like associated pH and alkalinity, the concentration of calcium within a lake's water depends on the geology of the lake's watershed. Recently, the combination of calcium concentration and pH has been used to determine what lakes can support zebra mussel populations if they are introduced. The commonly accepted pH range for zebra mussels is 7.0 to 9.0, so Lower Ninemile Lake's pH of 7.4 falls within this range. Lakes with calcium concentrations of less than 12 mg/L are considered to have very low susceptibility to zebra mussel establishment. The calcium concentration of Lower Ninemile Lake was found to be 4.6 mg/L, indicating that Lower Ninemile Lake has a very low susceptibility to zebra mussel establishment if they were ever introduced.

Researchers at the University of Wisconsin - Madison have developed an AIS suitability model called smart prevention (Vander Zanden and Olden 2008). In regards to zebra mussels, this model relies on measured or estimated dissolved calcium concentration to indicate whether a given lake in Wisconsin is suitable, borderline suitable, or unsuitable for sustaining zebra mussels. Within this model, suitability was estimated for approximately 13,000 Wisconsin waterbodies and is displayed as an interactive mapping tool (www.aissmartprevention.wisc.edu). Based upon this analysis, Lower Ninemile Lake was considered not suitable for mussel establishment.

Plankton tows were completed by Onterra staff during the summer of 2011 and these samples were processed by the WDNR for larval zebra mussels. Upon inspection of the samples by WDNR staff, no veligers (larval form of the mussel) were found.

In 1999-2001, several Lower Ninemile Lake residents participated in a United States Geological Survey study which measured the impact of shoreline development on water quality and nutrient yields in nearshore areas of Lower Ninemile Lake as well as several other area lakes. During the study period, water samples were collected from surface runoff and ground water and analyzed for nutrients. These studies were conducted on several developed (lawn covered) and undeveloped (undisturbed forest) areas on each lake.

The study found that nutrient yields were greater from lawns than from forested catchments, and that runoff volumes were the most important factor in determining whether lawns or wooded catchments contributed more nutrients to the lake. Ground-water inputs to the lake were found to be significant in terms of water flow and nutrient input. Nitrate plus nitrite nitrogen and total phosphorus yields to the ground-water system from a lawn catchment were three or sometimes four times greater than those from wooded catchments.

Recommendations from the study include choosing the appropriate landscape position for lawns; in other words, the researchers recommended locating lawns on flat, unsloped areas or in sloped areas that do not terminate at the lake's edge in order to reduce the adverse effect of lawns on the shallow ground water.

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.

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 exceeding 10-15:1, 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 (high residence time, i.e., years), there may be a buildup of phosphorus in the sediments that may reach sufficient levels over time that internal nutrient loading may become a problem. 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 affect 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.

Lower Ninemile Lake Watershed

The Lower Ninemile Lake watershed is quite large; at 18,568 acres, it is approximately 21 times larger than the lake surface area (Map 2). This creates a watershed to lake area ratio of 21:1. As discussed above, this indicates that the size of the watershed likely impacts Lower Ninemile Lake more so than the land cover types within the lake. Much of the watershed (49% or 9,045 acres) consists of wetlands or forested wetlands, while forested land (43% or 7,942 acres) can be found in abundance as well (Figure 3.2-1). The surface area of the lake and pasture/grass land comprise 4% of the watershed each, while medium-density urban and residential areas are found minimally within the watershed.

It is not uncommon for impoundments to have substantial watersheds. Because of this, impoundments also often have higher nutrient loads as well. WiLMS was utilized to calculate the annual phosphorus load for Lower Ninemile Lake, using the land cover data displayed within Figure 3.2-1. WiLMS calculated an annual load of 1,865 lbs per year, a moderate to low number considering Lower Ninemile Lake's large watershed (Figure 3.2-2). The largest land cover type in the watershed, forested wetlands and wetlands, contribute 43% (807 lbs) of this load, while forested lands contribute another 34% (637 lbs). The lake surface collects 12% (225 lbs) of the annual load through atmospheric deposition, and pasture/grass lands contribute the last 11% (196 lbs).

The watershed contains a combined total of 92% forested lands and wetlands, which are ideal land cover types for a lake to have in its watershed. As discussed in the Water Quality Section, forested wetlands and wetlands reduce export of nutrients into a lake ecosystem, however they may produce natural organic acids (sometimes called "tannins") that can stain lake water a root beer color. These acids are harmless, but can reduce the water clarity within a lake.

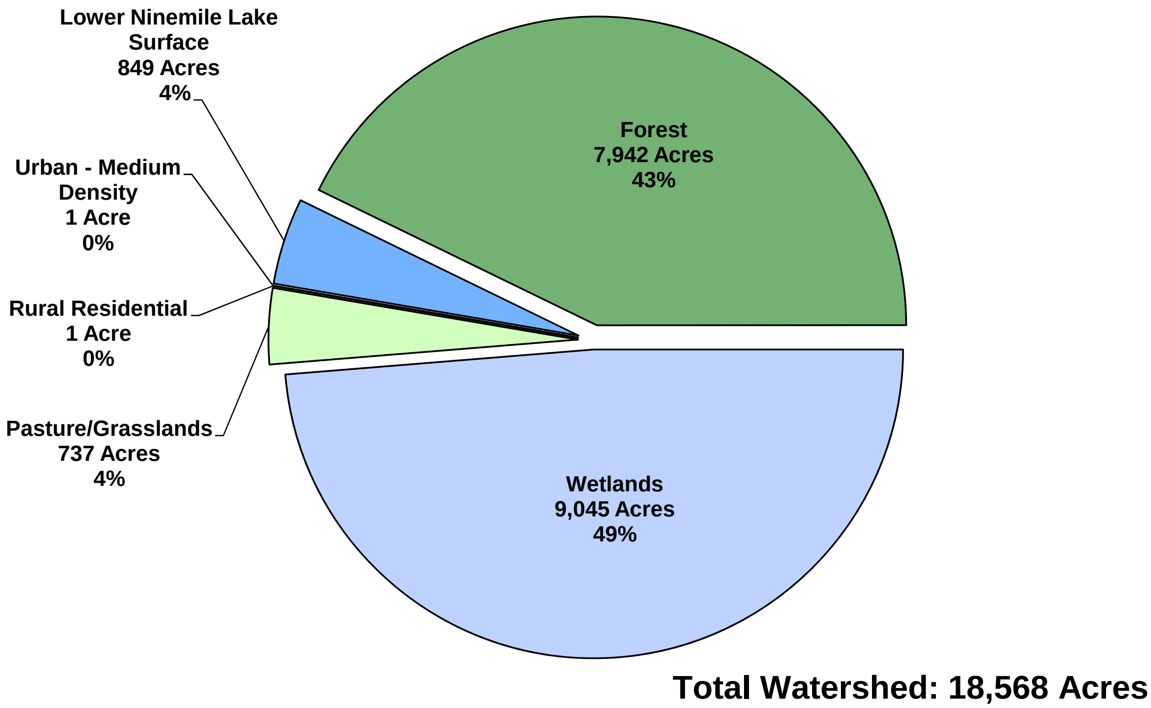


Figure 3.2-1. Lower Ninemile Lake watershed land cover types in acres. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

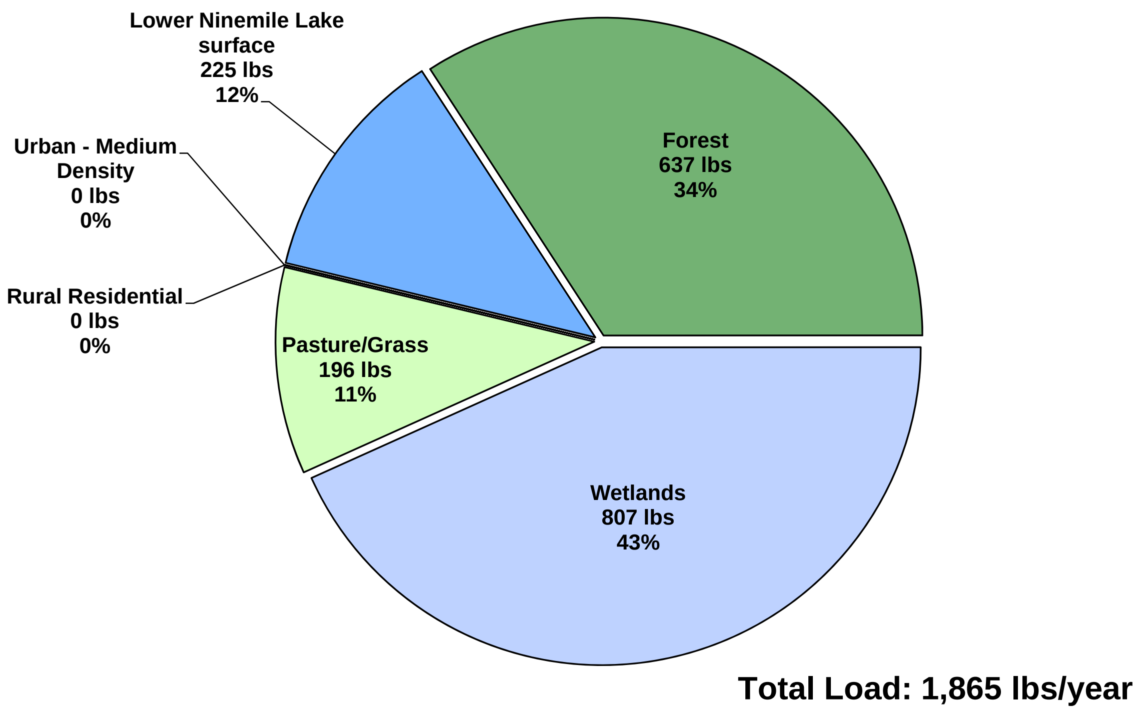


Figure 3.2-2. Lower Ninemile Lake watershed phosphorus loading in pounds. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

3.3 Shoreland Condition Assessment

The Importance of a Lake's Shoreland Zone

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

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

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

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

Shoreland Zone Regulations

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

Wisconsin-NR 115: Wisconsin's Shoreland Protection Program

Wisconsin's shoreland zoning rule, NR 115, sets the minimum standards for shoreland development. First adopted in 1966, the code set a deadline for county adoption of January 1, 1968. By 1971, all counties in Wisconsin had adopted the code and were administering the shoreland ordinances it specified. Interestingly, in 2007 it was noted that many (27) counties had recognized inadequacies within the 1968 ordinance and had actually adopted more strict shoreland ordinances. Passed in February of 2010, the final NR 115 allowed many standards to remain the same, such as lot sizes, shoreland setbacks and buffer sizes. However, several standards changed as a result of efforts to balance public rights to lake use with private property rights. The regulation sets minimum standards for the shoreland zone, and requires all counties in the state to adopt shoreland zoning ordinances of their own. County ordinances may be more restrictive than NR 115, but not less so. These policy regulations require each county to amend ordinances for vegetation removal on shorelands, impervious surface standards, nonconforming structures and establishing mitigation requirements for development. Minimum requirements for each of these categories are as follows (Note: counties must adopt these standards by February 2014, counties may not have these standards in place at this time):

- Vegetation Removal: For the first 35 feet of property (shoreland zone), no vegetation removal is permitted except for: sound forestry practices on larger pieces of land, access and viewing corridors (may not exceed the lesser of 30 percent of the shoreline frontage), invasive species removal, or damaged, diseased, or dying vegetation. Vegetation removed must be replaced by replanting in the same area (native species only).
- Impervious surface standards: The amount of impervious surface is restricted to 15% of the total lot size, on lots that are within 300 feet of the ordinary high-water mark of the waterbody. A county may allow more than 15% impervious surface (but not more than 30%) on a lot provided that the county issues a permit and that an approved mitigation plan is implemented by the property owner.

- Nonconforming structures: Nonconforming structures are structures that were lawfully placed when constructed but do not comply with distance of water setback. Originally, structures within 75 ft of the shoreline had limitations on structural repair and expansion. New language in NR-115 allows construction projects on structures within 75 feet with the following caveats:
    - No expansion or complete reconstruction within 0-35 feet of shoreline
    - Re-construction may occur if no other build-able location exists within 35-75 feet, dependent on the county.
    - Construction may occur if mitigation measures are included either within the footprint or beyond 75 feet.
    - Vertical expansion cannot exceed 35 feet

- Mitigation requirements: New language in NR-115 specifies mitigation techniques that may be incorporated on a property to offset the impacts of impervious surface, replacement of nonconforming structure, or other development projects. Practices such as buffer restorations along the shoreland zone, rain gardens, removal of fire pits, and beaches all may be acceptable mitigation methods, dependent on the county.
- Contact the county's regulations/zoning department for all minimum requirements.

Wisconsin Act 31

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

Shoreland Research

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

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

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

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

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

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

National Lakes Assessment

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

Through the National Lakes Assessment, a number of potential stressors were examined, including nutrient impairment, algal toxins, fish tissue contaminants, physical habitat, and others.

The 2007 NLA report states that "*of the stressors examined, poor lakeshore habitat is the biggest problem in the nations lakes; over one-third exhibit poor shoreline habitat condition*" (USEPA 2009). Furthermore, the report states that "*poor biological health is three times more likely in lakes with poor lakeshore habitat*".

The results indicate that stronger management of shoreline development is absolutely necessary to preserve, protect and restore lakes. This will become increasingly important as development pressure on lakes continues to steadily grow.

Native Species Enhancement

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

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

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

Cost

The cost of native, aquatic, and shoreland plant restorations is highly variable and depends on the size of the restoration area, the depth of buffer zone required to be restored, the existing plant density, the planting density required, the species planted, and the type of planting (e.g. seeds, bare-roots, plugs, live-stakes) being conducted. Other sites may require erosion control stabilization measures, which could be as simple as using erosion control blankets and plants and/or seeds or more extensive techniques such as geotextile bags (vegetated retaining walls), geogrids (vegetated soil lifts), or bio-logs (see above picture). Some of these erosion control techniques may reduce the need for rip-rap or seawalls which are sterile environments that do nott allow for plant growth or natural shorelines. Questions about rip-rap or seawalls should be directed to the local Wisconsin DNR Water Resources Management Specialist. Other measures possibly required include protective measures used to guard newly planted area from wildlife predation, wave-action, and erosion, such as fencing, erosion control matting, and animal deterrent sprays. One of the most important aspects of planting is maintaining moisture levels. This is done by watering regularly for the first two years until plants establish themselves, using soil amendments (i.e., peat, compost) while planting, and using mulch to help retain moisture.

Most restoration work can be completed by the landowner themselves. To decrease costs further, bare-root form of trees and shrubs should be purchased in early spring. If additional assistance is needed, the lakefront property owner could contact an experienced landscaper. For properties with erosion issues, owners should contact their local county conservation office to discuss cost-share options.

- In general, a restoration project with the characteristics described below would have an estimated materials and supplies cost of approximately $1,400. The more native vegetation a site has, the lower the cost. Owner's should contact the county's regulations/zoning department for all minimum requirements. The single site used for the estimate indicated above has the following characteristics:
  - Spring planting timeframe.
  - A 100' of shoreline.
  - An upland buffer zone depth of 35'.
  - An access and viewing corridor 30' x 35' free of planting (recreation area).
  - Planting area of upland buffer zone 2- 35' x 35' areas
  - Site is assumed to need little invasive species removal prior to restoration.
  - Site has only turf grass (no existing trees or shrubs), a moderate slope, sandy-loam soils, and partial shade.
  - Trees and shrubs planted at a density of 1 tree/100 sq ft and 2 shrubs/100 sq ft, therefore, 24 native trees and 48 native shrubs would need to be planted.
  - Turf grass would be removed by hand.
  - A native seed mix is used in bare areas of the upland buffer zone.
  - An aquatic zone with shallow-water 2 - 5' x 35' areas.
  - Plant spacing for the aquatic zone would be 3 feet.

- Each site would need 70' of erosion control fabric to protect plants and sediment near the shoreland (the remainder of the site would be mulched).
- Soil amendment (peat, compost) would be needed during planting.
- There is no hard-armor (rip-rap or seawall) that would need to be removed.
- The property owner would maintain the site for weed control and watering.

Advantages	***Disadvantages***
• Improves the aquatic ecosystem through species diversification and habitat enhancement. • Assists native plant populations to compete with exotic species. • Increases natural aesthetics sought by many lake users. • Decreases sediment and nutrient loads entering the lake from developed properties. • Reduces bottom sediment re-suspension and shoreland erosion. • Lower cost when compared to rip-rap and seawalls. • Restoration projects can be completed in phases to spread out costs. • Once native plants are established, they require less water, maintenance, no fertilizer; provide wildlife food and habitat, and natural aesthetics compared to ornamental (non-native) varieties. • Many educational and volunteer opportunities are available with each project.	• Property owners need to be educated on the benefits of native plant restoration before they are willing to participate. • Stakeholders must be willing to wait 3-4 years for restoration areas to mature and fill-in. • Monitoring and maintenance are required to assure that newly planted areas will thrive. • Harsh environmental conditions (e.g., drought, intense storms) may partially or completely destroy project plantings before they become well established.

Lower Ninemile Lake Shoreland Zone Condition

Shoreland Development

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

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

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

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

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

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

Figure 3.3-1. Shoreline assessment category descriptions.

On Lower Ninemile Lake, the development stage of the entire shoreline was surveyed during late summer 2011, using a GPS unit to map the shoreline. 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 areas of the shoreland one of the five descriptive categories in Figure 3.3-2.

Lower Ninemile Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 9.4 miles of natural/undeveloped and developed-natural shoreline (89%) were observed during the survey (Figure 3.3-2). 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, only 0.4 miles (4%) of urbanized and developed–unnatural shoreline were observed. If restoration of the Lower Ninemile 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. Map 3 displays the location of these shoreline lengths around the entire lake.

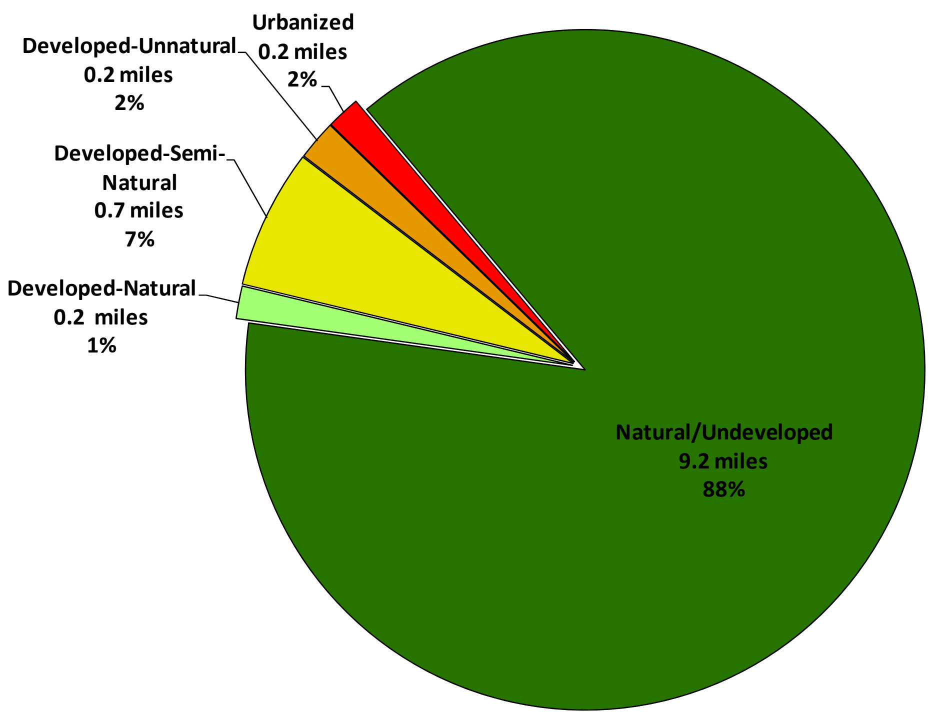


Figure 3.3-2. Lower Ninemile Lake shoreland categories and total lengths. Based upon a late summer 2011survey. Locations of these categorized shorelands can be found on Map 3.

Nicolet National Forest Bird Survey

Initiated due to the lack of information about breeding birds in northern Wisconsin, the Nicolet National Forest (NNF) Bird Survey program was initiated in 1987 by the US Forest Service, scientists from UW-Green Bay, and members of the Northeastern Wisconsin Audubon Society. The NNF Bird Survey takes place each year during the second weekend in June in which trained volunteers tally the number and species of birds observed and/or heard each during a morning (sunrise to 9:00 a.m.) sampling period. Currently, this program is the longest running volunteer-based bird monitoring program in the U.S. national forest.

This quantitative data has provided useful in understanding the species assemblages of these areas along with allowing for comparisons to be made between habitat types, land use, and human development factors (Howe and Roberts 2005). The data from these surveys have contributed to more than 11 Master's theses, 2 Ph.D. theses, and 15 peer-reviewed scientific publications. More information on the NNF Bird Survey can be found at www.uwgb.edu/birds/nnf/.

Three locations on Lower Ninemile Lake have been monitored every-other year since 1990 through the NNF Bird Survey (Figure 3.3-3). The bird survey data from Lower Ninemile Lake are pooled with other locations that represent lake and/or cattail marsh habitat. Table 3.3-1 shows the bird species found from the three locations (added together) during the NNF Bird Surveys since 1990.

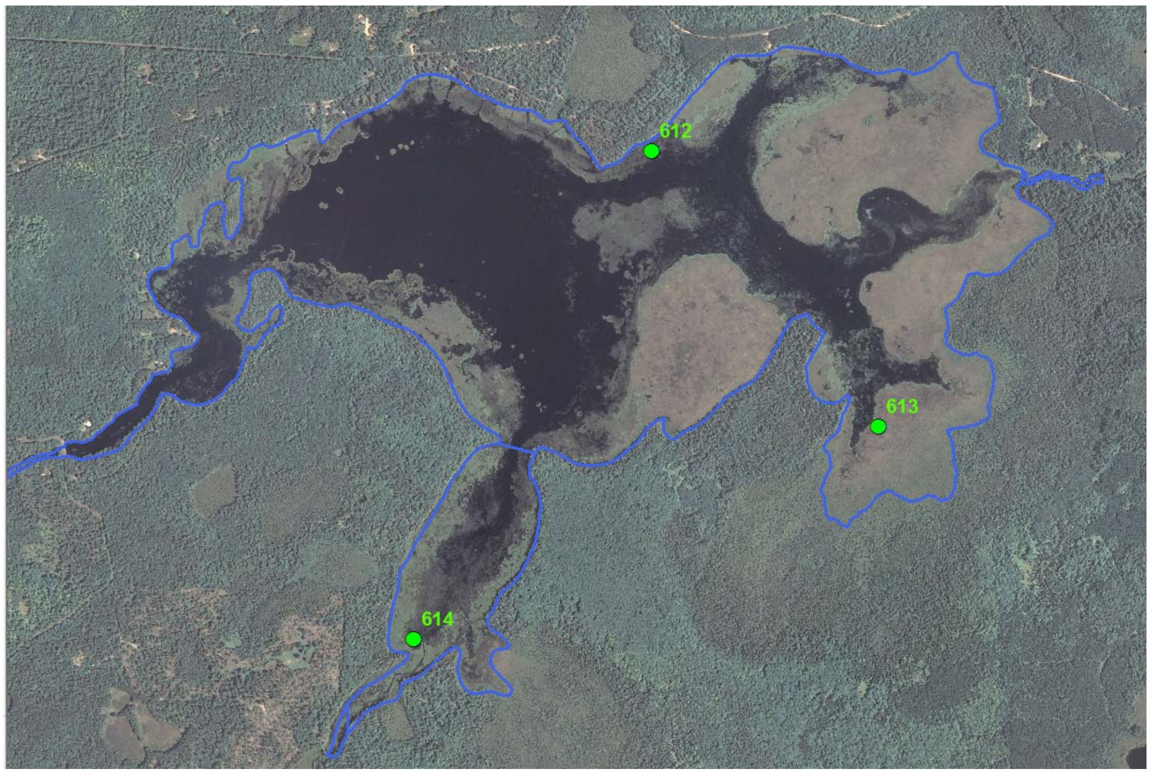


Figure 3.3-3. NNF Bird Survey Locations on Lower Ninemile Lake.

Table 3.3-1. Bird species located in Lower Ninemile Lake during NNF Bird Surveys

Species Name	1990	1992	1994	1996	1998	2002	2004	2006	2008	2010	2012
Alder Flycatcher					1			3			1
American Bittern		1		1	2			2	3		
American Crow		4	3	1	3		1	6	3	5	2
American Goldfinch		1	1								
American Redstart			1				1	2	1	1	1
American Robin		1	1	1				1	2		
Bald Eagle	2			1			1				
Belted Kingfisher		1				2			1		
Black-and-white Warbler	2	1		3		1		1		3	
Black-capped Chickadee		1		2				1	2	1	
Black-throated Green Warbler						1		1			1
Blue Jay	1	2	2	2			2	2	1	1	1
Blue-headed (Solitary) Vireo				1		1					
Blue-winged Teal											1
Boreal Chickadee				1							
Canada Goose										8	
Canada Warbler							1		1		
Cedar Waxwing									5		
Chestnut-sided Warbler	1	1		1			1		1	2	1
Chipping Sparrow										1	
Common Grackle								2		1	
Common Loon	2	1		2	3			1	3	2	
Common Raven			2								
Common Yellowthroat	1	2	2	5	1	4	1	7	3	2	4
Double-crested Cormorant									1		1
Eastern (Rufous-sided) Towhee			1								
Eastern Kingbird		1		1	2	1	1		1	1	
Eastern Phoebe		1	1								
Golden-crowned Kinglet						1					
Golden-winged Warbler			1								
Great Blue Heron		1		1							
Great-crested Flycatcher		1	1								
Hermit Thrush		1						1			4
Hooded Merganser					3						
Lincoln's Sparrow						1					
Magnolia Warbler						1					
Mallard	4	4			2		10	2	7	2	
Marsh Wren		1									

Table continued on following page

Continued from previous page

Species Name	1990	1992	1994	1996	1998	2002	2004	2006	2008	2010	2012
Mourning Dove								3	1		1
Nashville Warbler	1							3		1	3
Northern Flicker		3									
Northern Parula	1	1	1	1	1	1		1		2	3
Northern Rough-winged Swallow		1									
Northern Waterthrush					1						
Olive-sided Flycatcher	1										1
Osprey						3					
Ovenbird				3	1	2	1	1		1	1
Pied-billed Grebe		1	1								1
Pileated Woodpecker			1		1			1		1	
Pine Warbler				1					1		1
Red-breasted Nuthatch		2						1	1	1	3
Red-eyed Vireo	2	3	2	3	2	2	2	4	2	4	4
Red-winged Blackbird	11	8	10	4	7	8	2	11	10	5	7
Ring-necked Duck	5						3		1	2	
Rose-breasted Grosbeak		2									1
Ruby-crowned Kinglet					1						
Sandhill Crane					1				1		
Scarlet Tanager			1			1					
Sedge Wren		1	1						2		1
Song Sparrow	3	2	1	3	1	1	2	4	3	4	5
Sora					2	1					
Swamp Sparrow	2	4	2	2	1	3	5	7	1	6	2
Tree Swallow	1	2	3		3		1	3	5	1	2
Trumpeter Swan										2	1
Unidentified Duck	1								1		
Unidentified Swallow										2	
Veery		1			1						
Virginia Rail						1		1			
White-throated Sparrow	1	1	2	2			1	4	1	1	2
Wilson's (Common) Snipe		1	2	2	3		2	3			
Winter Wren		1						1		1	3
Wood Duck	2	1			1				1	4	
Yellow Warbler	1		3	1	1						
Yellow-bellied Flycatcher								1		1	
Yellow-bellied Sapsucker			1	1						1	
Yellow-rumped (Myrtle) Warbler				1		1		1			1

Trumpeter swans have been located from Lower Ninemile Lakes during the NNF Bird Survey in 2010 and 2012. These birds have been brought back from near-extinction since the 1880s, where market hunting and demand for their beautiful feathers greatly reduced their populations. Since they were put on the Wisconsin endangered species list in 1987, their population growth has exceeded expectations with nearly 200 nesting pairs being found in 23 counties. This success has taken them off the state endangered species list (WDNR 2013).

Trumpeter swans arrive at their Wisconsin breeding grounds each year just after the ice comes off the lakes. While trumpeter swan pairs have been observed on Lower Ninemile Lake at this time of year, they have not been known to nest at this location. Paired for life, it is believed that these trumpeter swans nest on Upper Ninemile Lake and feed on Lower Ninemile and other nearby lakes. While young trumpeter swans (cygnets) feed on aquatic invertebrates, the diet of adult trumpeter swans primarily consists of aquatic vegetation.

3.4 Aquatic Plants

Introduction

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

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

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

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

Aquatic Plant Management and Protection

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

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

Permits

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

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

Manual Removal

Manual removal methods include hand-pulling, raking, and hand-cutting. Hand-pulling involves the manual removal of whole plants, including roots, from the area of concern and disposing them out of the waterbody. Raking entails the removal of partial and whole plants from the lake by dragging a rake with a rope tied to it through plant beds. Specially designed rakes are available from commercial sources or an asphalt rake can be used. Hand-cutting differs from the other two manual methods because the entire plant is not removed, rather the plants are cut similar to mowing a lawn; however Wisconsin law states that all plant fragments must be removed. One manual cutting technique involves throwing a specialized "V" shaped cutter into the plant bed and retrieving it with a rope. The raking method entails the use of a two-sided straight blade on a telescoping pole that is swiped back and forth at the base of the undesired plants.

In addition to the hand-cutting methods described above, powered cutters are now available for mounting on boats. Some are mounted in a similar fashion to electric trolling motors and offer a 4-foot cutting width, while larger models require complicated mounting procedures, but offer an 8-foot cutting width. Please note that the use of powered cutters may require a mechanical harvesting permit to be issued by the WDNR.

When using the methods outlined above, it is very important to remove all plant fragments from the lake to prevent re-rooting and drifting onshore followed by decomposition. It is also important to preserve fish spawning habitat by timing the treatment activities after spawning. In Wisconsin, a general rule would be to not start these activities until after June 15th.

Cost

Commercially available hand-cutters and rakes range in cost from \$85 to \$150. Power-cutters range in cost from \$1,200 to \$11,000.

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

Bottom Screens

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

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

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

Water Level Drawdown

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

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

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

Mechanical Harvesting

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

Cost

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

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

Herbicide Treatment

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

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

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

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

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

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

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

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

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

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

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

Cost

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

Advantages	***Disadvantages***
• Herbicides are easily applied in restricted areas, like around docks and boatlifts. • Herbicides can target large areas all at once. • If certain chemicals are applied at the correct dosages and at the right time of year, they can selectively control certain invasive species, such as Eurasian water-milfoil. • Some herbicides can be used effectively in spot treatments. • Most herbicides are designed to target plant physiology and in general, have low toxicological effects on non-plant organisms (e.g. mammals, insects)	• All herbicide use carries some degree of human health and ecological risk due to toxicity. • Fast-acting herbicides may cause fishkills due to rapid plant decomposition if not applied correctly. • Many people adamantly object to the use of herbicides in the aquatic environment; therefore, all stakeholders should be included in the decision to use them. • Many aquatic herbicides are nonselective. • Some herbicides have a combination of use restrictions that must be followed after their application. • Overuse of same herbicide may lead to plant resistance to that herbicide.

Biological Controls

There are many insects, fish and pathogens within the United States that are used as biological controls for aquatic macrophytes. For instance, the herbivorous grass carp has been used for years in many states to control aquatic plants with some success and some failures. However, it is illegal to possess grass carp within Wisconsin because their use can create problems worse than the plants that they were used to control. Other states have also used insects to battle invasive plants, such as water hyacinth weevils (*Neochetina spp.*) and hydrilla stem weevil (*Bagous spp.*) to control water hyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata)*, respectively. Fortunately, it is assumed that Wisconsin's climate is a bit harsh for these two invasive plants, so there is no need for either biocontrol insect.

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

Cost

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

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

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

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

Cost

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

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

Analysis of Current Aquatic Plant Data

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

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

Primer on Data Analysis & Data Interpretation

Species List

The species list is simply a list of all of the species that were found within the lake, both exotic and native. The list also contains the life-form of each plant found, its scientific 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 life-forms that are present, can be an early indicator of changes in the health of the lake ecosystem.

Frequency of Occurrence

Frequency of occurrence describes how often a certain 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 comprehensive point-intercept surveys conducted in 2011 on Lower Ninemile Lake, plant samples were collected from plots laid out on a grid that covered the entire system (Map 1). Using the data collected from these plots, an estimate of occurrence of each plant species can be determined. In this section, two types of data are displayed: littoral frequency of occurrence and relative frequency of occurrence. Littoral frequency of occurrence is used to describe how often each species occurred in the plots that are less than the maximum depth of plant growth (littoral zone). Littoral frequency is displayed as a percentage.

Relative frequency of occurrence uses the littoral frequency for occurrence for each species compared to the sum of the littoral frequency of occurrence from all species. These values are presented in percentages and if all of the values were added up, they would equal 100%. For example, if water lily had a relative frequency of 0.1 and we described that value as a percentage, it would mean that water lily made up 10% of the population.

In the end, this analysis indicates the species that dominate the plant community within the lake. Shifts in dominant plants over time may indicate disturbances in the ecosystem. For instance, low water levels over several years may increase the occurrence of emergent species while decreasing the occurrence of floating-leaf species. Introductions of invasive exotic species may result in major shifts as they crowd out native plants within the system.

Species Diversity and Richness

Species diversity is probably the most misused value in ecology because it is often confused with species richness. Species richness is simply the number of species found within a system or community. Although these values are related, they are far from the same because diversity also takes into account how evenly the species occur within the system. A lake with 25 species may not be more diverse than a lake with 10 if the first lake is highly dominated by one or two species and the second lake has a more even distribution.

A lake with high species diversity is much more stable than a lake with a low diversity. This is analogous to a diverse financial portfolio in that a diverse lake plant community can withstand environmental fluctuations much like a diverse portfolio can handle economic fluctuations. For example, a lake with a diverse plant community is much better suited to compete against exotic infestation than a lake with a lower diversity.

Simpson's diversity index is used to determine this diversity in a lake ecosystem. Simpson's diversity (1-D) is calculated as:

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

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

Box Plot or box-and-whisker diagram graphically shows data through five-number summaries: minimum, lower quartile, median, upper quartile, and maximum. Just as the median divides the data into upper and lower halves, quartiles further divide the data by calculating the median of each half of the dataset.

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. Between 2005 and 2009, WDNR Science Services conducted point-intercept surveys on 252 lakes within the state. In the absence of comparative data from Nichols (1999), the Simpson's Diversity Index values of the lakes within the WDNR Science Services dataset will be compared to Lower Ninemile Lake. Comparisons will be displayed using boxplots that showing median values and upper/lower quartiles of lakes in the same ecoregion (Water Quality section, Figure 3.1-2) and in the state. Please note for this parameter, the Northern Lakes and Forests Ecoregion data includes both natural and flowage lakes.

As previously stated, species diversity is not the same as species richness. One factor that influences species richness is the "development factor" of the shoreline. This is not the degree of human development or disturbance, but rather it is a value that attempts to describe the nature of the habitat a particular shoreline may hold. This value is referred to as the shoreline complexity.

It specifically analyzes the characteristics of the shoreline and describes to what degree the lake shape deviates from a perfect circle. It is calculated as the ratio of lake perimeter to the circumference of a circle of area equal to that of the lake. A shoreline complexity value of 1.0 would indicate that the lake is a perfect circle. The further away the value gets from 1.0, the more the lake deviates from a perfect circle. As shoreline complexity increases, species richness increases, mainly because there are more habitat types, bays and back water areas sheltered from wind.

Floristic Quality Assessment

Floristic Quality Assessment (FQA) is used to evaluate the closeness of a lake's aquatic plant community to that of an undisturbed, or pristine, lake. The higher the floristic quality, the closer a lake is to an undisturbed system. FQA is an excellent tool for comparing individual lakes and the same lake over time. In this section, the floristic quality of Lower Ninemile Lake will be compared to lakes in the same ecoregion and in the state (Figure 3.4-1).

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.

The floristic quality of a lake is calculated using its species richness and average species conservatism. As mentioned above, species richness is simply the number of species that occur in the lake, for this analysis, only native species are utilized. Average species conservatism utilizes the coefficient of conservatism values for each of those species in its calculation. A species coefficient of conservatism value indicates that species likelihood of being found in an undisturbed (pristine) system. The values range from one to ten. Species that are normally found in disturbed systems have lower coefficients, while species frequently found in pristine systems have higher values. For example, cattail, an invasive native species, has a value of 1, while common hard and softstem bulrush have values of 5, and Oakes pondweed, a sensitive and rare species, has a value of 10. 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 survey and does not include incidental species or those encountered during other aquatic plan surveys.

Community Mapping

A key component of the aquatic plant survey is the creation of an aquatic plant community map. The map represents a snapshot of the important plant communities in the lake as they existed during the survey and is valuable in the development of the management plan and in comparisons with surveys completed in the future. A mapped community can consist of submergent, floating-leaf, or emergent plants, or a combination of these life-forms. Examples of submergent plants include wild celery and pondweeds; while emergents include cattails, bulrushes, and arrowheads, and floating-leaf species include white and yellow pond lilies. Emergents and floating-leaf communities lend themselves well to mapping because there are distinct boundaries between communities. Submergent species are often mixed throughout large areas of the lake and are seldom visible from the surface; therefore, mapping of submergent communities is more difficult and often impossible.

Exotic Plants

Because of their tendency to upset the natural balance of an aquatic ecosystem, exotic species are paid particular attention to during the aquatic plant surveys. Two exotics, curly-leaf pondweed and Eurasian water milfoil are the primary targets of this extra attention.

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

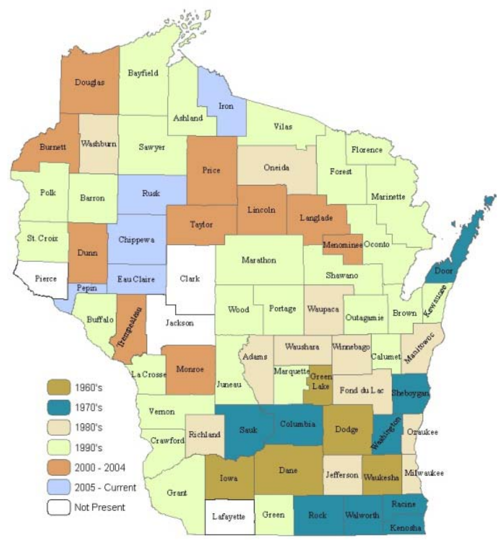


Figure 3.4-1. Spread of Eurasian water milfoil within WI counties. WDNR Data 2011 mapped by Onterra.

Curly-leaf pondweed is a European exotic first discovered in Wisconsin in the early 1900's that has an unconventional lifecycle giving it a competitive advantage over our native plants. Curly –leaf pondweed begins growing almost immediately after ice-out and by mid-June is at peak biomass. While it is growing, each plant produces many turions (asexual reproductive shoots) along its stem. By mid-July most of the plants have senesced, or died-back, leaving the turions in the sediment. The turions lie dormant until fall when they germinate to produce winter foliage, which thrives under the winter snow and ice. It remains in this state until spring foliage is produced in early May, giving the plant a significant jump on native vegetation. Like Eurasian water-milfoil, curly-leaf pondweed can become so abundant that it hampers recreational activities within the lake. Furthermore, its mid-summer die back can cause algal blooms spurred from the nutrients released during the plant's decomposition.

Because of its odd life-cycle, a special survey is conducted early in the growing season to inventory and map curly-leaf pondweed occurrence within the lake. Although Eurasian water milfoil starts to grow earlier than our native plants, it is at peak biomass during most of the summer, so it is inventoried during the comprehensive aquatic plant survey completed in mid to late summer.

Aquatic Plant Survey Results

As mentioned above, numerous plant surveys were completed as a part of this project. On June 22, 2011, a survey was completed on Lower Ninemile Lake that focused upon curly-leaf pondweed. This meander-based survey did not locate any occurrences of curly-leaf pondweed. It is believed that this aquatic invasive species either does not occur in Lower Ninemile Lake or exists at an undetectable level.

On July 28, 2011, two crews visited Lower Ninemile Lake to conduct the comprehensive aquatic plant point-intercept survey. Due to the non-navigability of certain areas because of dense growth of emergent and floating-leaf aquatic vegetation, only 317 of the 603 point-intercept locations in this grid-based survey were sampled. Additionally, vast areas of the central/eastern part of Lower Ninemile Lake are covered by emergent wet meadow communities. These areas are dominated by sedge species (*Carex spp.*) but also include some aquatic/wetland species such as cattails, spikerushes, etc. While this survey was being conducted, an additional crew completed the emergent and floating-leaf plant community mapping survey by delineating the locations of emergent and floating-leaf species on the lake.

During the point-intercept and aquatic plant mapping surveys, 49 species of plants were located in Lower Ninemile Lake (Table 3.4-1). Twenty-nine of these species were documented on the rake during the point-intercept survey, while 20 species were observed either during the community mapping survey or incidentally during the point-intercept survey. No aquatic invasive plant species were located during any of the surveys that took place on Lower Ninemile Lake in 2011.

Table 3.4-1 also displays the aquatic plant species recorded during a point-intercept survey conducted in 2007 by Northern Environmental (now Stantec) as part of a baseline limnological study and aquatic plant management plan. The species lists indicate that all of the species located in the 2007 survey, except for spiny hornwort, water stargrass, and crested arrowhead, were located again in 2011. Both spiny hornwort and water stargrass were found in very low abundance in 2007, so it is likely they are still present in Lower Ninemile Lake but were not detected in 2011. Crested arrowhead forms small sterile, submersed rosettes that are often difficult to identify to the species level; this species was likely recorded as *arrowhead rosette* in the 2011 survey. Twelve aquatic plant species not recorded in the 2007 survey (not including emergent incidental species) were located during the 2011 survey (Table 3.4-1).

Table 3.4-1. Aquatic plant species located in Lower Ninemile Lake during Northern Environmental 2007 and Onterra 2011 aquatic plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (C)	2007 (Northern Env.)	2011 (Onterra)
Emergent	*Carex aquatilis*	Water sedge	7		I
	Carex bebbii	Bebb's oval sedge	4		I
	Carex comosa	Bristly sedge	5		I
	Carex crinita	Fringed sedge	6		I
	Carex lasiocarpa	Wooly-fruit sedge	9		I
	Carex utriculata	Yellow lake sedge	7		I
	Decodon verticillatus	Water-willow	7		I
	Dulichium arundinaceum	Three-way sedge	9		I
	Eleocharis erythropoda	Bald spike-rush	3		I
	Eleocharis palustris	Creeping spikerush	6		I
	Equisetum fluviatile	Water horsetail	7		I
	Glyceria canadensis	Rattlesnake grass	7		I
	Iris versicolor	Northern blue flag	5		I
	Sagittaria latifolia	Common arrowhead	3		I
	Schoenoplectus tabernaemontani	Softstem bulrush	4		I
	Scirpus cyperinus	Wool grass	4		I
	Typha spp.	Cattail spp.	1		X
	Zizania palustris	Northern wild rice	8	X	X
FL	*Nuphar variegata*	Spatterdock	6	X	X
	Nymphaea odorata	White water lily	6	X	X
FL/E	*Sparganium emersum*	Short-stemmed bur-reed	8		I
	Sparganium fluctuans	Floating-leaf bur-reed	10	X	X
Submergent	*Bidens beckii*	Water marigold	8	X	X
	Ceratophyllum demersum	Coontail	3	X	X
	Ceratophyllum echinatum	Spiny hornwort	10	X	
	Chara spp.	Muskgrasses	7	X	X
	Elodea canadensis	Common waterweed	3	X	X
	Elodea nuttallii	Slender waterweed	7		X
	Heteranthera dubia	Water stargrass	6	X	
	Myriophyllum sibiricum	Northern water milfoil	7	X	X
	Myriophyllum verticillatum	Whorled water milfoil	8		X
	Najas flexilis	Slender naiad	6	X	X
	Nitella spp.	Stoneworts	7	X	X
	Potamogeton amplifolius	Large-leaf pondweed	7	X	X
	Potamogeton epihydrus	Ribbon-leaf pondweed	8		X
	Potamogeton foliosus	Leafy pondweed	6		I
	Potamogeton gramineus	Variable pondweed	7	X	X
	Potamogeton natans	Floating-leaf pondweed	5	X	I
	Potamogeton obtusifolius	Blunt-leaf pondweed	9		I
	Potamogeton pusillus	Small pondweed	7	X	X
	Potamogeton richardsonii	Clasping-leaf pondweed	5	X	X
	Potamogeton robbinsii	Fern pondweed	8	X	X
	Potamogeton spirillus	Spiral-fruited pondweed	8		X
	Potamogeton zosteriformis	Flat-stem pondweed	6	X	X
	Sagitaria sp. (rosette)	Arrowhead rosette	N/A		X
	Utricularia intermedia	Flat-leaf bladderwort	9		X
	Utricularia vulgaris	Common bladderwort	7	X	X
	Vallisneria americana	Wild celery	6	X	X
S/E	*Eleocharis acicularis*	Needle spikerush	5		X
	Sagittaria cristata	Crested arrowhead	9	X	
	Sagittaria cuneata	Arum-leaved arrowhead	7		X
	Sagittaria graminea	Grass-leaved arrowhead	9		X

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

The sediment within Lower Ninemile Lake is very conducive for supporting aquatic plant growth. Data from the 2011 point-intercept survey indicates that 97% of the sampling locations contained fine organic sediment (muck) while the remaining 3% were sand (Figure 3.4-2).

Approximately 75% of the point-intercept locations that fell within the maximum depth of aquatic plant growth (6 feet), or the littoral zone, contained aquatic vegetation. Map 5 indicates the entire area of Lower Ninemile Lake supports aquatic plant growth. As discussed in the water quality section, the water clarity in Lower Ninemile Lake is quite good which allows sunlight penetration throughout the entire water column within the lake. Figure 3.3-3 shows that the majority of the aquatic vegetation in Lower Ninemile Lake grows at a depth of five to six feet, though vegetation is abundant at all depths.

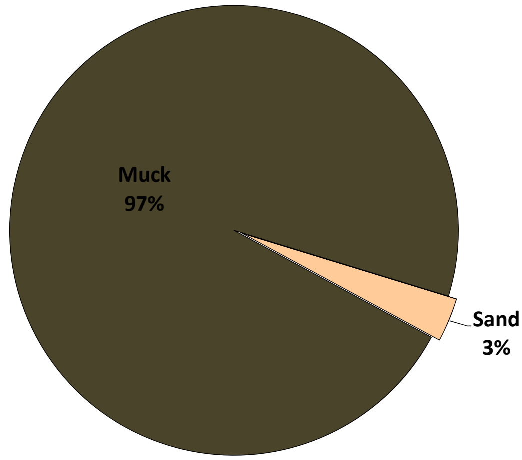


Figure 3.4-2. Lower Ninemile Lake proportion of substrate types within littoral areas. Created using data from July 2011 aquatic plant point-intercept survey (Map 4).

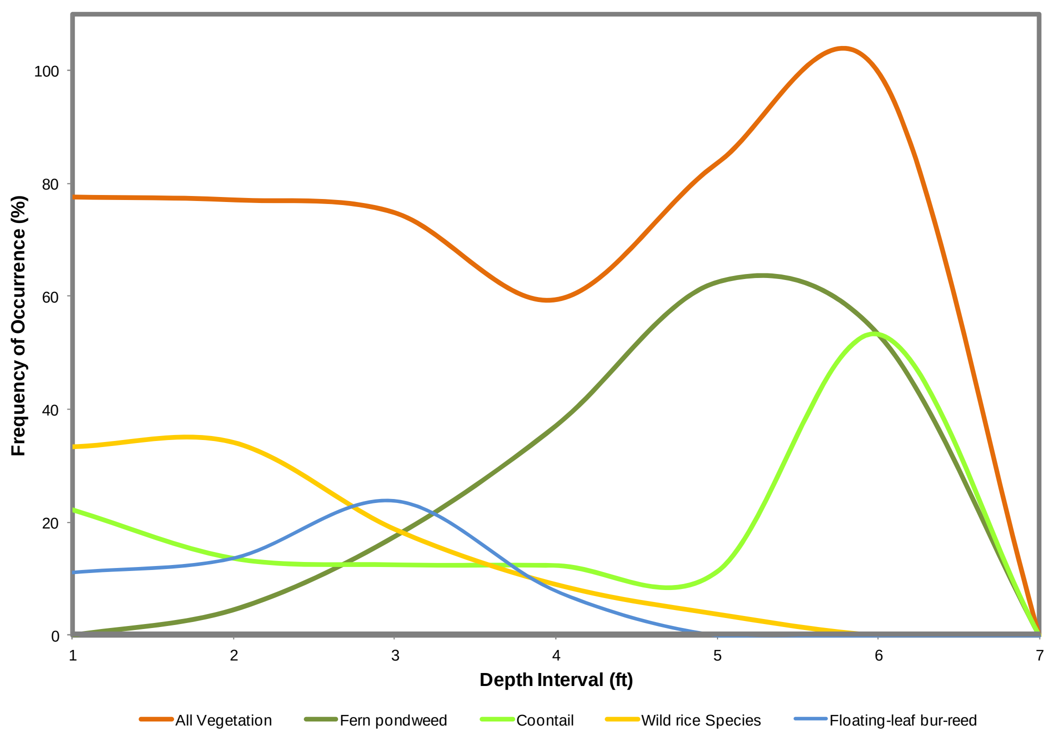


Figure 3.4-3. Frequency of occurrence at littoral depths for several Lower Ninemile Lake plant species. Created using data from July 2011 aquatic plant point-intercept survey.

Eurasian water milfoil (*Myriophyllum spicatum*), a common aquatic invasive plant in Wisconsin, was not found within Lower Ninemile Lake. However, two native milfoil species, northern water milfoil (*Myriophyllum sibiricum*) and whorled water milfoil (*Myriophyllum verticillatum*) were located in Lower Ninemile Lake in 2011. These two species may closely resemble

Eurasian water milfoil, especially since they may take on a reddish appearance as they react to sun exposure throughout the summer. But certain morphological features, chiefly the number of leaflets per leaf, differentiate these species from Eurasian water milfoil.

During the 2011 point-intercept survey on Lower Ninemile Lake, fern pondweed (*Potamogeton robbinsii*), coontail or hornwort (*Ceratophyllum demersum*), northern wild rice (*Zizania palustris*) and floating-leaf bur-reed (*Sparganium fluctuans*) were the most frequently encountered aquatic plant species (Figure 3.4-4). Fern pondweed is a low-growing plant that was likely named after its palm-frond or fern-like appearance. This plant is known to provide habitat for smaller aquatic animals that are used as food by larger, predatory fishes. Coontail, able to obtain the majority of its essential nutrients directly from the water, does not produce extensive root systems making it susceptible to uprooting by wave-action and water movement. When this occurs, uprooted plants may float and aggregate on the water's surface where they can continue to grow and form dense mats. The stiff, whorled leaves of coontail provide excellent structural habitat for aquatic invertebrates and fish.

Northern wild rice, the third most common plant on Lower Ninemile Lake, is an emergent aquatic grass that grows in shallow water of lakes and slow-moving rivers. Because of its presence in Lower Ninemile Lake and voiced concern by lake residents over what is perceived to be the spread of this species, northern wild rice is discussed in depth towards the end of the Aquatic Plant Section. The fourth most commonly occurring species in Lower Ninemile Lake, floating-leaf bur-reed, is an aquatic plant which includes long (2.5 to 5 ft) stems and long (2 to 3.25 ft) linear, ribbon-like leaves. Several species of bur-reed exist in Wisconsin, and while some differences exist in the leaves of these plants, the best way to differentiate between them is by the characteristics of their fruits. Floating-leaf bur-reed shares a similar habitat to northern wild rice. When northern wild rice is in its intermediate growth stage, stretching out along the surface of the water as opposed to emerging out of the water vertically as it does late in its growth period, it can easily be mistaken for floating-leaf bur-reed, and vice versa. Northern wild rice often has a narrower, light green colored stalk and leaf while floating-leaf bur-reed will have a thicker leaf and darker green color. As previously stated, northern wild rice will eventually stand erect out of the water in the late summer months, while floating-leaf bur-reed does not reach this point in its life cycle. Additionally, the seeds and fruits of each plant differ dramatically.

Figure 3.4-5 compares the littoral frequency of occurrence of 16 frequently encountered aquatic plant species on Lower Ninemile Lake from the 2007 and 2011 point-intercept surveys. As discussed earlier, most of the species located in 2007 were located in 2011. However, as Figure 3.4-5 illustrates, the composition of the plant community or the abundances of these species between these two years is quite dynamic. For instance, northern wild rice was located at 45% of the point-intercept sampling points visited in 2007 compared to only 14% in 2011. In fact, all of the species displayed in Figure 3.4-5 aside from fern pondweed and hornwort spp. had lower littoral occurrences in 2011 than in 2007. Some species, like northern wild rice and slender naiad, saw large differences in occurrence between these two years, while other plants such as muskgrasses and water marigold did not exhibit large changes. Overall, aquatic vegetation in Lower Ninemile Lake was much more prevalent in 2007 with 98% of the point-intercept locations sampled containing aquatic vegetation compared to 75% in 2011.

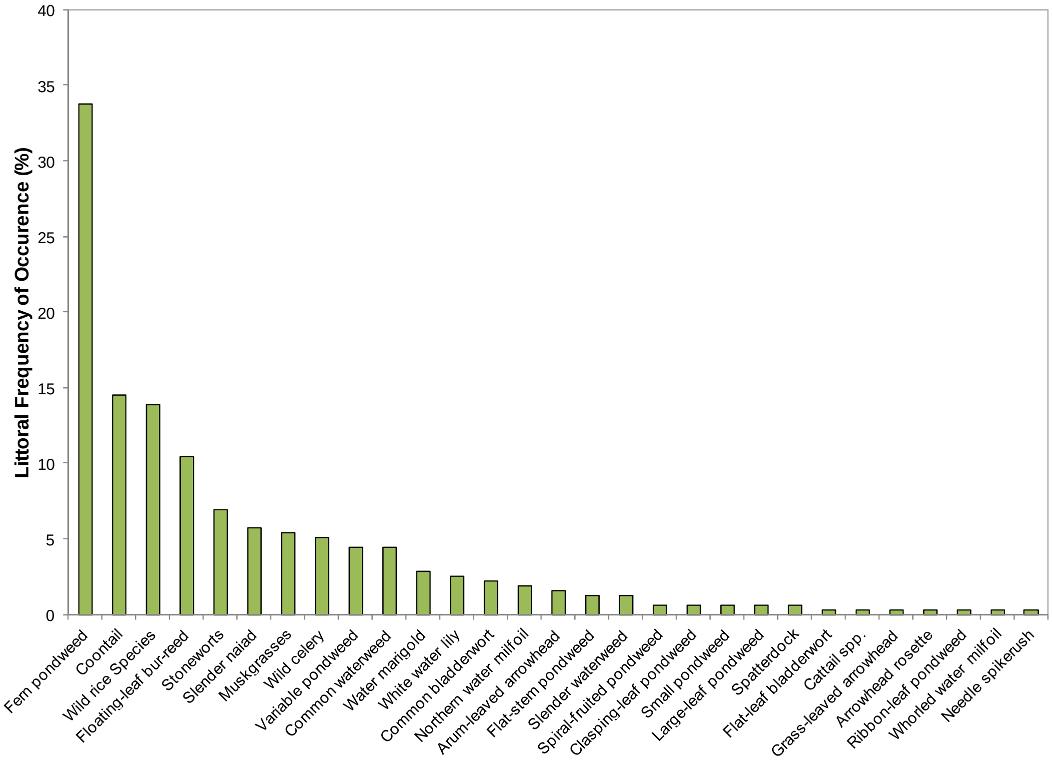


Figure 3.4-4. Lower Ninemile Lake 2011 aquatic plant littoral frequency of occurrence. Created using data from July 2011 surveys.

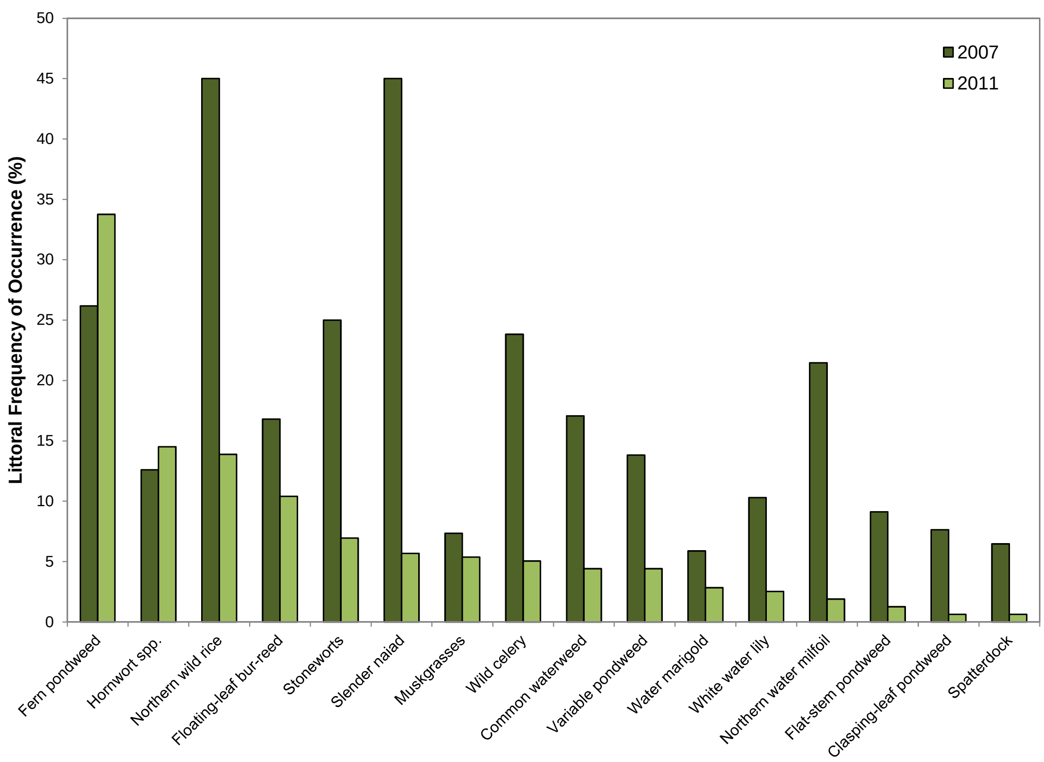


Figure 3.4-5. Comparison of 16 aquatic plant species' littoral occurrence from 2007 and 2011 point-intercept surveys on Lower Ninemile Lake. Created using data from July 2007 Northern Environmental and July 2011 Onterra surveys.

Aquatic plant communities are often dynamic in terms of their species composition over time, and reflect the current conditions that occur within the lake environment. The species abundances captured in 2007 and 2011 represent snapshots in time, and while data are not available between these years, it is clear that the plant community of Lower Ninemile Lake is likely very dynamic from year to year. These changes in species abundances are likely a result of a number of environmental factors.

Being a Wisconsin Valley Improvement Company (WVIC) managed system, Lower Ninemile Lake can experience water level fluctuations of up to 4.58 feet in any given year. In years when the water level is drawn down to the minimum level during the winter months, the majority of the lake bed is likely exposed. Some years, depending on snow/ice cover, temperature, and other factors, these exposed areas may freeze or dry out (desiccate), and aquatic plant species that can best tolerate these conditions will be the most resilient the following spring. In other years, these areas may remain saturated, and other aquatic plant species that are not so tolerant to freezing or desiccation will not be impacted. Water level fluctuations during the growing season, water clarity, temperature, precipitation, and other environmental factors influence a lake's aquatic plant community on an annual basis. While changes in the aquatic plant community can often indicate negative impacts from anthropogenic activities, the dynamics observed in Lower Ninemile Lake's plant community between 2007 and 2011 are not indicative of water quality degradation or a decline in some other environmental factor, but are a result of a highly dynamic reservoir system.

As explained above in the Primer on Data Analysis and Data Interpretation Section, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while fern pondweed was found at 34% of the sampling locations in Lower Ninemile Lake in 2011, its relative frequency of occurrence was 27%. Explained another way, if 100 plants were randomly sampled from Lower Ninemile Lake, 27 of them would be fern pondweed. Looking at the 2011 relative frequency of occurrence (Figure 3.4-6), 10 species comprised approximately 84% of the plant community in Lower Ninemile Lake.

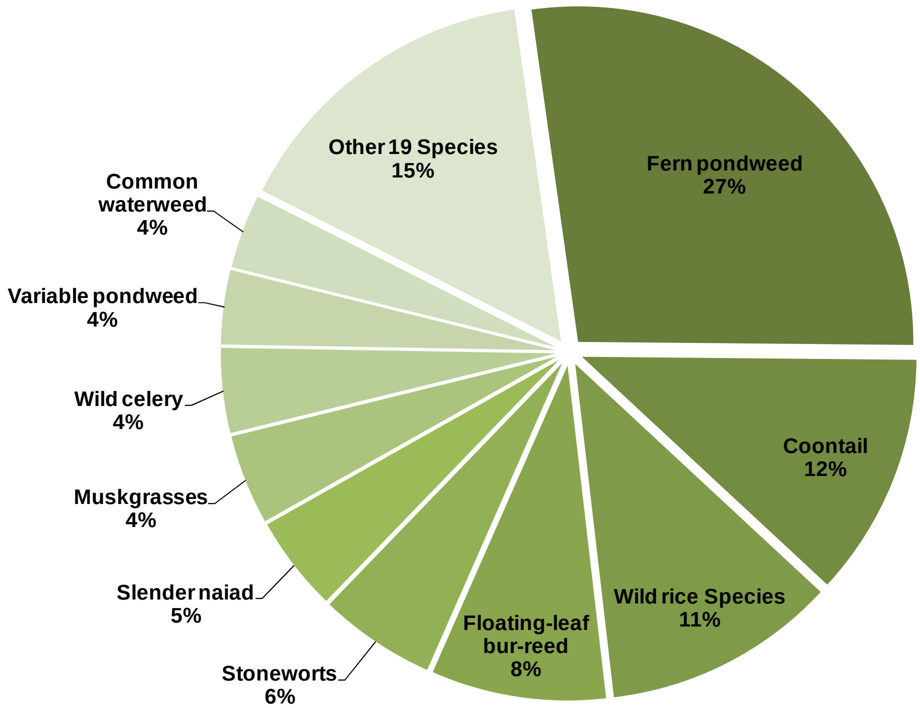


Figure 3.4-6. Lower Ninemile Lake aquatic plant relative frequency of occurrence. Created using data from July 2011 surveys.

As discussed previously, the calculations used for the Floristic Quality Index (FQI) for a lake's aquatic plant community are based on the aquatic plant species that were encountered on the rake during the point-intercept survey and does not include incidental species. For example, while 49 native aquatic plant species were located in Lower Ninemile Lake during the 2011 surveys, 29 were encountered on the rake during the point-intercept survey. Figure 3.4-7 shows that in 2007 Lower Ninemile Lake was found to have a native species richness of 22, which was comparable to the median species richness of other flowages within the Northern Lakes and Forests Ecoregion and higher than median for flowages within all of Wisconsin. In 2011, the native species richness of 29 exceeded both the medians for flowages in the ecoregion and the state (Figure 3.4-7).

Data collected from both the 2007 and 2011 aquatic plant surveys show that the average conservatism values, 6.7 and 6.6, respectively, are higher than both the medians for flowages within the ecoregion and the state (Figure 3.4-7). This indicates that the aquatic plant community of Lower Ninemile Lake is of higher quality than most other flowages in the state. This also indicates that despite observing large fluctuations in the occurrence of many species from 2007 to 2011, the quality of the plant community is maintained.

The Floristic Quality Index (FQI) of the lake's aquatic plant community is calculated by combining the native species richness and average conservatism values (equation shown below). In 2007, the FQI was found to be 30.7 compared to 35.8 in 2011, both of which exceed the ecoregional and state medians (Figure 3.4-7). The higher native species richness documented in 2011 is the reason the FQI for 2011 is also higher.

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

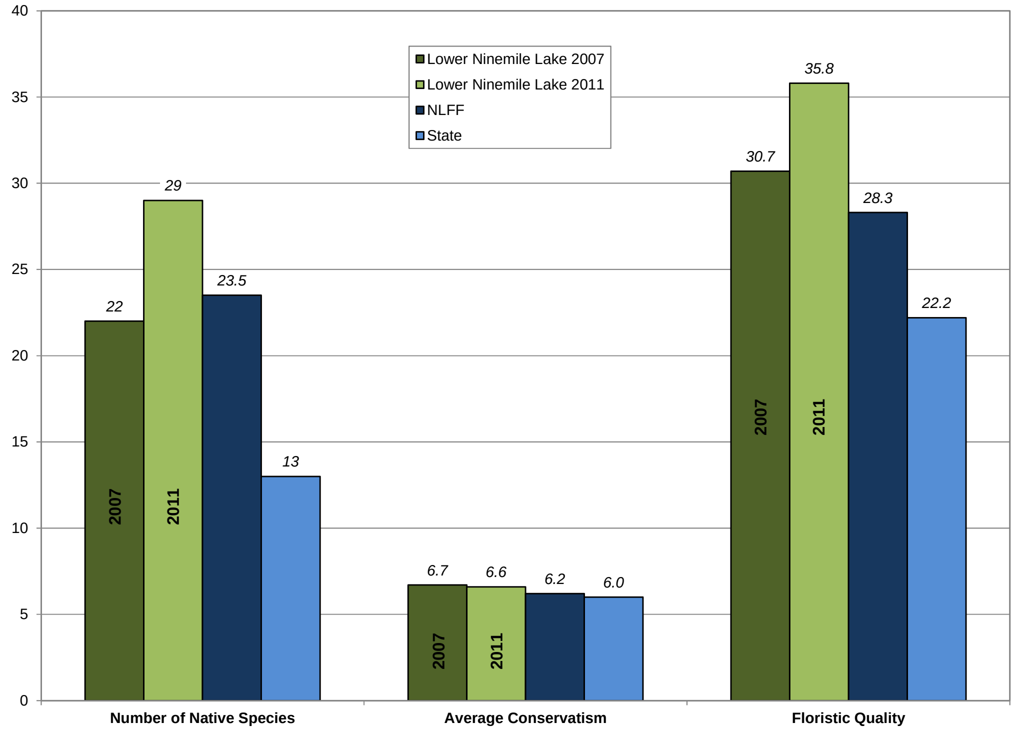


Figure 3.4-7. Lower Ninemile Lake 2007 and 2011 Floristic Quality Assessment. Created using data from 2007 Northern Environmental and 2011 Onterra aquatic plant surveys. Analysis following Nichols (1999) where NLFF = Northern Lakes Flowages and Forests ecoregion.

Because Lower Ninemile Lake contains a high number of native aquatic plant species, one may assume their aquatic plant communities have high species diversity. However, as discussed earlier, species diversity is also influenced by how evenly the plant species are distributed within the community. Figure 3.4-8 indicates that although fern pondweed comprises a large portion of the aquatic plant community, many other species are found in high abundance as well. This broad distribution helps to create higher diversity within an aquatic plant community.

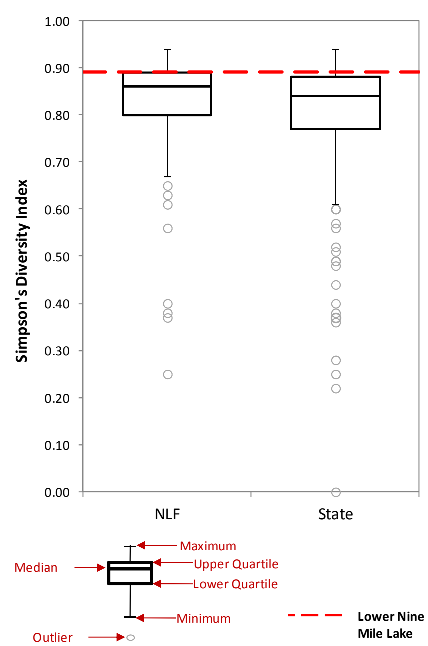


Figure 3.4-8. Lower Ninemile Lake species diversity index. Created using data from July 2011 aquatic plant surveys. Ecoregion data provided by WDNR Science Services.

The aquatic plant community in Lower Ninemile Lake was found to be highly diverse, with a Simpson's diversity value of 0.89 (Figure 3.4-8). This value ranks even with the upper quartile value for lakes within the Northern Lakes and Forest ecoregion, and above the upper quartile value for lakes across the state. Lakes with diverse aquatic plant communities have higher resilience to environmental disturbances and greater resistance to invasion by non-native plants. A plant community with a mosaic of species with differing morphological attributes provides zooplankton, macroinvertebrates, fish and other wildlife with diverse structural habitat and various sources of food. The highly dynamic nature of the Lower Ninemile Lake system on an annual basis likely prevents one or a few species from becoming dominant within the plant community and maintains high species diversity.

The quality of Lower Ninemile Lake's plant community is also a product of emergent and floating-leaf plant communities that occur in near-shore areas around the lake. The 2011 community map indicates that approximately 321 acres (38%) of the 849-acre lake contain these types of plant communities (Table 3.4-2 and Map 6). Twenty-three floating-leaf and emergent species were located on Lower Ninemile Lake, providing valuable structural habitat for invertebrates, fish, and other wildlife. These communities also stabilize lake substrate and shoreline areas by dampening wave action from wind and watercraft.

Table 3.4-2. Lower Ninemile Lake acres of emergent and floating-leaf aquatic plant communities. Created from a July 2011 community mapping survey.

Plant Community	**Acres**
Emergent	65.5
Floating-leaf	32.5
Mixed Floating-leaf and Emergent	223.4
Total	321.4

Because the community map represents a 'snapshot' of the important emergent and floating-leaf plant communities, a replication of this survey in the future will provide a valuable understanding of the dynamics of these communities within Lower Ninemile Lake. This is important 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 shorelines when compared to the undeveloped shorelines in Minnesota lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

Pale-yellow Iris

Pale-yellow iris (*Iris pseudacorus*) is a large, showy iris with bright yellow flowers. Native to Europe and Asia, this species was sold commercially in the United States for ornamental use and has since escaped into Wisconsin's wetland areas forming large monotypic colonies and displacing valuable native wetland species.

As shown on Map 6, one area of Lower Ninemile Lake is known to contain pale yellow iris (USFS, personal comm.). At this time, the only means of controlling pale-yellow iris populations is continual hand removal and monitoring. The FLNML plans to monitor for this non-native plant and hand-remove occurrences that are encountered.

Lower Ninemile Lake Water Levels

The United States Forest Service (USFS) gained ownership of the wetlands that surrounded the Ninemile Creek prior to that land being flooded to create the Lower Ninemile Lake. Through federal land grants, the Wisconsin Board of Commissioners of Public Lands (BCPL) also acquired lands from the federal government surrounding the Ninemile Creek. In 1893, the Nine Mile Creek Improvement Company was granted the right to flood these areas and create Lower Ninemile Lake. In 1907, those rights were acquired by the Wisconsin Valley Improvement Company (WVIC) from the Nine Mile Creek Improvement Company. The WVIC currently maintains deeded flowage rights and prescriptive rights on the flooded lands.

Lower Ninemile Lake is one of 21 WVIC water storage reservoirs used to maintain as uniform a flow as practicable in the Wisconsin River by storing surplus water in reservoirs for discharge when river flows are naturally low, typically in summer and winter. The reservoir system is operate to maintain a reasonable balance among the benefits the water resource provides including water conservation, flood control, low flow, augmentation, hydroelectric generation, water quality, wildlife and recreation (Figure 3.4-9).

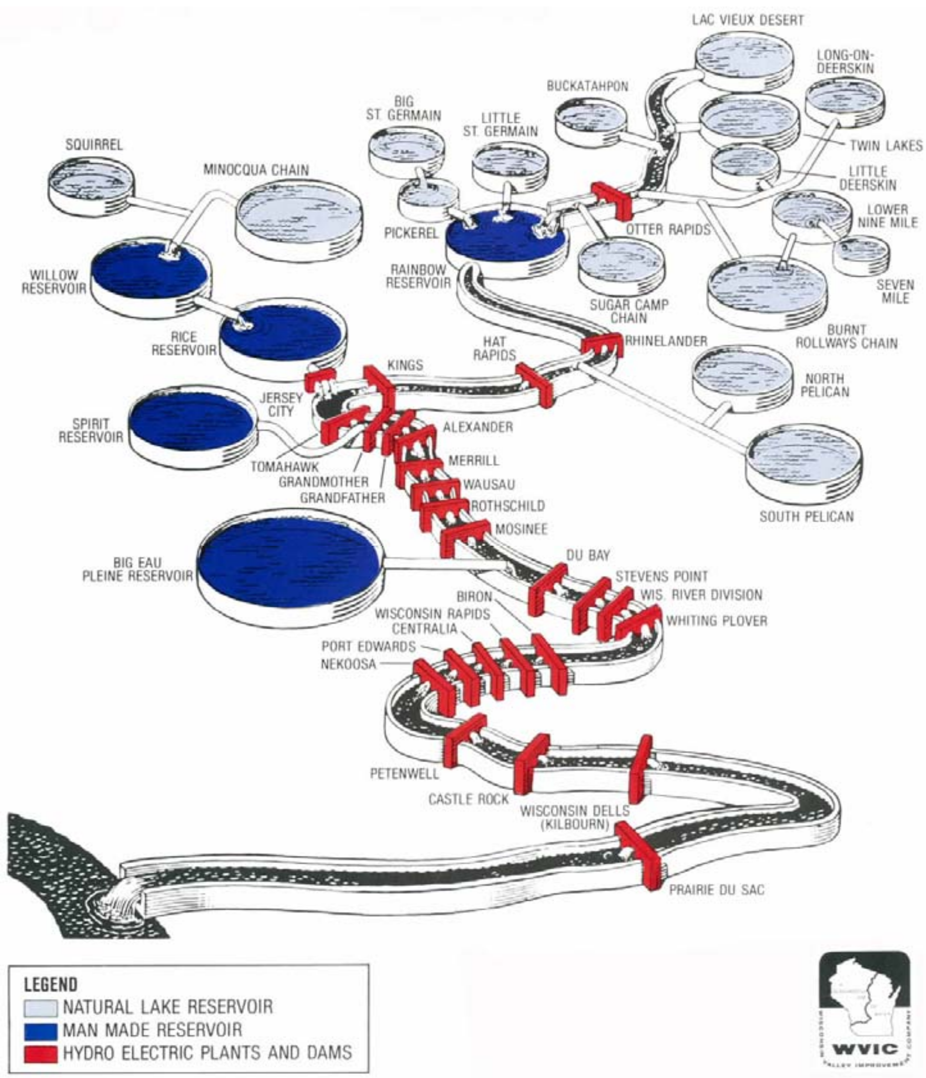


Figure 3.4 -9. WVIC reservoir system. Adapted from WVIC website.

Hydroelectric power projects are licensed by the Federal Energy Regulatory Commission (FERC). As part of the FERC operation license, the minimum and maximum water levels are set for each waterbody. 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. Lower Ninemile Lake is one of the natural lake reservoirs in the WVIC system, and has an operational range of 4.58 feet (Figure 3.4-10).

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. For instance, in Lower Ninemile Lake, even if water levels are at the minimum threshold, the dam still needs to release 5.0 cubic feet per second of water flow to Ninemile Creek.

Figure 3.4-10 shows the ideal operation cycle for these storage reservoirs. During the spring rains and snow melt, the water is stored in the reservoirs to mitigate flooding and maintain flow during the summer when precipitation is generally less. Some water storage occurs again during the early fall to replenish water supplies released during the summer. Over the winter months, the water is released to augment flow and allow for storage capacity in the flowages once the spring rains and runoff come again.

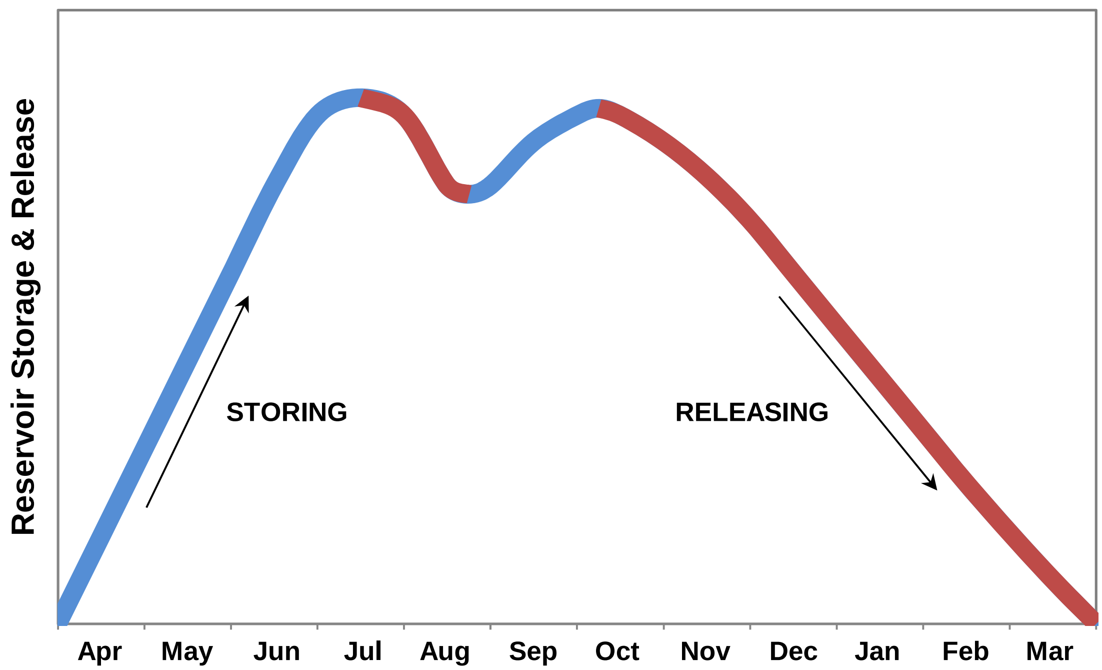


Figure 3.4-10. WVIC reservoir system ideal operation cycle. Adapted from WVIC website.

However, on Lower Ninemile Lake, in normal years water levels are maintained at a stable level over the course of the summer (Figure 3.4-11). As alluded to, this cycle is the 'ideal' storage-release plan when precipitation is at normal levels. Sustained drought or high precipitation periods cause this plan to be altered to prevent flooding, maintain minimal flows in the Wisconsin River, and of course supply water for downstream hydroelectric facilities. It is important to note that the water level regime of Lower Ninemile Lake is different from a natural regime. The native plant community that currently exists in that lake has been selected over time for those species that can tolerate this unnatural fluctuation.

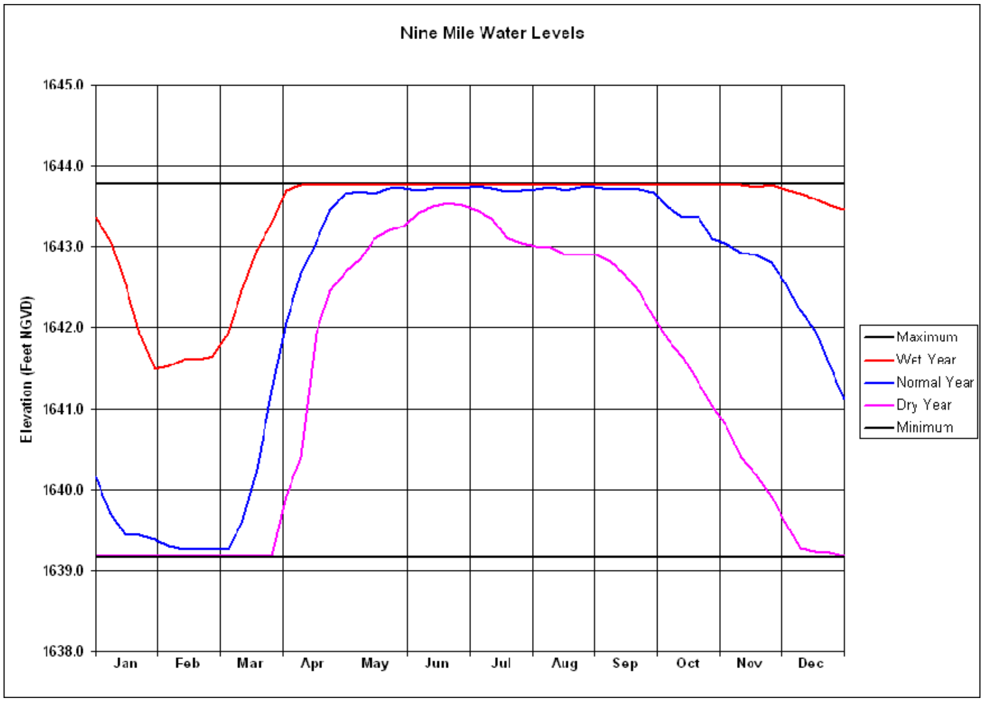


Figure 3.4-11. Lower Ninemile Lake water levels. Chart courtesy of WVIC, 2012.

Northern Wild Rice

Photo 3.4-1. Northern wild rice (*Z. palustris*) on Lower Ninemile Lake. Taken in early September 2011.

Wild rice is an emergent aquatic grass that grows in shallow water of lakes and slow-moving rivers. Manoomin, as it is referred to by Ojibewe Tribal Communities, is of great cultural significance. In addition, wild rice harvesting and consumption is carried out by and benefits both tribal and non-tribal members. Wild rice is also an important diet component for waterfowl, muskrats, deer, and many other species. Established wild rice communities can provide valuable nursery and brooding habitat for wetland bird and amphibian species as well as spawning habitat for various fish. Perhaps one of the most overlooked benefits of having established wild rice communities is their ability to utilize excessive nutrients, stabilize sediments, and form natural wave-breaks to protect shoreline areas.

Wild rice is an annual plant that relies strictly on seed production to maintain its populations from year-to-year. Water levels and depth have a significant impact on this aquatic species. Once dropped from the parent plant, the seed must be submersed in water to germinate the following year, or remaining dormant until another year when conditions are suitable. Deep water prevents light from reaching submersed seedlings, and water that is too shallow prevents good development of the floating leaf stage of the plant and will lead to a poor crop (Aiken et al. 1988). It has been suggested that northern wild rice requires constant or slowly falling water levels throughout the growing season to prevent uprooting in soft sediments (Vennum 1988). Table 3.4-3 contains the optimal habitat conditions for wild rice in Wisconsin provided by the United States Department of Agriculture. As the table indicates, Lower Ninemile Lake possesses all of the listed optimal habitat conditions for sustaining a wild rice population.

Table 3.4-3. Optimal habitat conditions for wild rice in Wisconsin. Adapted from the United States Department of Agriculture Biological Technical Note 4.

Optimal Conditions for Wild Rice	Conditions Present in Lower Ninemile Lake
Water	
Flowing Water (Rivers & Flowages)	Yes
Water Depth: 0.5 - 3 feet	Yes
Periodic Water Level Fluctuations	Yes
Stable or Slight Decline in Water Level During Growing Season	Yes
Winter Drawdowns to Knock-back Competing Vegetation	Yes
Relatively Clear Water	Yes
pH Range: 6.0 - 8.0	Yes
Soils	
Several Inches of Soft Organic Muck	Yes

Harvesting wild rice (ricing) may occur within the state by tribal and non-tribal members. Permits are available to Wisconsin residents anywhere that WDNR licenses are sold. For a relatively low cost ($8.25), family members are able to gather wild rice using self-propelled boats no longer than 17 feet and no wider than 38 inches. The mature grain is harvested using wooden sticks, bending the stalks over the ricer's boat. Because some of the rice ends up in the boat and some ends up back in the water, this activity promotes wild rice reseeding and potential growth in subsequent years. Additional rules, regulations, and restrictions to wild rice harvesting exist.

Becoming a wild rice harvester is a great way to promote rice stewardship while reaping the benefits of utilizing this nutritious resource. Figure 3.4-12 shows the amount of wild rice that was harvested from Lower Ninemile Lake since 2003, according to Great Lakes Indian Fish & Wildlife Commission (GLIFWC) telephone and mail surveys. It is interesting to note that in recent years (2008 and 2009); the majority of the rice harvest on Lower Ninemile Lake was conducted by Wisconsin state residents as opposed to by tribal members. Please note that the information contained in 3.4-12 is based on, and extrapolated from those tribal and non-tribal ricers that purchased a permit and responded to GLIFWC-distributed surveys. Actual wild rice harvests are believed

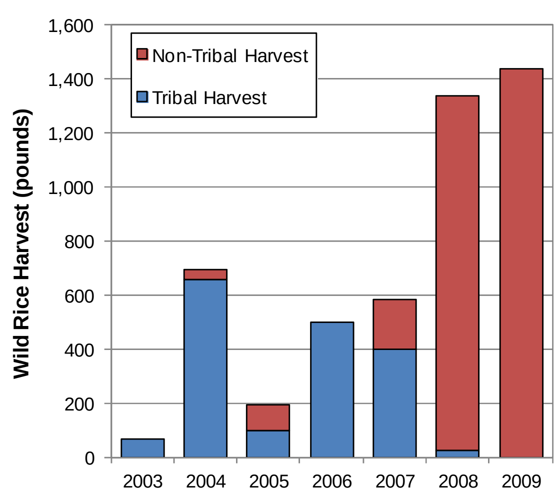


Figure 3.4-12. Wild rice harvest on Lower Ninemile Lake. Data provided by GLIFWC.

to be higher than shown in this figure, but that knowledge is limited by the survey methodologies.

Coupling the water level regime and hydrology of Lower Ninemile Lake and the productive nature of the soft sediments and ample nutrients with the ecology of wild rice, it is easy to see why this aquatic emergent plant would grow so well here. From the 2011 community mapping survey, it was determined that approximately 233 acres of plant communities dominated by northern wild rice exist on Lower Ninemile Lake (Map 7). Another 25.6 acres contain abundant wild rice, but were dominated more so by floating-leaf bur-reed. Little historical information exists regarding rice densities on Lower Ninemile Lake in the past besides anecdotal accounts. A 2008 GLIFWC wild rice report indicated an estimated 19 acres of wild rice cover in 2005, however this number was derived through aerial surveys and therefore is not entirely comparable to the 233 acres determined to be present in 2011 (David 2008).

While many Lower Ninemile Lake stakeholders indicated that wild rice populations have been expanding, data from the 2007 and 2011 point-intercept surveys indicate that wild rice had an occurrence of 45% in 2007 compared to only 14% in 2011. Figure 3.4-13 displays the point-intercept sampling locations that contained wild rice from these two surveys. As the figure illustrates, wild rice was more abundant in 2007 than in 2011. However, the point-intercept method is not the most appropriate survey for evaluating floating-leaf and emergent plant communities as this survey methodology tends to underestimate the abundance of plants that are growing in shallower water along the margins of the lake. Therefore, this information should be used with caution.

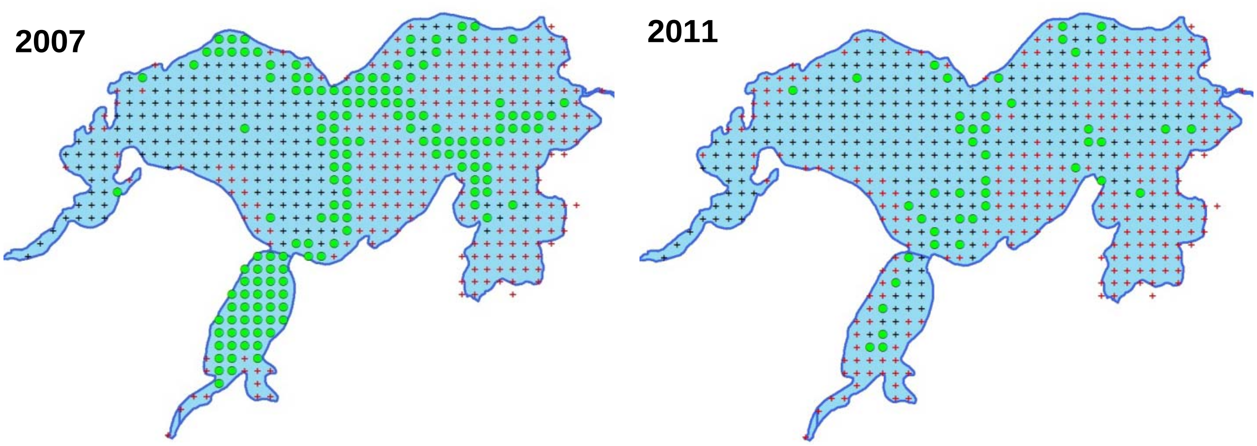


Figure 3.4-13. Locations of northern wild rice in Lower Ninemile Lake as documented from the 2007 and 2011 point-intercept surveys. Green dot represents presence of northern wild rice, black cross represents absence of wild rice, and red cross represents sampling location was non-navigable. Created using data from 2007 Northern Environmental and 2011 Onterra surveys.

Because wild rice is an annual plant and relies solely on seed for population sustenance, variations in seed production in a given year will impact the size of rice bed in subsequent years. Other factors, such as spring temperatures and water levels, also impact rice populations by affecting seed germination. According to Aiken et al. (1988), over the course of four years it is likely that there will be a boom year, a bust year, and a couple of average years. However, it has been documented that in systems with higher rates of water flow, rice production and population dynamics are more consistent over time. While the rice population on Lower Ninemile Lake may not fluctuate as drastically as populations located in natural lakes, the 2007 and 2011 data indicate that wild rice abundances do fluctuate between years.

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 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 numerous fisheries biologists overseeing Lower Ninemile Lake. The goal of this section is to provide a summary overview of the data that is readily available, particularly in regards to specific issues (e.g. spear fishery, fish stocking, angling regulations, etc) that were brought forth by the FLNML stakeholders within the stakeholder survey and other planning activities. Although current fish data were not collected, the following information was compiled based upon data available from the WDNR and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) (WDNR 2012 & GLIFWC 2011A and 2011B).

Lower Ninemile Lake Fishery

Lower Ninemile Lake Fish Species and Fishing Activity

Based on data collected from the stakeholder survey (Appendix B), fishing was the highest ranked important or enjoyable activity on Lower Ninemile Lake (Question #14), with walleye, yellow perch, and bluegill/sunfish topping the list of species stakeholders enjoy catching (Question #11). Approximately 62% of these respondents believed that the quality of fishing on the lake was either fair or poor (Question #9); and approximately 74% believe that the quality of fishing has remained the same or gotten worse since they began fishing the lake (Question #12).

Table 3.5-1 shows the popular game fish that are present in the system. When examining the fishery of a lake, it is important to remember what "drives" that fishery, or what is responsible for determining its mass and composition. The gamefish in Lower Ninemile Lake are supported by an underlying food chain. At the bottom of this food chain are the elements that fuel algae and plant growth – nutrients such as phosphorus and nitrogen, and sunlight. The next tier in the food chain belongs to zooplankton, which are tiny crustaceans that feed upon algae and plants, and insects. Smaller fish called planktivores feed upon zooplankton and insects, and in turn become food for larger fish species. The species at the top of the food chain are called piscivores, and are the larger gamefish that are often sought after by anglers, such as bass and walleye.

A concept called energy flow describes how the biomass of piscivores is determined within a lake. Because algae and plant matter are generally small in energy content, it takes an incredible amount of this food type to support a sufficient biomass of zooplankton and insects. In turn, it takes a large biomass of zooplankton and insects to support planktivorous fish species. And finally, there must be a large planktivorous fish community to support a modest piscivorous fish community. Studies have shown that in natural ecosystems, it is largely the amount of primary productivity (algae and plant matter) that drives the rest of the producers and consumers in the aquatic food chain. This relationship is illustrated in Figure 3.5-1.

Table 3.5-1. Gamefish present in the Lower Ninemile Lake with corresponding biological information (Becker, 1983)**.**

Common Name	Scientific Name	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
Black Crappie	*Pomoxis nigromaculatus*	7	May - June	Near *Chara* or other vegetation, over sand or fine gravel	Fish, cladocera, insect larvae, other invertebrates
Bluegill	*Lepomis macrochirus*	11	Late May - Early August	Shallow water with sand or gravel bottom	Fish, crayfish, aquatic insects and other invertebrates
Largemouth Bass	*Micropterus salmoides*	13	Late April - Early July	Shallow, quiet bays with emergent vegetation	Fish, amphipods, algae, crayfish and other invertebrates
Muskellunge	*Esox masquinongy*	30	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*	25	Late March - Early April	Shallow, flooded marshes with emergent vegetation with fine leaves	Fish including other pike, crayfish, small mammals, water fowl, frogs
Pumpkinseed	*Lepomis gibbosus*	12	Early May - August	Shallow warm bays 0.3 - 0.8 m, with sand or gravel bottom	Crustaceans, rotifers, mollusks, flatworms, insect larvae (terrestrial and aquatic)
Rock Bass	*Ambloplites rupestris*	13	Late May - Early June	Bottom of course sand or gravel, 1 cm - 1 m deep	Crustaceans, insect larvae, and other invertebrates
Walleye	*Sander vitreus*	18	Mid April - early May	Rocky, wavewashed shallows, inlet streams on gravel bottoms	Fish, fly and other insect larvae, crayfish
Yellow Perch	*Perca flavescens*	13	April - Early May	Sheltered areas, emergent and submergent veg	Small fish, aquatic invertebrates

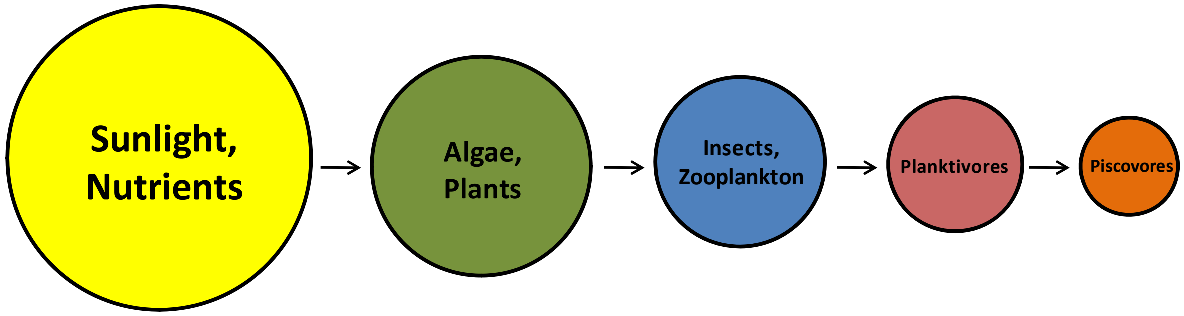


Figure 3.5-1. Aquatic food chain. Adapted from Carpenter et. al 1985.

As discussed in the Water Quality section, Lower Ninemile Lake is a eutrophic system, meaning it has high nutrient content and thus relatively high primary productivity. Simply put, this means Lower Ninemile Lake should be able to support sizable populations of predatory fish (piscovores) because the supporting food chain is relatively robust.

Wisconsin Spear Harvesting Background

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 3.5-2). Lower Ninemile Lake falls within the ceded territory based on the Treaty of 1842. This allows for a regulated open water spear fishery by Native Americans on specified systems. This highly structured process begins with an annual meeting between tribal and state management authorities. Reviews of population estimates are made for ceded territory lakes and then an "allowable catch" is established based on estimates of the adult population (generally fish from age 3 to age 5 and older). This figure is usually about 35% of the lake's walleye population In lakes where population estimates are out of date by 3 years, a model that estimates walleye abundance based on lake size is used. The allowable catch number is then reduced by a percentage agreed upon by biologists that reflects the confidence they have in their population estimates for the particular lake. This number is called the "safe harvest level". The safe harvest is a conservative estimate of the number of fish that can be harvested by efficient methods. The safe harvest is then multiplied by the Indian communities claim percent, or declaration. This result is called the quota, and represents the maximum number of fish that can be taken by tribal spearers (Spangler, 2009). Daily bag limits for walleye are then reduced for hook-and-line anglers to accommodate the tribal quota and prevent over-fishing. Bag limits may be increased at the end of May on lakes where spearing quotas are not met. The tribes have historically selected a percentage which allows for a 2-3 daily bag limit for hook-and-line anglers (USDI 2007).

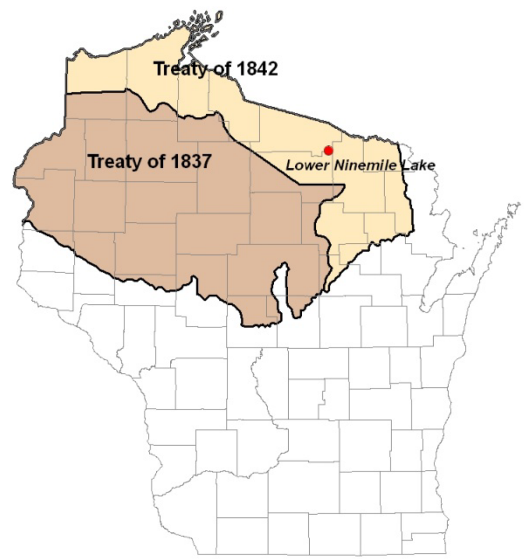


Figure 3.5-2. Location of Lower Ninemile Lake within the Native American Ceded Territory (GLIFWC 2011A). This map was digitized by Onterra; therefore it is a representation and not legally binding.

Spearers are able to harvest muskellunge, walleye, northern pike, and bass during the open water season. The spear harvest is monitored through a nightly permit system and a complete monitoring of the harvest (GLIFWC 2011B). 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. An updated nightly quota is determined each morning by 9 a.m. based on the data collected from the successful spearers. Harvest of a particular species ends once the quota is met or the season ends. In 2011, a new reporting requirement went into effect on lakes with smaller quotas. Starting with the 2011 spear harvest season, on lakes with a harvestable quota of 75 or fewer fish, reporting of harvests may take place at a location other than the landing of the speared lake.

Although Lower Ninemile Lake has been declared as a spear harvest lake, it has not historically seen a harvest. It is possible that spearing efforts have been concentrated on other larger lakes in the region, which would potentially have a higher estimated safe harvest for both walleye and muskellunge.

Lower Ninemile Lake Fish Stocking

To assist in meeting fisheries management goals, the WDNR may stock fish in a waterbody that were raised in nearby permitted hatcheries. Stocking of a lake is sometimes done to assist the population of a species due to a lack of natural reproduction in the system, or to otherwise enhance angling opportunities. Between 1987 and 1994, walleye were stocked at a rate of 0.2, 0.4 or 0.8 fish per acre on five occasions (Table 3.5-2).

Table 3.5-2. Walleye stocking data available from the WDNR from 1987 to 1994 (WDNR 2012).

Year	Age Class	# Stocked	Avg. Length (inches)
1987	Fingerling	43,200	2
1989	Fingerling	20,060	1
1991	Fingerling	10,017	3
1992	Fingerling	10,038	2
1994	Fingerling	20,390	2

Lower Ninemile Lake Angler Regulations

Because Lower Ninemile Lake is located within ceded territory, special fisheries regulations may occur, specifically in terms of walleye. An adjusted walleye bag limit pamphlet is distributed each year by the WDNR which explains the more restrictive bag or length limits that may pertain to Lower Ninemile Lake. In 2012-2013, no restrictive bag limits were set on the lake. Statewide and regional regulations apply to walleye in Lower Ninemile Lake, which include five fish daily that are above the minimum length limit of 15”.

For bass species, the first Saturday in May through the third Saturday in June is reserved for a catch and release season only. Following the third Saturday in June, five bass of either species may be harvested, with a minimum length of 14”. Lower Ninemile Lake is in the northern half of the muskellunge and northern pike management zone. Muskellunge must be 40” to be harvested, with a daily bag limit of one fish, while no minimum length limit exists for northern pike and five pike may be kept in a single day. Statewide regulations apply for all other fish species.

Lower Ninemile Lake Substrate Type

According to the point-intercept survey conducted by Onterra, 97% of the substrate sampled in the littoral zone on Lower Ninemile Lake was muck, with the remaining 3% being classified as sand (Map 4). Substrate and habitat are critical to fish species that do not provide parental care to their eggs, in other words, the eggs are left after spawning and not tended to by the parent fish. Muskellunge is one species that does not provide parental care to its eggs (Becker 1983). Muskellunge 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 is 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 in muck as well.

4.0 SUMMARY AND CONCLUSIONS

The design of this project was intended to fulfill four objectives:

1) Collect baseline data to increase the general understanding of the Lower Ninemile Lake ecosystem.
2) Collect detailed information regarding invasive plant species within the lake
3) Collect sociological information from Lower Ninemile Lake stakeholders regarding their use of the lake and their thoughts pertaining to the past and current condition of the lake and its management.
4) Collect detailed information regarding wild rice and other aquatic vegetation that is perceived to impede riparian access to the lake.

These four objectives were fulfilled during the project and have provided detailed insights into the Lower Ninemile Lake ecosystem, the people who care about the lake, and what needs to be completed to protect and enhance it.

The water quality analyses conducted indicate that the lake is borderline mesotrophic-eutrophic, or relatively highly productive. As discussed within the Water Quality Section (3.1), changes in water quality over time have not been observed, although the historical dataset is not very large. Being an impoundment, Lower Ninemile Lake's drainage basin, or watershed, is 21 times larger than the lake itself. This large watershed funnels an incredible amount of water into and through Lower Ninemile Lake, as indicated by a water residence time of only 36.5 days. So every 36.5 days, there is completely new water within the lake, making nutrient and algae concentrations within the lake highly variable depending on the amount of precipitation, and thus runoff, within the lake's watershed. The clarity of Lower Ninemile Lake's water is driven by two primary factors: free-floating algae and dissolved organic compounds within the water. In years with higher precipitation amounts, the amount of algae within the lake may be lower due to a higher flushing rate, but the amount of dissolved organic compounds within the water may be higher due to increased runoff. Conversely, in years with lower precipitation, algae may increase while dissolved organic compounds may decrease. Overall, the water quality of Lower Ninemile Lake is what is to be expected within a lake of its type.

Lower Ninemile Lake's watershed is in excellent condition with 92% of the land cover being comprised of intact forest and wetlands which export minimal amounts of phosphorus. In addition to a mostly natural watershed, 88% of the immediate shoreline areas around Lower Ninemile Lake are currently in a natural or undeveloped state. These areas should be a primary focus for conservation. While only 4% of the immediate shoreland was classified as either *Developed-unnatural* or *Urbanized*, it is always beneficial to any lake ecosystem to restore these areas to more natural conditions.

Surveys focusing on aquatic plants in 2011 revealed that Lower Ninemile Lake's native aquatic plant community are of very high quality when compared to other flowages within the region and the state. Except for a single dominant plant (fern pondweed), the composition of the submersed aquatic plant community of Lower Ninemile Lake is evenly divided amongst numerous other species. The health of this plant community is likely one of the reasons why Lower Ninemile Lake does not currently contain any non-native submergent species. Lower Ninemile Lake is not a primary source of transient boaters, which also helps insulate the system from exposure to these treats. Invasive species thrive in disturbance situations and once established in a productive lake, can have devastating impacts on its health.

According to GIS Software, Lower Ninemile Lake is approximately 830 acres. Aquatic plant surveys conducted in 2011 identified over 320 acres of emergent and/or floating-leaf vegetation and another 250 acres of wetland marsh/bog habitat. The Friends of Lower Ninemile Lake are proud of the fact that only 31% of their lake consists of open water and enjoy the lake for its aesthetic beauty as wildlife habitat.

The establishment (potentially re-establishment) of wild rice within Lower Ninemile Lake in recent years was initially highly valued by lake residents. However, the population of wild rice in some years has exceeded what riparians can tolerate as access from their property to the lake is almost completely blocked. Through this management planning process, education about the biology, life cycle, and benefits of wild rice have been stressed. The Friends of Lower Ninemile Lake are optimistic that a management solution to riparian access concerns can be reached through cooperative discussions with the WDNR and GLIFWC.

5.0 IMPLEMENTATION PLAN

During the planning meetings that took place during 2012, the Lower Ninemile Lake Planning Committee discussed the results of the 2011 management plan study with ecologists/planners from Onterra and closely examined Lower Ninemile Lake as well as the people who live around it. The Planning Committee discussed the strengths and weaknesses of Lower Ninemile Lake and its stakeholders, as well as the opportunities and threats they face. These issues were discussed in terms of 1) feasibility of addressing the issue, and 2) level of the issue's importance. As a result of the discussion, the FLNML was able to identify goals for protection and enhancing Lower Ninemile Lake, as well as communicating and educating individuals who use the lake.

The implementation plan presented below represents the path the FLNML will follow in order to meet their lake management goals. The goals detailed within the plan are realistic and achievable, as are the action steps required to reach these goals. The implementation plan is a living document that 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 lake's stakeholders.

Management Goal 1: Increase FLNML's Capacity to Communicate with Lake Stakeholders and Facilitate Partnerships with Other Management Entities

Management Action: Use education to promote lake protection and enjoyment through stakeholder education

Timeframe: Continuation of current efforts

Facilitator: FLNML Planning Committee

Description: Education represents an effective tool to address many lake issues. Currently, the FLNML distributes an annual newsletter to association members, as well as special mailings as appropriate. This level of communication is important within a management group because it builds a sense of community while facilitating the spread of important association news, educational topics, and even social happenings. It also provides a medium for the recruitment and recognition of volunteers. Perhaps most importantly, the dispersal of a well written newsletter can be used as a tool to increase awareness of many aspects of lake ecology and management among association members. By doing this, meetings can often be conducted more efficiently and misunderstandings based upon misinformation can be avoided. Educational pieces within the association newsletter may contain monitoring results, association management history, as well as other educational topics listed below.

In addition a variety of educational efforts will be initiated by the FLNML Planning Committee. These may include educational materials, awareness events and demonstrations for lake users as well as activities which solicit local and state government support. This committee will also investigate the creation of an association website and/or other social media such as Facebook®. This will directly increase the association's ability to communicate with interested stakeholders by allowing them to post information and social messages.

Example Educational Topics

- Specific topics brought forth in other management actions
- Aquatic invasive species issues
  - identification and education
  - control methods
  - risks related to AIS establishment
  - risks related to AIS control methods
- Basic lake ecology
- Wild rice ecology, and cultural/historical significance
- Shoreland restoration and protection
- Pier rules
- Wildlife, including trumpeter swans
- Noise, air, and light pollution
- Shoreline habitat protection
- Septic system maintenance
- Fishing regulations

Action Steps:

See description above as this is an established program.

<u>Management Action:</u> Continue FLNML's involvement with other entities that have a hand in managing (management units) Lower Ninemile Lake

Timeframe: Continuation of current efforts

Facilitator: FLNML Commissioners

Description: In 2007, Lower Ninemile Lake stakeholders organized to form the Friends of Lower Ninemile Lake (FLNML). The group was created over strife of an expanding northern wild rice population within the lake. Over time, the association expanded its purpose to preserve and protect the lake and its surroundings to enhance the water quality, fishery, safety, and aesthetic value of the lake as a public recreational facility for today and future generations. The waters of Wisconsin belong to everyone and therefore this goal of protecting and enhancing these shared resources is also held by other entities. Some of these entities are governmental while others organizations rely on voluntary participation.

It is important that the FLNML 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. While not an inclusive list, the primary management units regarding Lower Ninemile

Lake are the WDNR, Vilas County Land and Water Conservation Department (VCLWCD), the Vilas County Lakes Association (VCLA), The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and the Wisconsin Valley Improvement Company (WVIC). Each entity will be specifically addressed below.

Action Steps:

See table guidelines on the next page

Partner	Contact Person	Role	Contact Frequency	Contact Basis
County Lakes & Rivers Associations	Vilas: www.vclra.us/home Oneida: www.oclra.com/	Protects county. waters through facilitating discussion and education.	Twice a year or as needed.	Become aware of training or education opportunities, partnering in special projects, or networking on other topics pertaining to Vilas Co. waterways.
Vilas County AIS Coordinator	AIS Coordinator (Ted Ritter – 715.479.3738)	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 Mr. Ritter.
County Land and Water Conservation Departments	Vilas County: 715.479.3721 Oneida County: 715-365-2750	Oversees conservation efforts for land and water projects.	Twice a year or more as needed.	Shoreland habitat and zoning related components can first be addressed through this point of contact
United States Forest Service	Biologist (Mike Peczynski – 715.479.2827)	Oversees conservation efforts on Federal Lands	As needed	To keep informed on USFS management intentions and ecological survey results (i.e. bird surveys)
Wisconsin Valley Improvement Company	Environmental Specialist (Ben Niffenegger – 715.848.2976)	Manages water levels of system and oversees environmental and recreational issues realated to FERC license	As needed	Keep in contact with water level management team, particularly as weather and climate impact outcome.
Great Lakes Indian Fish and Wildlife Commission	Manoomin (wild rice) Biologist (Lisa David – 715.682.6619)	Oversees management and conservation within the ceded territory	As needed	To build off the relationship that was developed during the planning project. Discussion of association's plans to alleviate recreational impediments caused by wild rice.
Townships	Washington (715.479.1669) Three Lakes(715.546.3316)	Part of Lower Ninemile Lake falls within township boundaries.	As needed.	Town staff may be contacted regarding ordinance reviews or questions, and for information on community events.
Wisconsin Department of Natural Resources	Fisheries Biologist (Stephen Gilbert – 715.356.5211)	Manages the fishery of Lower Ninemile.	Once a year, as issues arise.	Stocking activities, scheduled surveys, survey results, volunteer opportunities for improving fishery.
	Lakes Coordinator (Kevin Gauthier – 715.365.8937)	Oversees management plans, grants, all lake activities.	Every 5 years, or more as necessary.	Information on updating a lake management plan (every 5 years) or to seek advice on other lake issues.
	Warden (Tim Price – 715.545.3045)	Oversees regulations handed down by the state.	As needed.	Contact regarding suspected violations pertaining to recreational activity on Lower Ninemile Lake, include fishing, boating safety, ordinance violations, etc.
	Citizens Lake Monitoring Network contact (Sandra Wickman – 715.365.8951)	Provides training and assistance on CLMN monitoring, methods, and data entry.	Twice a year or more as needed.	Late winter: arrange for training as needed, in addition to planning out monitoring for the open water season. Late fall: report monitoring activities.
Wisconsin Lakes	General staff (800.542.5253)	Facilitates education, networking and assistance on all matters involving WI lakes.	As needed. May check website (www.wisconsinlakes.org) often for updates.	PLPOA members may attend WL's annual conference to keep up-to-date on lake issues. WL reps can assist on grant issues, AIS training, habitat enhancement techniques, etc.

Management Goal 2: Maintain Current Water Quality Conditions

Management Action: Monitor water quality through WDNR Citizens Lake Monitoring Network.

Timeframe: Initiate Immediately

Facilitator: FLNML Planning 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.

The Citizens Lake Monitoring Network (CLMN) is a WDNR program in which volunteers are trained to collect water quality information on their lake. At this time, there are no FLNML members currently collecting data as a part of the CLMN. Volunteers trained by the WDNR as a part of the CLMN program begin by collecting Secchi disk transparency data for at least one year, then if the WDNR has availability in the program, the volunteer may enter into the advanced program and collect water chemistry data including chlorophyll-a, and total phosphorus. The Secchi disk readings and water chemistry samples are collected three times during the summer and once during the spring. Note: as a part of this program, these data are automatically added to the WDNR database and available through their Surface Water Integrated Monitoring System (SWIMS).

At a minimum, CLMN volunteers collecting Secchi disk data should be in place on Lower Ninemile Lake. Currently, the advanced CLMN program is not accepting additional lakes to participate in the program. However, it is important to get volunteers on board with the base Secchi disk data CLMN program so that when additional spots open in the advanced monitoring program, volunteers from the Lower Ninemile Lake will be ready to make the transition into more advanced monitoring.

It is the responsibility of the Planning Committee to coordinate new volunteers as needed. When a change in the collection volunteer occurs, it will be the responsibility of the Planning Committee to contact Sandra Wickman (715.365.8951) or the appropriate WDNR/UW Extension staff to ensure the proper training occurs and the necessary sampling materials are received by the new volunteer.

Action Steps:

1. Trained CLMN volunteer(s) collects data and report results to WDNR and to association members during annual meeting.
2. CLMN volunteer and/or LLPLD Commissioners would facilitate new

volunteer(s) as needed

3. Coordinator contacts Sandra Wickman (715.365.8951) to acquire necessary materials and training for new volunteer (s)

Management Goal 3: Prevent Aquatic Invasive Species Introductions to Lower Ninemile Lake

Management Action: Initiate Clean Boats Clean Waters watercraft inspections at Lower Ninemile public access locations.

Timeframe: Initiate Immediately

Facilitator: FLNML Planning Committee

Description: At this time, Lower Ninemile Lake is believed to be free of Eurasian water milfoil and curly-leaf pondweed. At this time, the only invasive species known to exist in the or around the system are reed canary grass and pale yellow iris.

Members of the FLNML would be trained through the Clean Boats Clean Waters (CBCW) program and monitor the public boat landings throughout the summer with higher intensity monitoring occurring during periods of higher use (e.g. weekends and holidays). Because this system is currently free of exotic species, the intent of the boat inspections is to prevent additional invasives from entering the lake through its public access point. Lower Ninemile Lake is not considered a primary fishing-destination in Vilas County nor is not visited on a frequent basis by lake users that do not have property on the lake. Therefore, a modified inspection program aimed at the most busy weekends of the year would be targeted for watercraft inspections by volunteers from Lower Ninemile Lake.

In addition to continuing these efforts, an Education Initiative comprised of developing materials and programs that will promote clean boating and responsible use of these waters (See Education Goal).

Action Steps:

1. Trained CBCW volunteer(s) conducts inspections during high-risk weekends, report results to WDNR and to association members during annual meeting.
2. Members of association periodically attend Clean Boats Clean Waters training session through the volunteer AIS Coordinator (Erin McFarlane – 715.346.4978) to update their skills to current standards. It may be appropriate to be re-trained once every third year.
3. Promote enlistment and training of new volunteers to keep program fresh

Management Action: Initiate aquatic invasive species rapid response plan upon new exotic infestation

Timeframe: Initiate upon exotic infestation

Facilitator: FLNML Planning Committee with professional help as needed

Description: In the event that an aquatic invasive species is suspected on Lower Ninemile Lake, the location would be marked (e.g. GPS, maker buoy) and a plant specimen would be taken to the Vilas County Invasive Species Coordinator (Ted Ritter) for verification. Once verified, the WDNR Lake Coordinator (Kevin Gauthier) should be contacted to discuss a formal monitoring and/or control strategy. The WDNR would also be able to help financially through the AIS Grant Program's Early Detection and Response program. This grant program is non-competitive and doesn't have a specific application deadline, but is offered on a first-come basis to the sponsor of project waters that contain new infestations (less than 5 years). Currently this program will fund up to 75% percent of monitoring and control costs, up to $20,000.

If verified as an aquatic invasive species, the area would be professionally surveyed, either by agency personnel or a private consulting firm during that plant species' peak growth phase (late summer for Eurasian water milfoil, early summer for curly-leaf pondweed). The results of the survey would be used to create a prospective control strategy.

Hand-removal Control Strategy

Small isolated infestations of Eurasian water milfoil and curly-leaf pondweed can most appropriately be controlled using strategic manual removal methods, likely through snorkeling efforts. The responsible use of this technique is well supported by FLNML stakeholders as indicated by approximately 70% of stakeholder survey respondents indicating that they are at least moderately supportive of a manual removal program (Appendix B, Question #27). In order for this technique to be successful, the entire plant (including the root) needs to be removed from the lake. During manual extraction, careful attention would need to be paid to all plant fragments that may detach during the control effort. Additional guidance on hand-removal methods can be found within educational pamphlet, *Eurasian Water Milfoil Manual Removal*, co-authored by the Lumberjack Resource Conservation & Development (RC&D) Council, Inc. and Golden Sands RC&D Council, Inc. This pamphlet can be obtained by contacting the Golden Sands RC&D (www.goldensandsrcd.org).

Herbicide Control Strategy

At this time, the most feasible method to control larger infestations is through herbicide applications, specifically, early-spring treatments with 2,4-D. Likely as a condition of the WDNR herbicide application permit, a spring refinement and verification survey by professionals would precede the treatment as well as post treatment surveys to evaluate the control action. Just over a third (37%) of FLNML stakeholders were not supportive of an herbicide control program (Appendix B, Question #26). Depending on the level of support for an herbicide control program at the time of an aquatic invasive species population discovery; if the population is too large to be controlled using manual removal techniques, the FLNML needs to be educated on potential alternative strategies including what would likely happen if no action is taken. Sixty percent of stakeholder survey respondents indicated that they would like to learn more about aquatic invasive species control methods and 51% indicated they wanted to learn more about the risks of aquatic invasive species control (Appendix B, Question #27). The FLNML would like to address these issues through an educational initiative. FLNML members would create educational pieces within its newsletters, as well as solicit area research managers (e.g. WDNR, Vilas County LWCD, Vilas County Lakes Association, etc) to present at association meetings.

If large populations of aquatic invasive species are located and the FLNML would like to initiate an herbicide control program, a formal monitoring strategy consistent with the Appendix D of the WDNR Guidance Document, *Aquatic Plant Management in Wisconsin* (WDNR 2010) would need to be developed. This form of monitoring is required by the WDNR for all large scale herbicide applications (exceeding 10 acres in size or 10% of the area of the water body that is 10 feet or less in depth) and grant-funded projects where scientific and financial accountability are required.

The presence of wild rice in proximity of potential herbicide treatments is also an issue that requires attention, as this species is particularly vulnerable to early season herbicide treatments (Nelson et al., 2003). It remains unclear whether Eurasian water milfoil and/or curly-leaf pondweed have the ability to displace wild rice when populations overlap. Due to the cultural and ecological significance of wild rice, and the potential for treatment chemicals to adversely affect wild rice, GLIFWC should be consulted well in advance of submitting an application for a potential herbicide treatment.

Action Steps:

1. Engage all stakeholders in the process.
2. Professionally survey and map the aquatic invasive species occurrences.
3. Determine control strategy based upon professional findings and stakeholder support.
4. Initiate hand-removal methods as applicable with guidance from the Hand Removal Pamphlet co-authored by the Lumberjack Resource Conservation & Development (RC&D) Council, Inc. & Golden Sands RC&D Council,

Inc (2012)

5. The association, with help from an herbicide applicator if applicable, obtains the proper permits to implement management action.
   a. WDNR Plant Management and Protection Program: www.dnr.state.wi.us/lakes/plants
   b. The UW Extension Lake List is a great resource for locating an herbicide applicator: www.uwsp.edu/cnr/uwexlakes/lakelist/businessSearch.asp
6. Association updates management plan to reflect changes in control strategy.

Management Goal 4: Improve Fishery Resource and Fishing

Management Action: Work with fisheries managers to enhance the overall fishery on Lower Ninemile Lake

Timeframe: Initiate immediately

Facilitator: Planning Committee

Description: The FLNML understands the difficulties in managing Lower Ninemile Lake's fishery, especially since the water levels are brought down over the winter to levels that offer very little refugia for fish populations. That being said, they would like to continue to work with the WDNR fisheries biologist (Steve Gilbert – 715.358.9229) to protect and enhance the overall fishery of Lower Ninemile Lake. Stakeholders have expressed interest in learning from fisheries managers why the walleye stocking program ended on the lake and if there were other fish species that would be more appropriate for stocking or enhancing their population.

Action Steps:

See description above

Management Goal 5: Maintain Riparian Navigability on Lower Ninemile Lake

Management Action: Support reasonable and responsible actions by shoreland property owners to gain navigational access to open water areas of Lower Ninemile Lake

Timeframe: Upon plan acceptance

Facilitator: Planning Committee

Description: The FLNML members enjoy Lower Ninemile Lake for its aesthetic beauty and wildlife habitat. After investigating multiple sources, it is unclear of the origin of wild rice on Lower Ninemile Lake. Wild rice populations on Lower Ninemile Lake have been established (or potentially reestablished) within the last 10-15 years. As indicated within the Aquatic Plant Section, Lower Ninemile Lake is excellent habitat for wild rice. But this species' success has lead to navigational concerns and riparian user conflicts.

Approximately 75% of stakeholder survey respondents indicated that wild rice *often* or *always* negatively impacts their enjoyment of the lake (Appendix B, Question #23). Overwhelmingly, 85.7% of stakeholder survey respondents believed aquatic plant control is needed (answered *definitely yes* or *probably yes*) on Lower Ninemile Lake (Appendix B, Question #25).

WDNR and GLIFWC jointly oversee the management and harvest of this culturally and ecologically significant plant species. While manual cutting and raking of other native aquatic plant species within a 30-foot-wide area containing a pier, boatlift, or swim raft is exempt from a state permit, the removal of wild rice always requires a permit.

During this management planning project, Onterra ecologists facilitated a meeting between FLNML planning committee members, the WDNR, and GLIFWC regarding wild rice-related issues. Transfer of education and information occurred in both directions. Additional conversations between Onterra, WDNR, and GLIFWC also took place following the meeting. It is suggested that the framework below both promotes wild rice as a resource and offers resolution to riparian use conflicts.

Because wild rice populations can vary greatly from year to year, this management action needs to be flexible and account for differing levels of associated user conflicts. Natural wild rice population fluctuations resulted in relatively limited riparian user conflicts in 2012. WDNR and GLIFWC biologists had planned to visit the lake with Onterra during the late-summer of 2012 to evaluate the perceived recreational impairment. However, the FLNML conveyed that wild rice populations were not causing wide-spread user conflicts in 2012 and therefore a site visit was not necessary.

Two management scenarios have been developed as a part of this management action, accounting for multiple tiers of wild rice population and density. Please note that while a 30-foot manual removal lane is allowed without a permit for native aquatic plants, the management actions below have been reduced to a 20-foot lane to limit this management plan's foot print and potential cumulative impacts. A manual removal plan has been developed in which 26 lanes would be potentially be considered for inclusion within the removal plan based upon the following scenarios (Map 8). If all 26 lanes required removal, the cumulative footprint would be approximately 4.3 acres of the approximately 233 acres of the Lower Ninemile Lake found to be dominated by northern wild rice during 2011 (Map 7). These lanes were adapted from already established riparian navigation use patterns.

Scenario 1: Manual removal of native plants, excluding wild rice

On an as-needed basis, manually remove native plants (aside from wild rice) within a 20-foot lane out from a riparian's dock to open water in years when the wild rice does not significantly impact navigation in these areas. No action would be taken towards wild rice during these years (e.g. 2012). A WDNR permit is not required for these activities as long as wild rice is not removed.

Scenario 2: Obtain a permit to remove wild rice

a) On an as-needed basis, manual removal of wild rice and native plants within a 20-foot navigation lane out from a riparian's dock to open water in years when the wild rice impairs lake access, to the level that motor boat navigation is *impaired*. The FLNML has identified a private firm that could be hired to carry out the hand-removal strategy, in addition to lake residents.

A single permit application from the FLNML would be applied for annually from the WDNR. Because this process will need a formal review by the WDNR and GLIFWC (through Voigt Intertribal Task Force), the permit should be applied for each year in early January even though it may not be necessary to implement these actions each year. When the FLNML believes that impairment exists, they will provide proof (i.e. photographs) to the WDNR Lake Specialist that the following conditions exist:

- Rake tows within the impaired areas are overflowing with plants (total rake fullness = 3)
- Target plants are surface matted and canopied at the surface

Based upon this information, the WDNR will schedule a site visit to confirm that impairment of navigation exists in each of the areas of concern proposed for manual removal. If the WDNR confirms that impairment of navigation exists, and if all other permit conditions have been met, a permit will be issued to manually remove native plants and wild rice within the permitted areas. Additional information on impairment of navigation and nuisance conditions is provided within *Aquatic Plant Management Strategy, Northern Region WDNR* (Appendix F).

b) If Scenario 2a proves to be ineffective at alleviating navigation impairment after a few trial years, the FLNML would investigate/give consideration to the use of mechanical removal techniques to allow navigation from their property to open water. In order for the FLNML to implement this action, the WDNR would request the following information be collected/provided to them as a potential condition of the mechanical harvesting permit:

- Documentation that Scenario 2a did not meet the FLNML management goals.
- A professional mapping survey of the wild rice within and adjacent to areas of proposed control.
- A ground-truthed and professionally produced map of mechanical harvest locations.
- Detailed outline of the specific equipment to be used within the management action.

Along with other state statues, the WDNR administrative code NR 109 is followed regarding permit issuance for removal of aquatic plants if either Scenario 2a or 2b is being considered. The purpose of this code is to ensure that control of aquatic plants is permitted "in a manner consistent with sound ecosystem management, shall consider cumulative impacts, and shall minimize the loss of ecological values in the body of water."

Excessive plant growth is often associated with increased nutrient levels. In order to minimize cumulative impacts to the ecosystem, shoreland best management practices (BMPs) for shoreland properties would need to be in place (or are in the process of being implemented) for Scenario 2a or 2b to be implemented. Shoreland property owners should use the information provided within the Shoreland Condition Assessment Section (3.3) as well as Appendix G to determine if their individual shoreland is in healthy condition and follows BMPs. The WDNR would likely conduct secondary site visits to confirm that shoreland BMPs are being followed in the areas requesting a permit.

The FLNML would like the WDNR to consider granting a multi-year permit after an agreed upon strategy has been implemented successfully for a number of years. The FLNML understand that while a multiyear permit may be in place, they would not be able to conduct the manual removal activities until receiving approval from the WDNR that the impairment exists.

In order to understand the cumulative impacts of these management actions, the FLNML would periodically (e.g. once every 5 years) have the wild rice professionally mapped following implementation of management actions.

Action Steps:

See description above

6.0 METHODS

Lake Water Quality

Baseline water quality conditions were studied to assist in identifying potential water quality problems in Lower Ninemile Lake (e.g., elevated phosphorus levels, anaerobic conditions, etc.). Water quality was monitored at the deepest point in the lake that would most accurately depict the conditions of the lake (Map 1). Samples were collected with a 3-liter Van Dorn bottle at the subsurface (S) and near bottom (B). Sampling occurred once in spring, fall, and winter and three times during summer. Samples were kept cool and preserved with acid following standard protocols. All samples were shipped to the Wisconsin State Laboratory of Hygiene for analysis. The parameters measured included the following:

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

In addition, during each sampling event Secchi disk transparency was recorded and a temperature, pH, conductivity, and dissolved oxygen profile was be completed using a Hydrolab DataSonde 5.

Watershed Analysis

The watershed analysis began with an accurate delineation of Lower Ninemile Lake's drainage area using U.S.G.S. topographic survey maps and base GIS data from the WDNR. The watershed delineation was then transferred to a Geographic Information System (GIS). These data, along with land cover data from the Wisconsin initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND) were then combined to determine the watershed land cover classifications. These data were modeled using the WDNR's Wisconsin Lake Modeling Suite (WiLMS) (Panuska and Kreider 2003)

Aquatic Vegetation

Curly-leaf Pondweed Survey

Surveys of curly-leaf pondweed were completed on Lower Ninemile Lake during a June 22, 2011 field visit, in order to correspond with the anticipated peak growth of the plant. Visual inspections were completed throughout the lake by completing a meander survey by boat.

Comprehensive Macrophyte Surveys

Comprehensive surveys of aquatic macrophytes were conducted on Lower Ninemile Lake to characterize the existing communities within the lake and include inventories of emergent, submergent, and floating-leaved aquatic plants within them. The point-intercept method as described in "Appendix D" of the Wisconsin Department of Natural Resource document, Aquatic Plant Management in Wisconsin, (April, 2007) was used to complete this study on July 28, 2011. A point spacing of 75 meters was used resulting in approximately 603 points.

Community Mapping

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

Representatives of all plant species located during the point-intercept and community mapping survey were collected and vouchered by the University of Wisconsin – Steven's Point Herbarium. A set of samples was also provided to the FLNML.

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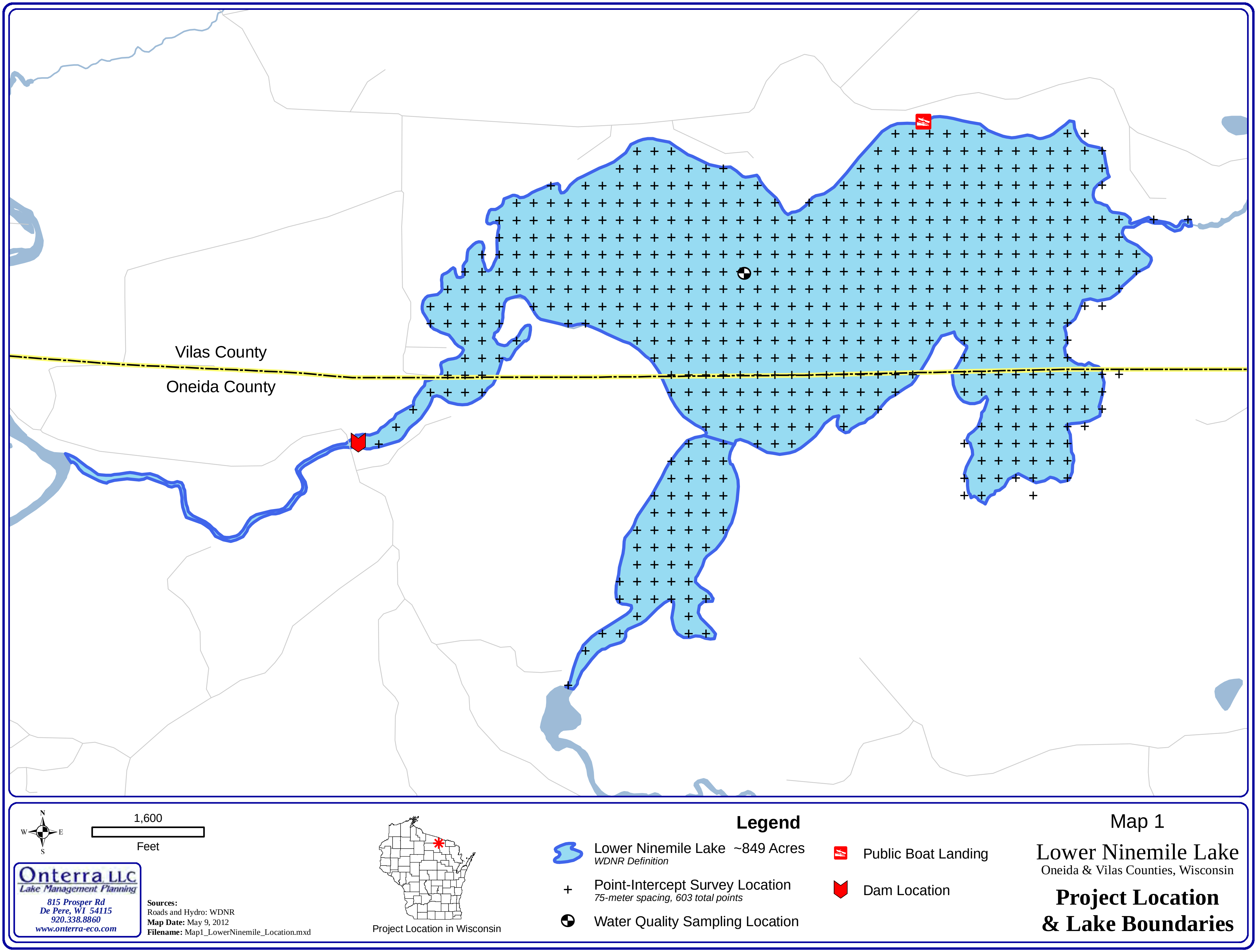
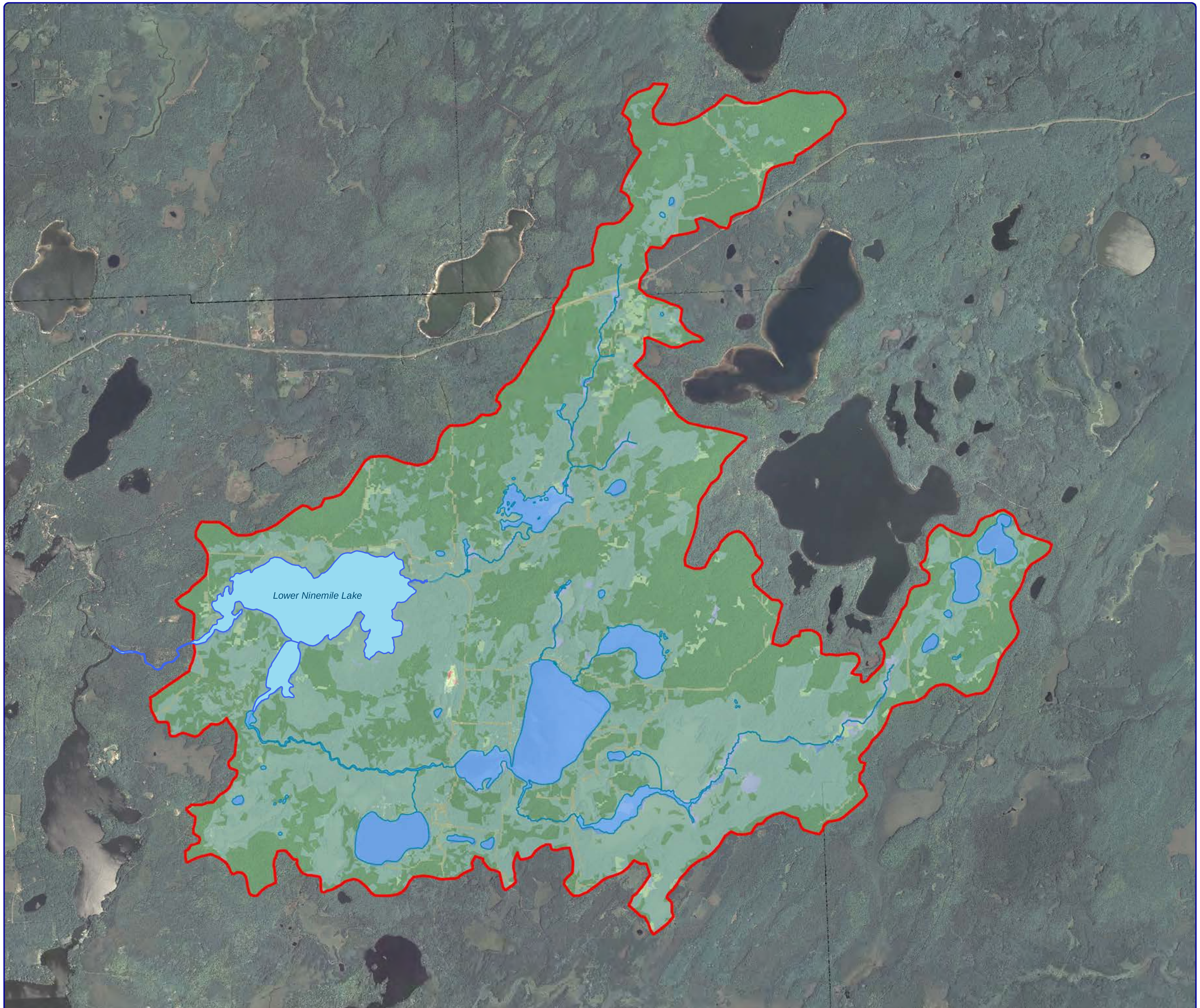
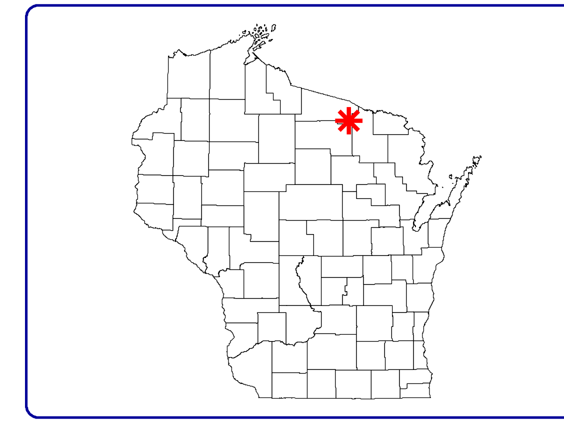


Vilas County
Oneida County
N
S
E
W
1,600
Feet
Onterra LLC
Lake Management Planning
815 Prosper Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com
Sources:
Roads and Hydro: WDNR
Map Date: May 9, 2012
Filename: Map1_LowerNinemile_Location.mxd
Project Location in Wisconsin
Legend
Lower Ninemile Lake ~849 Acres
WDNR Definition
Point-Intercept Survey Location
75-meter spacing, 603 total points
Water Quality Sampling Location
Public Boat Landing
Dam Location
Map 1
Lower Ninemile Lake
Oneida & Vilas Counties, Wisconsin
Project Location
& Lake Boundaries



Map 2
Lower Ninemile Lake
Oneida & Vilas Counties, Wisconsin

Watershed Boundary & Land Cover Types



Project Location in Wisconsin

Legend
- Watershed Boundary

Land Cover Types
- Forest
- Forested Wetlands
- Wetlands
- Open Water
- Lower Ninemile Lake
- River or Stream
- Rural Open Space
- Pasture/Grass
- Rural Residential
- Urban - Medium Density

1
Miles

N
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Sources:
Land Cover: NCLD, 2006
Hydro: WDNR
Orthophotography: NAIP, 2010
Map Date: May 9, 2012
Filename: Map2_LowerNinemile_Watershed.mxd

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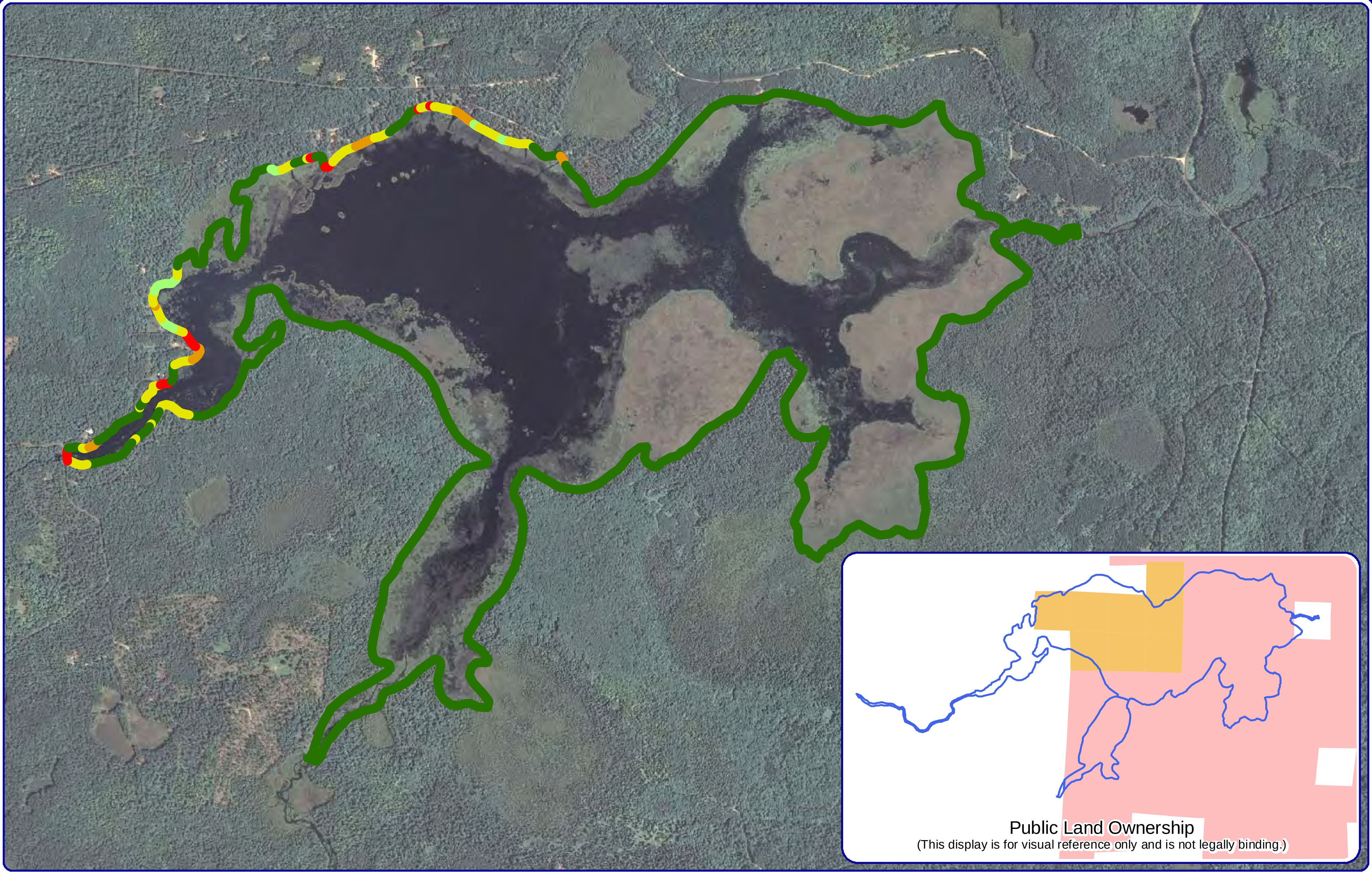

1,550

Feet

Onterra LLC
Lake Management Planning
815 Prosper Rd
De Pere, WI 54115
920.338.8860
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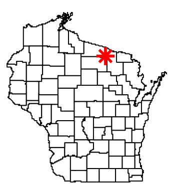
Sources:
Orthophotography: NAIP, 2010
Shoreline Assessment: Onterra, 2011
Land Ownership: USDA Forest Service,
Board of Commissioners of Public Lands (BCPL)
Map date: May 7, 2012
Filename: Map3_LowerNinemile_2011SA.mxd



Project Location in Wisconsin

Legend

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

Land Ownership (Inset map)

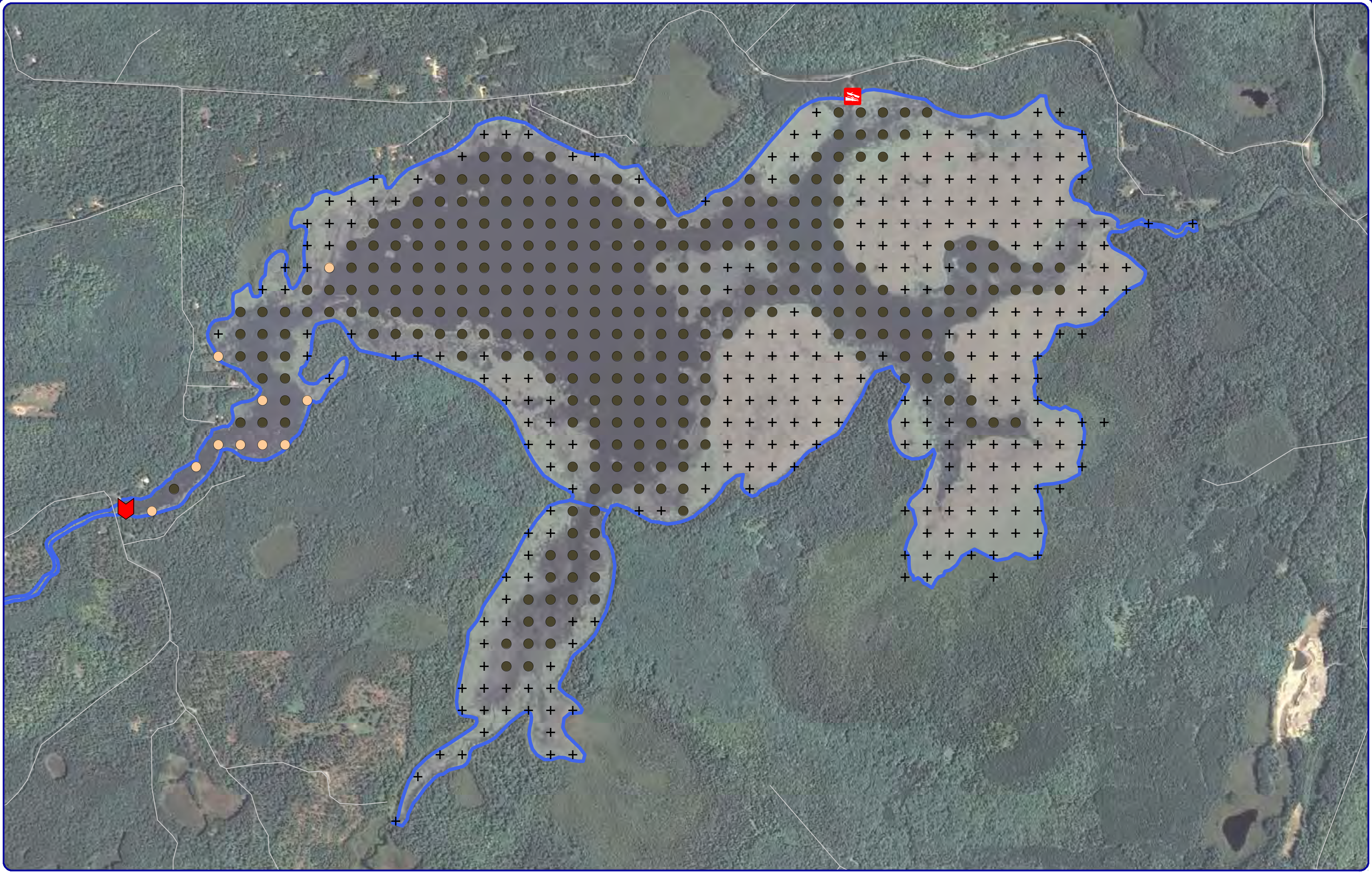
- Federal
- State (BCPL)
- County (none shown)

Map 3

Lower Nine Mile Lake

Vilas County, Wisconsin

Shoreline Condition



1,400

Feet

Onterra LLC
Lake Management Planning
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De Pere, WI 54115
920.338.8860
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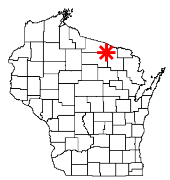
Sources:
Hydro: WDNR
Orthophotography: NAIP, 2010
Point-intercept Survey: Onterra, 2011
Map Date: May 9, 2012
Filename: Map4_LowerNinemile_SubstratePI.mxd



Project Location in Wisconsin

Legend

Point-intercept Sampling Locations

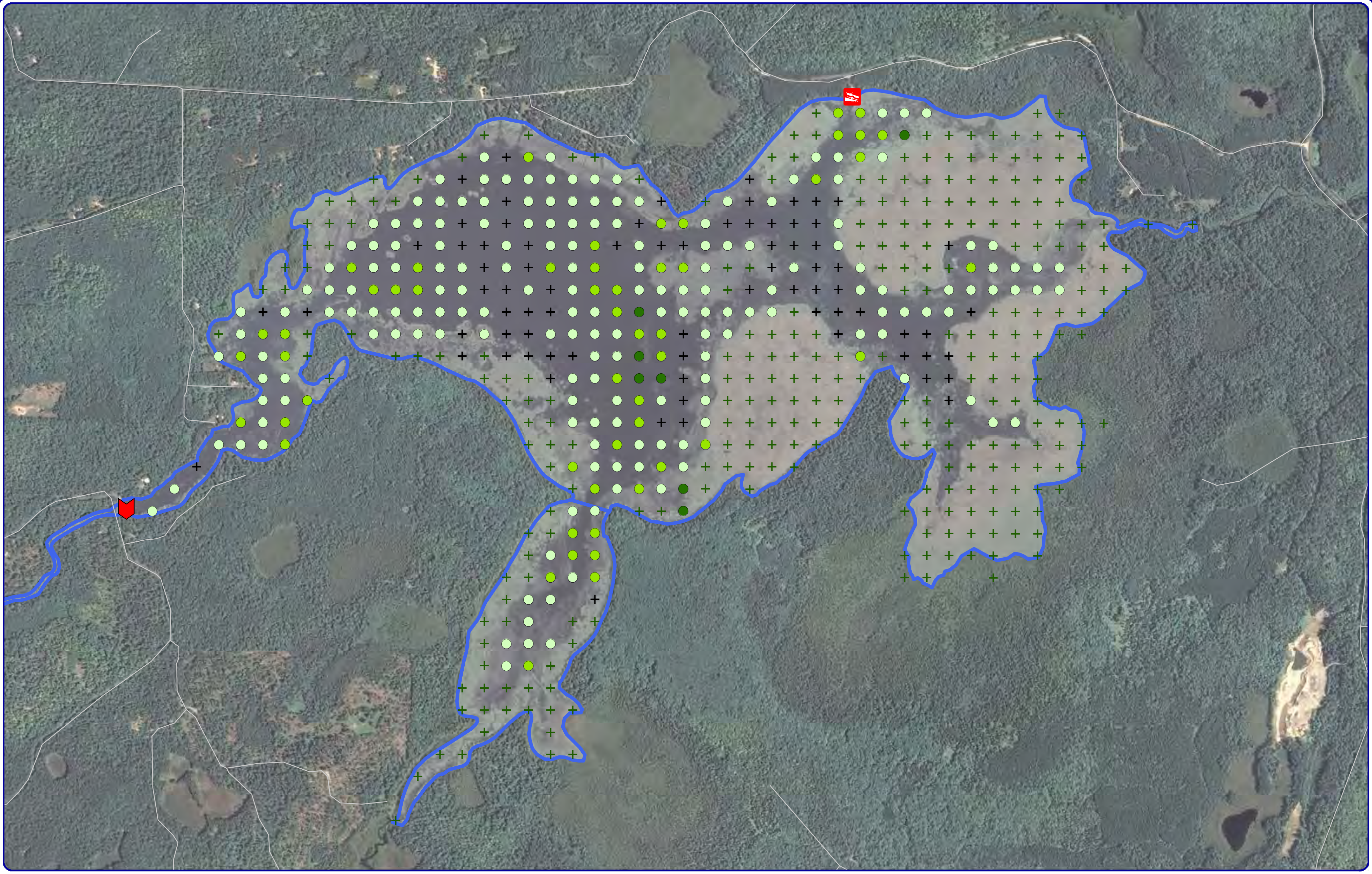
- + No Data (Non-navigable)
- Muck
- Sand
- Rock (None)
- Public Boat Landing
- Dam Location

Map 4

Lower Ninemile Lake

Oneida & Vilas Counties, Wisconsin

2011 PI Survey: Substrate Types

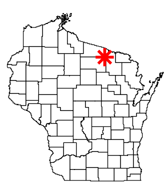


N
W E
S

1,400
Feet

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

Sources:
Hydro: WDNR
Orthophotography: NAIP, 2010
Point-intercept Survey: Onterra, 2011
Map Date: May 9, 2012
Filename: Map5_LowerNinemile_TRFPI.mxd



Project Location in Wisconsin

Legend

Point-intercept Sampling Locations

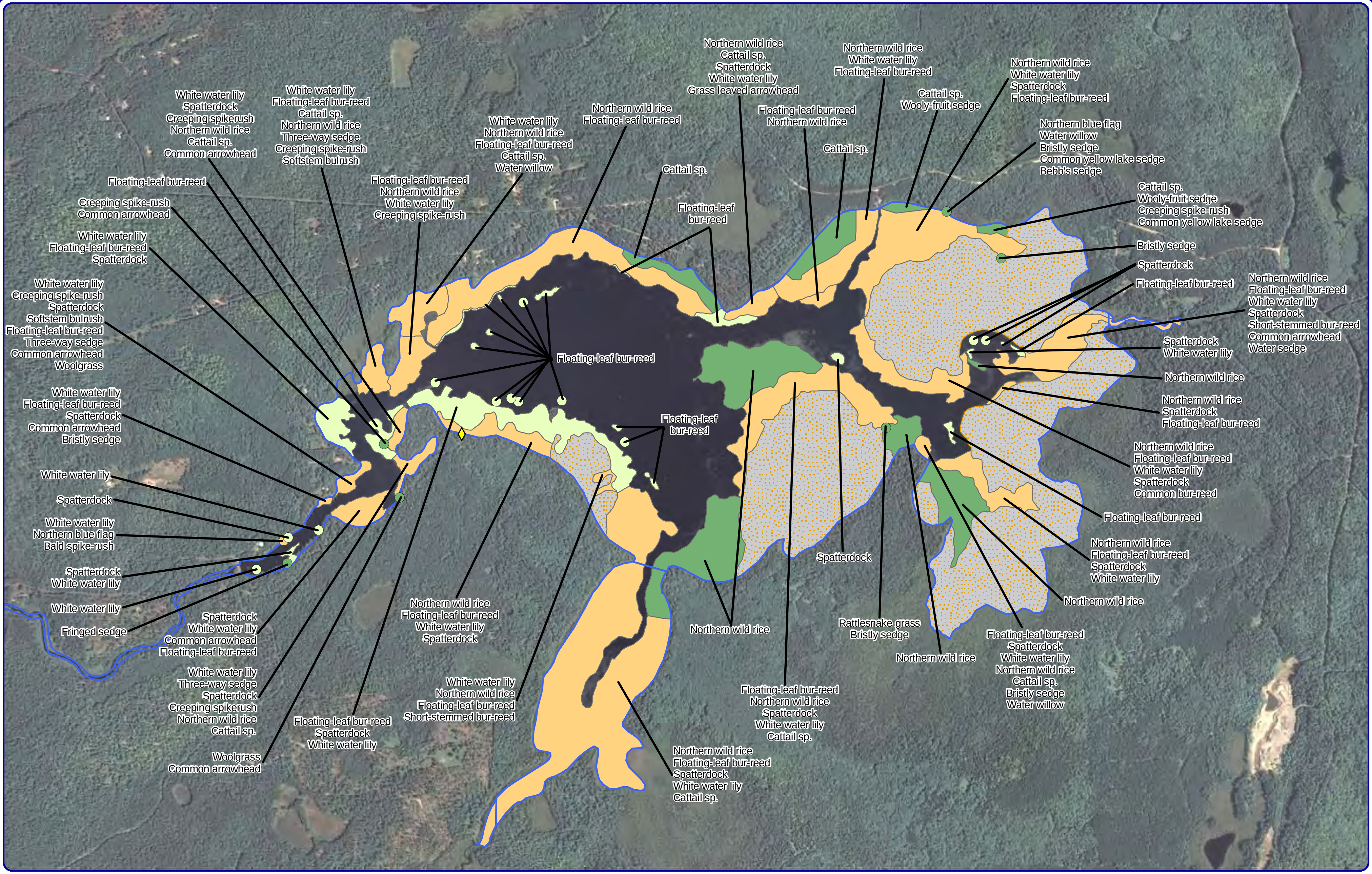
- No Data (Non-navigable)
- No Vegetation
- Total Rake-fullness = 1
- Total Rake-fullness = 2
- Total Rake-fullness = 3
- Public Boat Landing
- Dam Location

Map 5

Lower Ninemile Lake

Oneida & Vilas Counties, Wisconsin

2011 PI Survey:
Aquatic Vegetation Distribution



N
W E
S

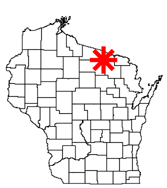
1,650

Feet

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

Sources:
Orthophotography: NAIP 2010
Hydro: WDNR
Aquatic Plants: Onterra
Pale Yellow Iris: USFS

Map Date: April 2, 2013



Project Location shown in red.

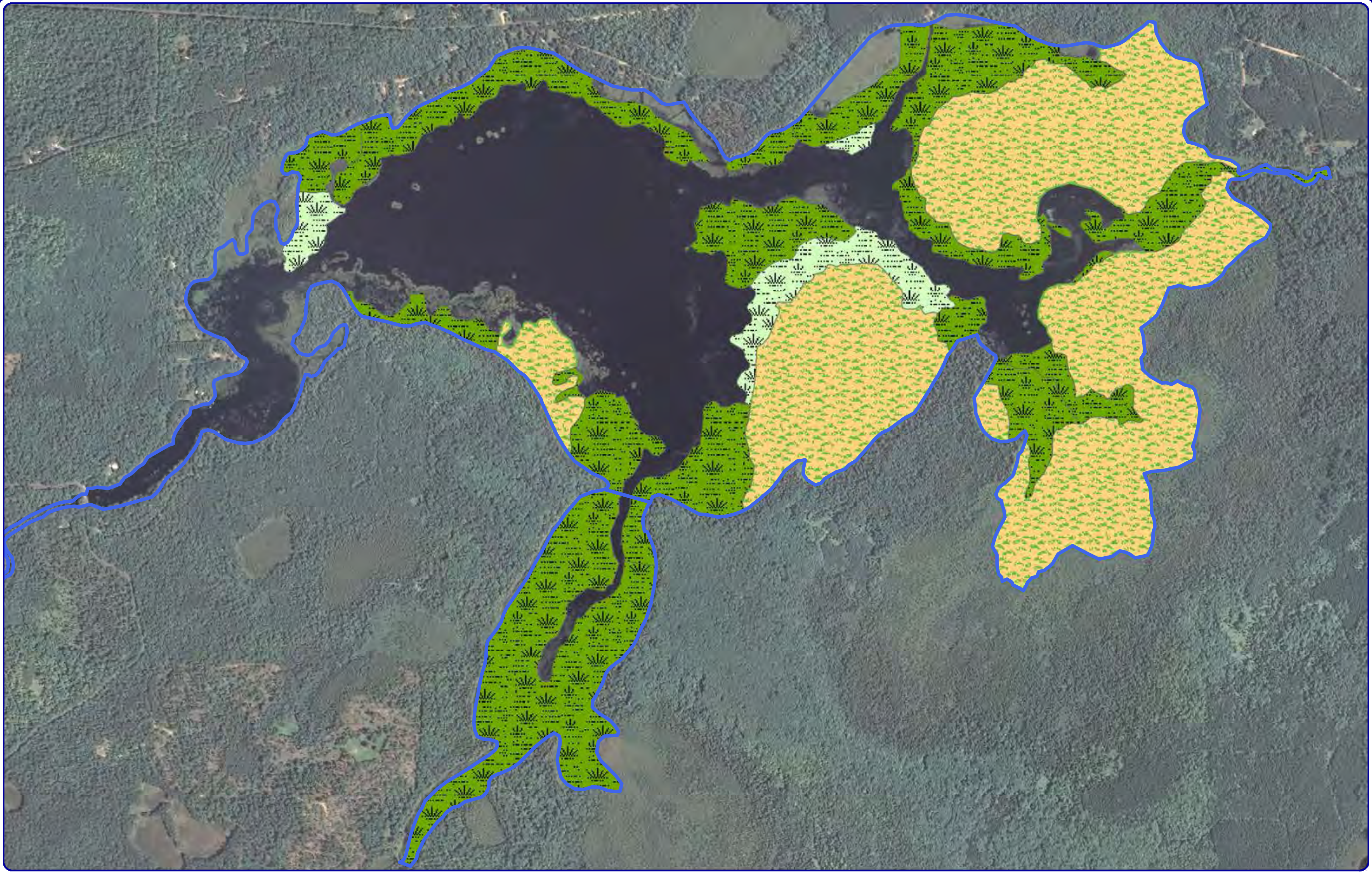
Legend

Large Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- Wet Meadow Area (mixed sedges, grasses, reeds)

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- Pale Yellow Iris (Exotic) *(Approximate location from USFS, 2011)*

Map 6
Lower Nine Mile Lake
Vilas County, Wisconsin

Aquatic Plant Communites



N W E S

1,250

Feet

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Lake Management Planning
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920.338.8860
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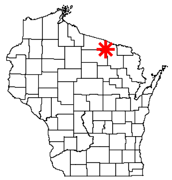
Sources:
Aquatic Plants: Onterra, 2011
Orthophotography: NAIP, 2010
Hydro: WDNR
Map date: May 7, 2012
Filename: Map6_LowerNinemile_RiceDist_2011.mxd



Project Location in Wisconsin

Legend

- Northern wild rice-dominated Community
- Mixed Nothern wild rice & Floating-leaf bur-reed Community
- Wet Meadow Area (mixed sedges, grasses, & reeds)

Map 7

Lower Ninemile Lake

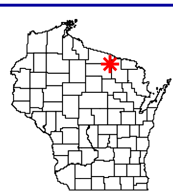
Oneida & Vilas Counties, Wisconsin

2011 Wild Rice Distribution

400
Feet

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

Sources:
Aquatic Plants: Onterra, 2011
Orthophotography: NAIP, 2010
Hydro: WDNR
Map date: April 2, 2013
Filename: Map8_LNM_Harvest.mxd



Project Location in Wisconsin

Legend

- Harvest Lane (20-foot wide)
- Wild Rice Dominated Plant Community
- Emergent Plant Community
- Floating-leaf Plant Community

Map 8

Lower Ninemile Lake

Oneida & Vilas Counties, Wisconsin

Potential Manual Removal Plan v.1