Lake Mildred

Oneida County, Wisconsin

Comprehensive Management Plan

August 2013

Sponsored by:

Lake Mildred Property Owners Association

WDNR Grant Program

LPL-1408-11, LPL-1409-11 & LPL-1410-11

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Onterra LLC
Lake Management Planning

Lake Mildred

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1.0 INTRODUCTION

Lake Mildred, Oneida County, is an approximately 172-acre seepage lake with a maximum depth of 45 feet (Map 1). The waterbody is connected to 41-acre Clear Lake through an intermittent channel. Lake Mildred contains 33 native aquatic plant species, of which stoneworts were the most common plant. No aquatic invasive species are known to exist in Lake Mildred.

Field Survey Notes

Crystal clear water, though water levels are quite low from OHWM. Eastern and central basin substrates are primarily sand and rock, while western-most basin has mucky sediment and more elodeid species.

Photograph 1.0-1 Lake Mildred, Oneida County

Lake at a Glance*

Morphology	
Acreage	172**
Maximum Depth (ft)	45**
Mean Depth (ft)	21.6*
Shoreline Complexity	8.0
Vegetation	
Curly-leaf Survey Date	June 29, 2011
Comprehensive Survey Date	July 21, 2011
Number of Native Species	33
Threatened/Special Concern Species	*Potamogeton bicupulatus* & *Utricularia resupinata*
Exotic Plant Species	-
Simpson's Diversity	0.93
Average Conservatism	8.2
Water Quality	
Trophic State	Oligotrophic-Mesotrophic
Limiting Nutrient	Phosphorus
Water Acidity (pH)	6.8
Sensitivity to Acid Rain	Low
Watershed to Lake Area Ratio	15:1

**These parameters/surveys are discussed in the sections to follow.*
***Condition at Ordinary High Water Mark (OHWM)*

Lake Mildred is located just west of the city of Rhinelander, within the Wisconsin River drainage basin. Under normal to high water level conditions, the lake is connected to nearby Clear Lake through a small channel. However, low water levels, which have affected many northern Wisconsin seepage lakes, have reduced navigation from Lake Mildred to Clear Lake in recent years.

The Lake Mildred Property Owners Association (LMPOA) submitted a grant proposal to the Wisconsin Department of Natural Resources (WDNR) in August of 2010 in hopes of receiving a lake management planning grant to partially fund a comprehensive management plan. Their efforts were successful, and field studies related to the project began in 2011.

The LMPOA became interested in creating a lake management plan for several reasons. First, there were several concerns lake residents had regarding the lake including low water levels, public access, fishing opportunity, etc. Secondly, the LMPOA wishes to be better prepared to react if Lake Mildred becomes established with an aquatic invasive species (AIS). With many other northern Wisconsin lakes around them becoming infested with AIS, this has become a great concern of many lake stakeholders across the state. Lastly, the LMPOA understands the importance of collecting baseline data and gaining knowledge about the ecosystem as a whole.

Special Note on Clear Lake

Clear Lake riparian owners had only recently joined the LMPOA at the time of this project's start. While intensive studies on Clear Lake were not included as part of the project proposal, a reconnaissance aquatic plant survey was completed to search Clear Lake for AIS as well as Lake Mildred. Additionally, Clear Lake residents were included within stakeholder participation activities, such as meetings with Onterra staff and the stakeholder survey. While the report sections and Implementation Plan focus upon Lake Mildred, with the exception of those aspects dealing with Lake Mildred's public access, all of the goals and actions described in this report are applicable to Clear Lake as well.

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.

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

Kick-off Meeting
On June 18, 2011, a project kick-off meeting was held at the Newbold Town Hall to introduce the project to the general public. The meeting was announced through a mailing and personal contact by LMPOA board members. The attendees observed a presentation given by Tim Hoyman and Dan Cibulka, both aquatic ecologists with Onterra. Their 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
On April 20, 2012, Tim Hoyman and Dan Cibulka met with the Lake Mildred Planning Committee to present the results of the scientific studies that had taken place on Lake Mildred and Clear Lake in 2011. During the meeting, committee members asked many questions regarding the study, and also brought forth additional topics such as lake water levels, fish habitat, ways of preventing aquatic invasive species introduction, and public lake usage. Following these discussions, Onterra staff and committee members held a brainstorming session on challenges Lake Mildred and the LMPOA may face in the near future, and then discussed management goals and actions the group could implement to address these challenges.

Project Wrap-up Meeting
On August 10, 2013, the LMPOA held a special meeting regarding the completion of the Lake Mildred Management Planning Project. Dan Cibulka of Onterra presented a summary of the project's results to the attendees, and outlined the goals and actions the Lake Mildred and Clear Lake Planning Committee had created through the planning process.

Management Plan Review and Adoption Process
The Lake Mildred Planning Committee received the Results Section (Section 3.0) of the Lake Mildred Management Plan in early April 2012, in preparation for the planning committee meeting. Comments and suggestions on this material were discussed at the planning meeting and revisions made to the document in the month following. On October 2 of 2012, a draft of

the Implementation Plan was provided to the planning committee for review. In late December, the committee had finished reviewing the full document, and accepted the plan. A draft version of the full management plan was sent to the WDNR for further review that same month. In July of 2013, the WDNR provided comments on the management plan, which were incorporated into the final version of the document in August of 2013.

Stakeholder Survey

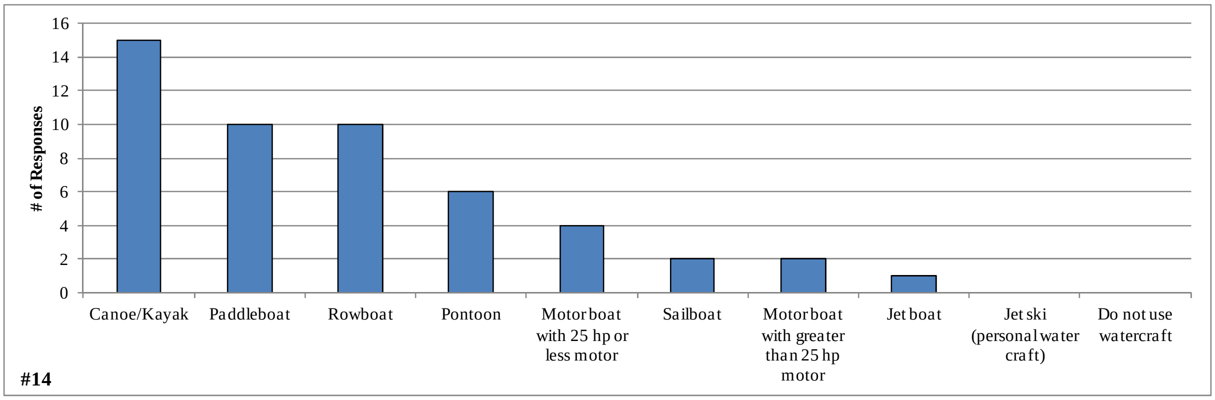
During fall of 2011, LMPOA members and Onterra staff created an anonymous survey that would be distributed to lake stakeholders. This survey was approved by a WDNR social scientist in October of 2011. Following this, an eight-page, 36-question survey was mailed to 138 riparian property owners in the Lake Mildred watershed. 57 percent of the surveys were returned and those results were entered into a spreadsheet by members of the Lake Mildred 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 Lake Mildred. The majority of stakeholders (44%) are year-round residents, while 28% visit on weekends through the year and 24% live on the lake during the summer months only. 46% of stakeholders have owned their property for less than 15 years, while about the same amount (47%) have owned their property for over 20 years.

The following sections (Water Quality, Watershed, Aquatic Plants and Fisheries Data Integration) discuss the stakeholder survey data with respect these particular topics. Figures 2.0-1 and 2.0-2 highlight several other questions found within this survey. Not surprisingly, on Clear Lake, passive types of watercraft (canoe/kayak, paddleboat, rowboat) were popular choices (Question #14). For Lake Mildred residents, canoes & kayaks were also a popular option, along with powered watercrafts such as motorboats with larger (25+ horsepower) motors and pontoon boats (Question #14). On relatively small lakes, the importance of responsible boating activities is increased. The need for responsible boating also increases during weekends, holidays, and during times of nice weather or good fishing conditions as well, due to increased traffic on the lake. Boat traffic was listed as a factor potentially impacting Lake Mildred in a negative manner (Question #26), and was also ranked highly (4^{th} of 17 options) on a list of stakeholder's top concerns regarding the lake (Question #27).

A concern of stakeholders noted throughout the stakeholder survey (see Question #25, #26 and survey comments – Appendix B) was water levels within Lake Mildred and Clear Lake, loss of fish habitat and lakeshore development. Water levels are controlled largely because of Lake Mildred and Clear Lake's hydrology and precipitation patterns within northern Wisconsin. This issue is touched upon within the Watershed Section, while aquatic habitat and shoreline development is discussed within the Aquatic Plant Section, the Summary & Conclusions section and within the Implementation Plan.

Clear Lake Survey Respondents - Question #14: What types of watercraft do you currently use on the lake?



Lake Mildred Survey Respondents - Question #14: What types of watercraft do you currently use on the lake?

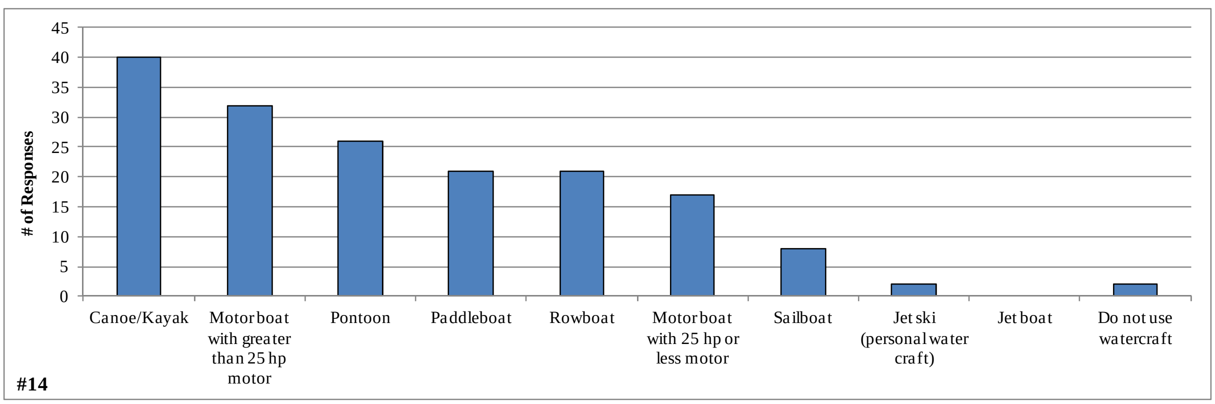
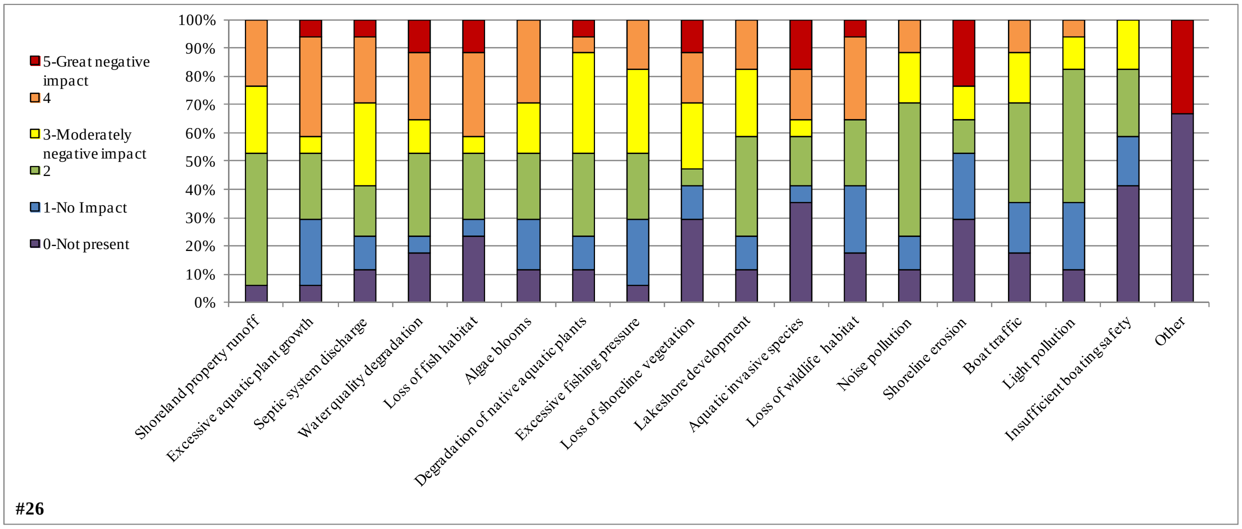


Figure 2.0-1. Select survey responses from the Lake Mildred & Clear Lake Stakeholder Survey. Additional questions and response charts may be found in Appendix B.

Clear Lake Survey Respondents - Question #26: To what level do you believe these factors may be negatively impacting Clear Lake?



Lake Mildred Survey Respondents - Question #26: To what level do you believe these factors may be negatively impacting Lake Mildred?

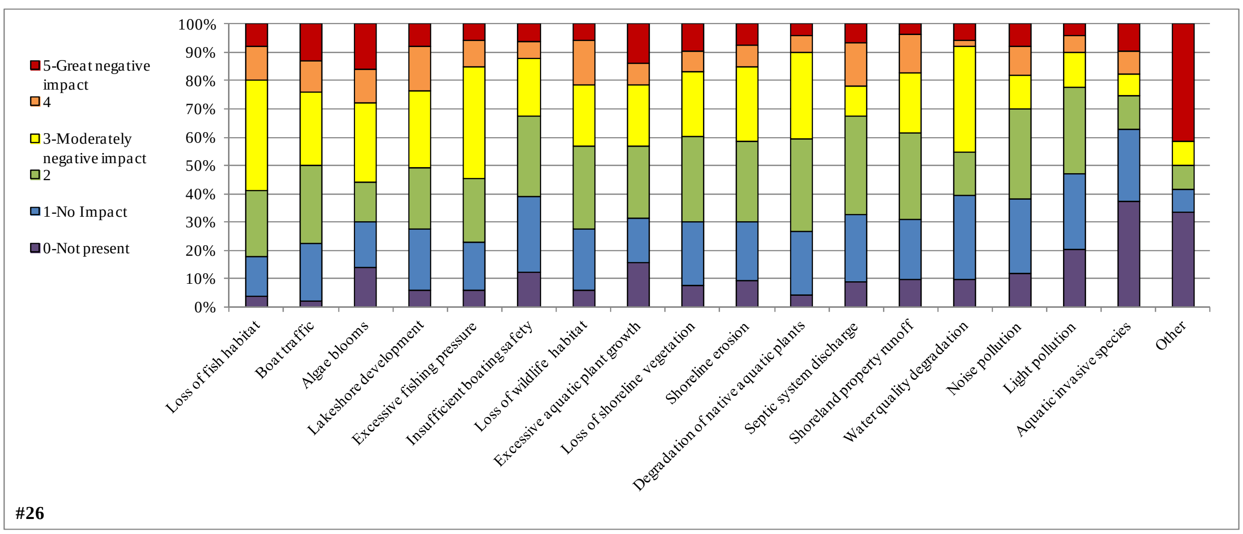
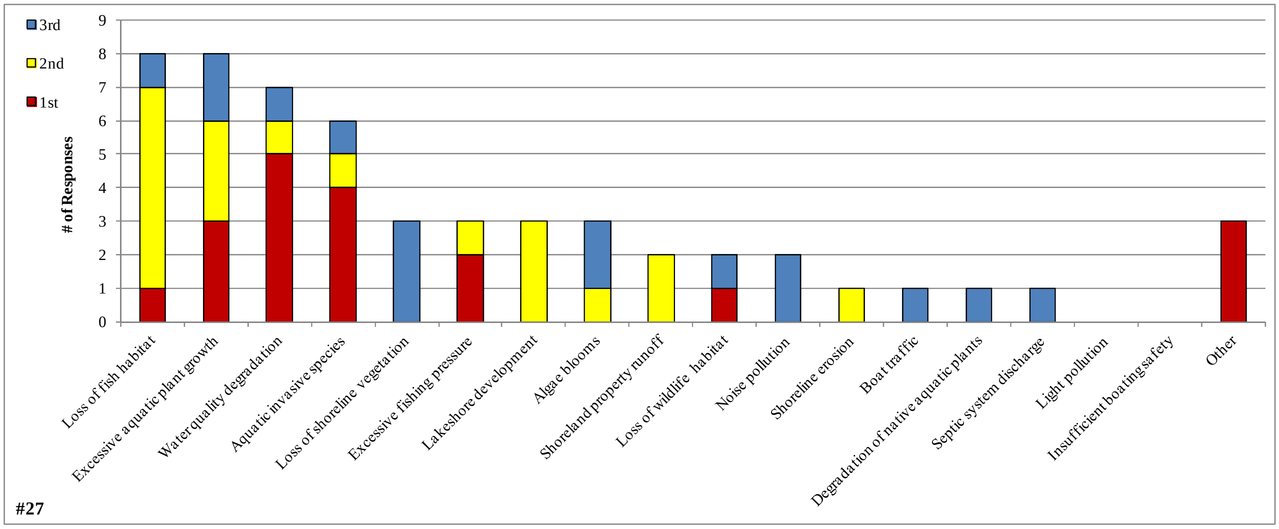


Figure 2.0-2. Select survey responses from the Lake Mildred & Clear Lake Stakeholder Survey, continued. Additional questions and response charts may be found in Appendix B.

Clear Lake Survey Respondents - Question #27: Please rank your top three concerns regarding Clear Lake.



Lake Mildred Survey Respondents - Question #27: Please rank your top three concerns regarding Lake Mildred.

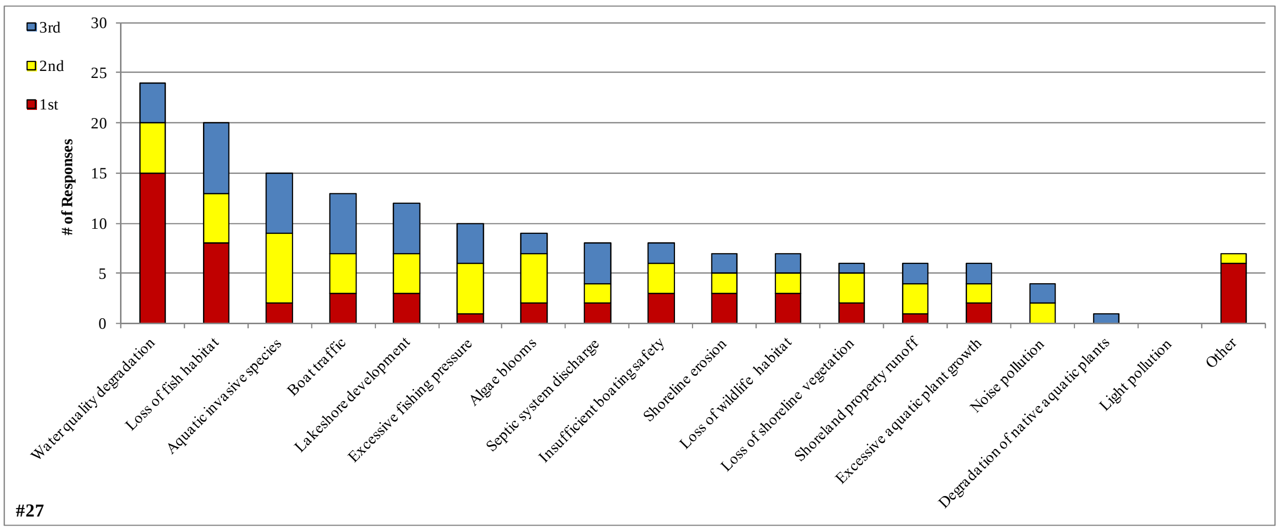


Figure 2.0-3. Select survey responses from the Lake Mildred & Clear Lake Stakeholder Survey, continued. Additional questions and response charts may be found in Appendix B.

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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 Lake Mildred is compared to other lakes in the state with similar characteristics as well as to lakes within the northern region (Appendix C). In addition, the assessment can also be clarified by limiting the primary analysis to parameters that are important in the lake's ecology and trophic state (see below). Three water quality parameters are focused upon in the Lake Mildred'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 descending 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.

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.

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.

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 Lake Mildred 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 all of the 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), which incorporates the maximum depth of the lake and the lake's surface area, is used to predict whether the lake is considered a shallow (mixed) lake or a deep (stratified) lake. The lakes are further divided into classifications based on their hydrology and watershed size:

> **Seepage Lakes** have no surface water inflow or outflow in the form of rivers and/or streams.
>
> **Drainage Lakes** have surface water inflow and/or outflow in the form of rivers and/or streams.
>
> > Headwater drainage lakes have a watershed of less than 4 square miles.
> >
> > Lowland drainage lakes have a watershed of greater than 4 square miles.

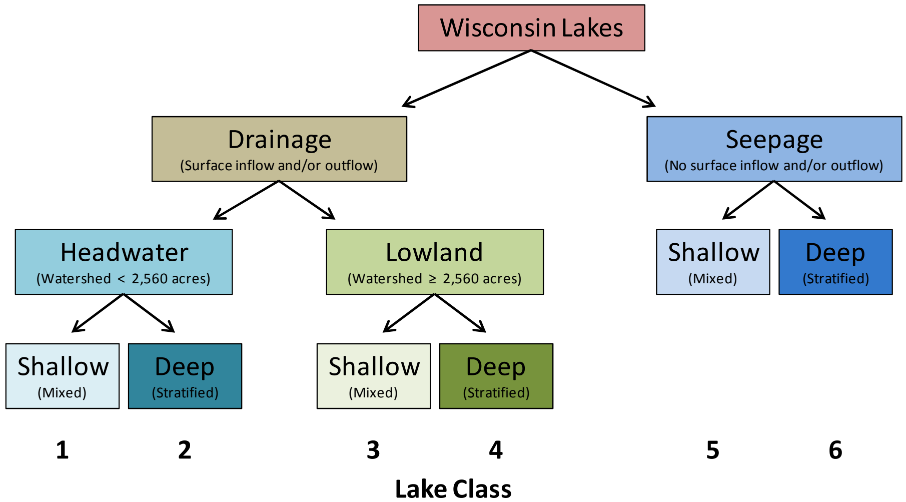

Figure 3.1-1. Wisconsin Lake Classifications. Lake Mildred is classified as a deep (stratified), seepage lake (Class 6). Adapted from WDNR PUB-SS-1044 2008.

Lathrop and Lillie 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. Lake Mildred is within the Northern Lakes and Forests ecoregion.

The Wisconsin 2010 Consolidated Assessment and Listing Methodology (WisCALM – WDNR 2009), created by the WDNR, is a process by which the general condition of Wisconsin surface waters are assessed to determine if they meet federal requirements in terms of water quality under the Clean Water Act. It is another useful tool in helping lake stakeholders understand the health of their lake compared to others within the state. This method incorporates both biological and physical-chemical indicators to assess a given waterbody's condition. One of the assessment methods utilized is Carlson's Trophic State Index (TSI). They divided the phosphorus, chlorophyll-*a*, and Secchi disk transparency data of each lake class into ranked categories and assigned each a "quality" label from "Excellent" to "Poor". The categories were based on pre-settlement conditions of the lakes inferred from sediment cores and their experience.

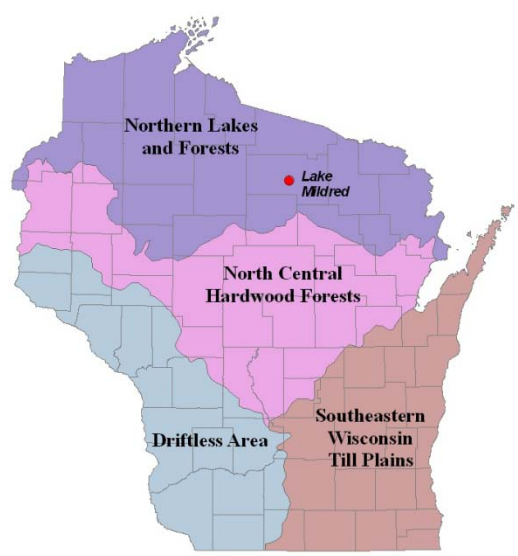

Figure 3.1-2. Location of Lake Mildred within the ecoregions of Wisconsin. After Nichols 1999.

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

Lake Mildred Water Quality Analysis

Lake Mildred Long-term Trends

The historic water quality data that exists for Lake Mildred is minimal, so it is impossible to complete a reliable long-term trend analysis. This is unfortunate because having understanding of how the lake has changed over the years is always interesting and leads to sound 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 Lake Mildred watershed were asked their perceptions of the water quality in Mildred Lake. About 65% of the respondents indicated they believed the current water quality was Good or Excellent. (Stakeholder Survey, Appendix B, Question #21). Roughly 58% of respondents did state that they believe the water clarity has not changed since they first visited the lake, while 29% indicated the water quality had somewhat degraded during this time (Question #12).

As described above, three water quality parameters are of most interest; total phosphorus, chlorophyll-*a*, and Secchi disk transparency. Total phosphorus data from Lake Mildred are contained in Figure 3.1-3. A weighted average across the available years of data indicates that concentrations are lower when compared to other deep, seepage lakes across the state. Overall, phosphorus levels in Lake Mildred can be described as ranking in the category of *Excellent*.

Chlorophyll-*a* measurements from Lake Mildred, like phosphorus data, are few and far between as well (Figure 3.1-4). A weighted average over all years of collected data is below values for other deep, seepage lakes across the state. As with what the total phosphorus dataset showed, the majority of these yearly averages fall into the *Excellent* category. This relationship is to be expected – algal production is heavily reliant upon nutrient content so low nutrient content usually results in less algae within a lake.

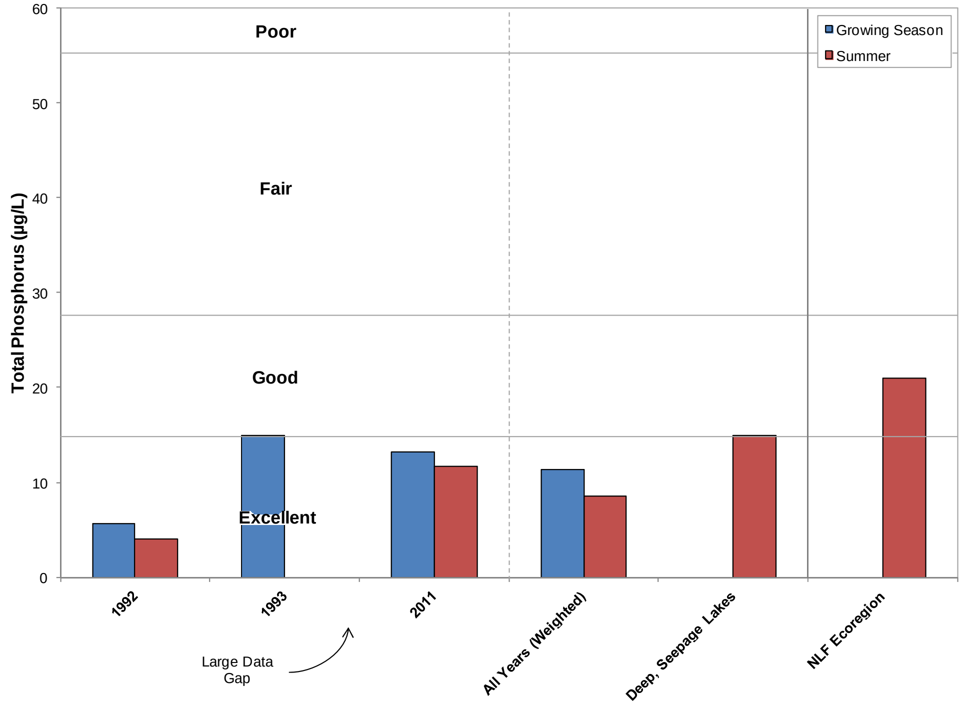

Figure 3.1-3. Lake Mildred, state-wide class 6 lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

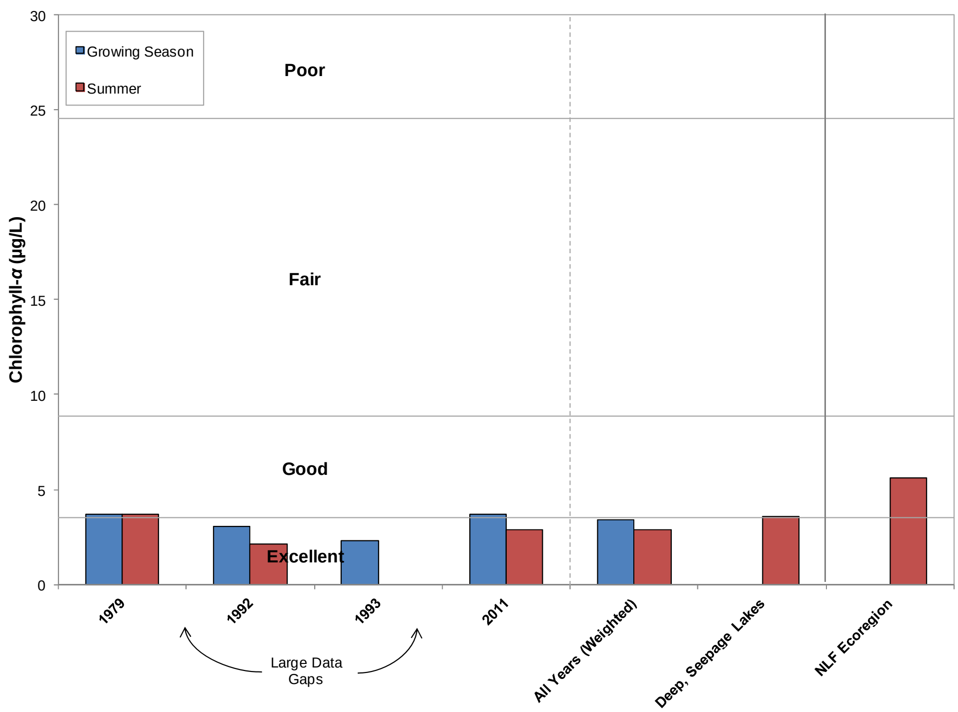

Figure 3.1-4. Lake Mildred, state-wide class 6 lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Secchi disk clarity has been monitored by volunteers through the Citizens Lake Monitoring Network (CLMN) with some regularity in recent years. These efforts are important because they produce consistent, reliable data regarding the clarity of the water on an annual basis. As Lake Mildred stakeholders know, and Figure 3.1-5 confirms, the water clarity of Lake Mildred is exceptional. A weighted average over all years of data collection is much higher than values for similar deep seepage lakes across the state and regionally. Overall, most annual averages rank within a water quality category of *Excellent*.

While no definitive trend can be observed from this small dataset that includes several data gaps, some variability is observed. For example, the Secchi disk clarity summer average for 1997 was 7.9 feet, nearly a third of the summer 2009 average. Several readings between 7-8 feet were collected during June and July of 1997, so an error in data collection is not suspected.

Many factors influence the water clarity within a lake, including algal abundance, concentration of dissolved organic acids, suspended sediment, etc. During years of heavy precipitation, the water clarity in a seepage lake may decrease due to the elevated runoff that occurs. When heavy rainfalls occur, the possibility exists for nearby wetlands to "flush", releasing dissolved organic acids that are the byproduct of decomposition. Unfortunately, there is no additional data (e.g. nutrient or algal abundance) to determine if this was the case or not in years such as 1997. We can however conclude that a) annual fluctuations in water clarity do exist in Lake Mildred that may or may not be influenced by nutrient content and b) continued monitoring of these three parameters is necessary to better understand the water quality of the lake.

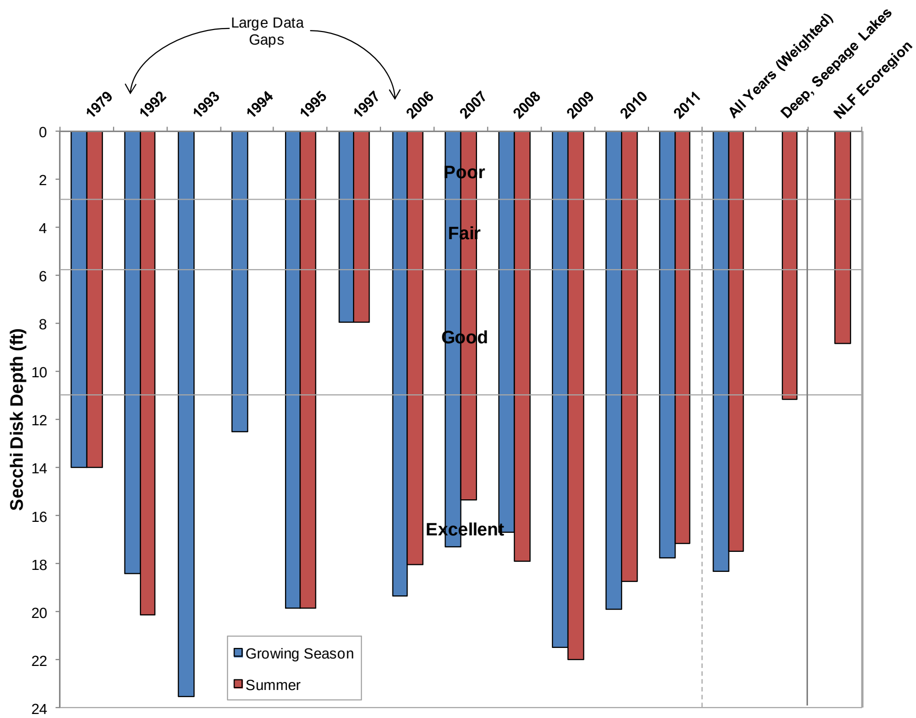

Figure 3.1-5. Lake Mildred, state-wide class 6 lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Limiting Plant Nutrient of Lake Mildred

Using midsummer nitrogen and phosphorus concentrations from Lake Mildred, a nitrogen:phosphorus ratio of 26:1 was calculated. This finding indicates that Lake Mildred 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.

Lake Mildred Trophic State

Figure 3.1-5 contain the WTSI values for Lake Mildred. The WTSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values spanning from mid-oligotrophic to upper mesotrophic. In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on total phosphorus and chlorophyll-*a* WTSI values, it can be concluded that Lake Mildred is in an oligotrophic-mesotrophic state.

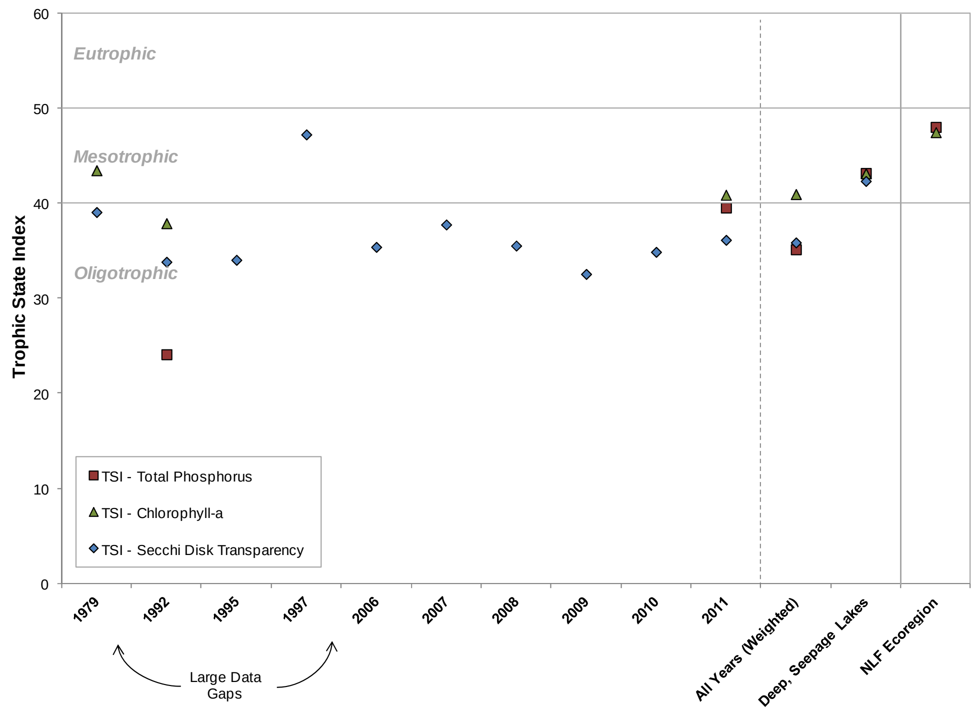

Figure 3.1-6. Lake Mildred, state-wide class 6 lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Lake Mildred

Dissolved oxygen and temperature were measured during water quality sampling visits to Lake Mildred by Onterra staff. Profiles depicting these data are displayed in Figure 3.1-6.

Lake Mildred stratified thermally during the summer months (June, July and August) of 2011, and mixed completely during the spring (April) and fall (October). This is a common occurrence in a lake of Mildred's depth and size. During periods of strong winds and air temperature change (spring and fall), the lake mixes, or "turns over". In other words, the water column mixes so that temperature, oxygen, and nutrients are mixed evenly. During the summer months, the warm air temperatures warm the surface water, and the cold, denser water remains near the bottom of the lake.

Dissolved oxygen remained quite high in the upper 30 feet of the water column throughout the study period. Only immediately near the bottom did oxygen drop significantly. This decrease is due to the decomposition of organic matter, which collects on the bottom of the lake. On some Wisconsin lakes that are shallower and hold abundant aquatic plants, decomposition may drop oxygen concentrations considerably during the winter months. During this time, oxygen is not replenished from the air-surface water interface. Algae and plant growth, which is diminished substantially during the winter months, are not producing oxygen as much either. As observed in the March 2012 oxygen profile, however, there is no reason for concern regarding winter oxygen levels in Lake Mildred.

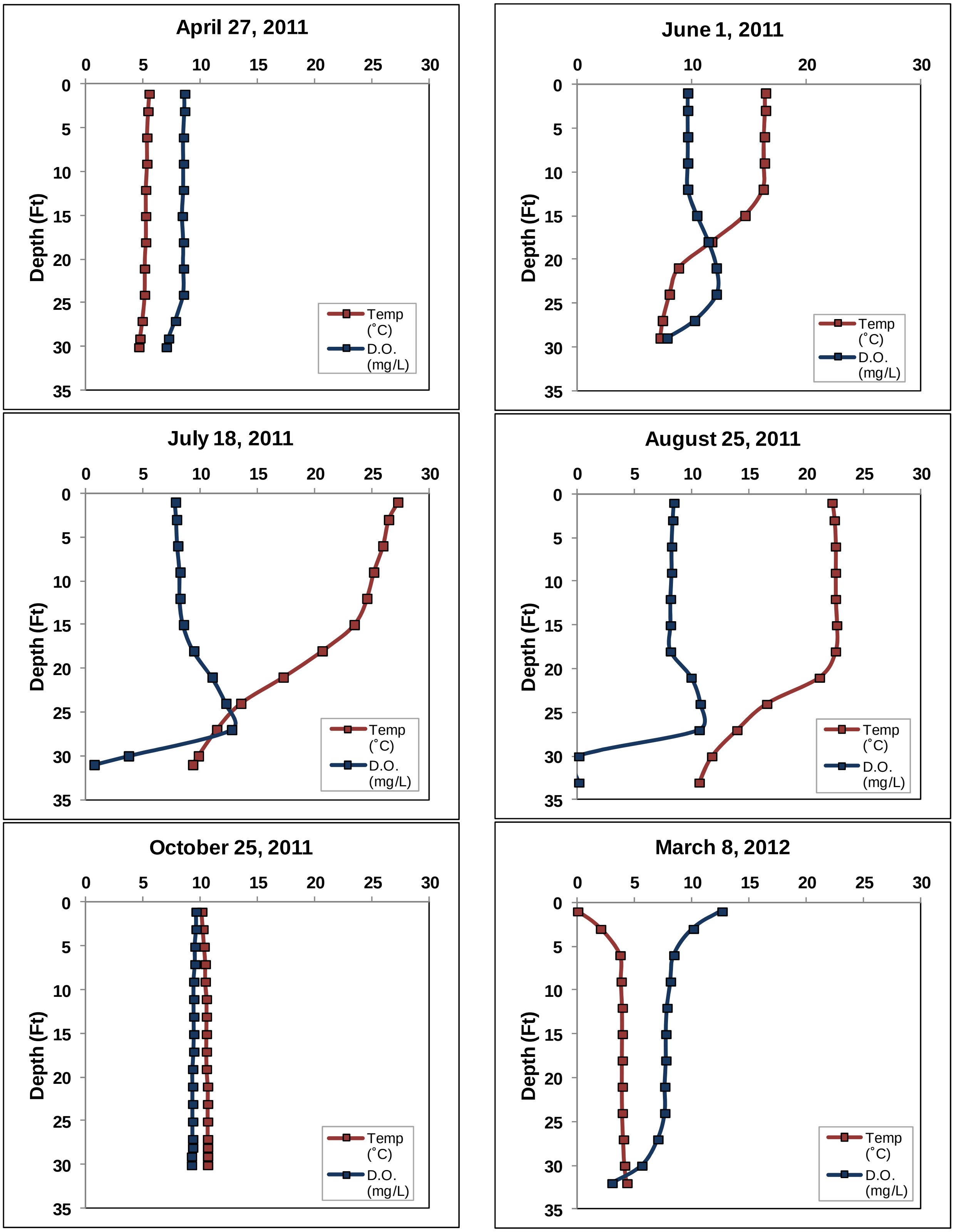

Figure 3.1-7. Lake Mildred dissolved oxygen and temperature profiles. The March 8, 2012 profile was collected through the ice.

Additional Water Quality Data Collected on Lake Mildred

The water quality section is centered on lake eutrophication. However, parameters other than water clarity, nutrients, and chlorophyll-*a* were collected as part of the project. These other parameters were collected to increase the understanding of Lake Mildred'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 Lake Mildred was found to be near neutral with a value of 6.8, 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 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 Lake Mildred was measured at 6.2 (mg/L as $CaCO_3$), indicating that the lake has some capacity to resist fluctuations in pH and has a moderate 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 Lake Mildred's pH of 6.8 falls slightly outside of this range. Lakes with calcium concentrations of less than 12 mg/L are considered to have very low susceptibility to zebra mussel establishment. The calcium concentration of Lake Mildred was found to be 1.7 mg/L, falling well below the optimal range for zebra mussels.

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, Lake Mildred was considered not suitable for mussel establishment.

Plankton tows were completed by Onterra staff during the summer of 2010 and these samples were processed by the WDNR for larval zebra mussels. No veligers (larval zebra mussels) were found within these samples.

3.2 Watershed Assessment

Watershed Modeling

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

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

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

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. For these reasons, it is important to maintain as much natural land cover (forests, wetlands, etc.) as possible within a lake's watershed to minimize the amount runoff (nutrients, sediment, etc.) from entering the lake.

In systems with 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 a lake's watershed or 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 buildup of phosphorus and internal nutrient loading may not 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.

Although WiLMS is primarily designed to model nutrient flow within drainage lakes, it can be utilized to understand nutrient budgets in a seepage lake as well, though to a more general extent. Lake Mildred's watershed is approximately 2,732 acres in size (Figure 3.2-1 and Map 2). The land cover within the watershed consists primarily of forested land (1,956 acres or 72% of the total). Wetlands account for 17% of the watershed land cover, while the surface of Lake Mildred and pasture/grass lands make up smaller amounts within this watershed. Within WiLMS, secondary lakes within the Lake Mildred watershed were modeled as wetlands, because they act very similar in being a "sink" for nutrients and sediments.

Considering the topography around Lake Mildred, the watershed itself is approximately 15 times larger than Lake Mildred, a watershed to lake area ratio of 15:1. As discussed above, most drainage lakes with a watershed to lake area ratio of this size would see increased (though not extraordinary) nutrient levels within the lake. However, Lake Mildred is a seepage lake, meaning it does not have a direct tributary source. There are other seepage lakes present within the Lake Mildred watershed also, in addition to permeable soils. This allows some of the surface water flow to percolate into the ground, and enter these seepage lakes through the groundwater. As a result, there is likely much less land contributing surface water flow to Lake Mildred. Particularly in times of drought or near-drought conditions, any flowing water from the northwest part of the watershed (refer to Map 2) likely enters Clear Lake and does not continue to Lake Mildred. In reality, during these times the Lake Mildred watershed is likely only 760 acres, which makes for a much smaller watershed to lake area ratio (5:1) and reduces the nutrient load much further that what WiLMS might predict with a 2,732 acre watershed.

Even under non-drought, high water conditions, the phosphorus load to Lake Mildred is still low. WiLMS modeling predicts that Lake Mildred receives 157 lbs of phosphorus annually from its watershed, under high-water conditions (Figure 3.2-2). Forested land, the largest land cover type in the watershed, contributes 56% (88 lbs) of this load, while wetlands contribute 27% (42 lbs). The Lake Mildred surface waters collect 15 lbs of phosphorus annually from atmospheric deposition, and pasture/grass land accounts for the last 11 lbs of this 157 lb total.

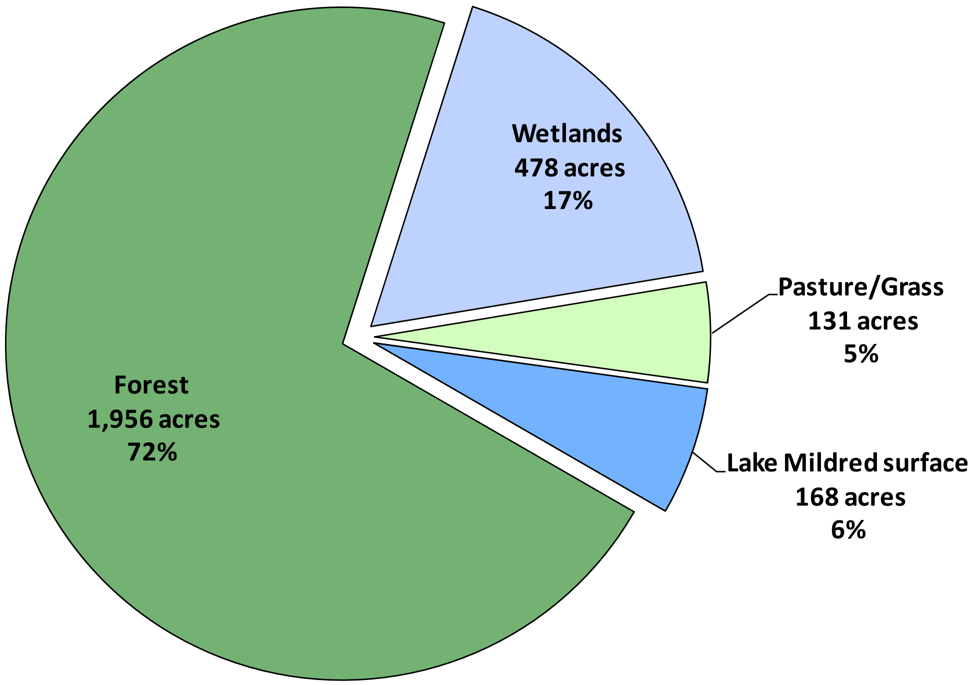

Figure 3.2-1. Lake Mildred watershed land cover types in acres. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

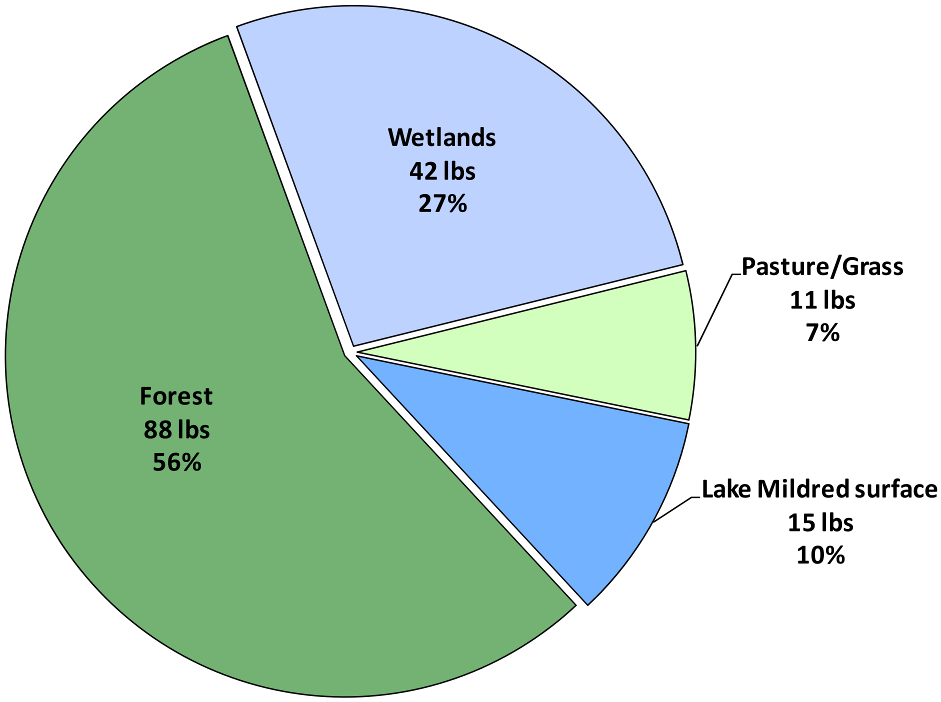

Figure 3.2-2. Lake Mildred watershed phosphorus loading in pounds. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Lake Mildred and Clear Lake Water Levels

In a stakeholder survey sent out to Lake Mildred and Clear Lake riparians, the majority of the comments received included concerns about the lakes' low water levels. The lakes of northern Wisconsin are sensitive to water level fluctuations due to lake morphology, geography and climate. The water levels of natural seepage lakes, like Lake Mildred and Clear Lake, reflect and are controlled by the height of the groundwater table. Lacking supplemental surface inflow from streams or rivers, seepage lakes are prone to dramatic declines in water levels if the groundwater aquifer declines. Precipitation levels vary not only year to year, but over larger periods of time as well, and recent years with lower rainfall and snowfall amounts mean less water to recharge groundwater aquifers.

While the low water levels on Lake Mildred and Clear Lake are due natural factors and may have negative recreational and short-term ecological impacts, it is important to remember that lake water level fluctuations are part of a naturally occurring cycle that has happened many times within the lifespan of these two lakes. While these fluctuations may have their drawbacks, these relatively short-term changes may actually benefit the lake ecosystem in the long-term by increasing emergent and floating-leaf aquatic plant habitat.

3.3 Shoreland Condition

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:

<u>Wisconsin-NR 115: Wisconsin's Shoreland Protection Program</u>

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 habitat provides shoreland erosion control, a carbon source for the lake, prevents suspension of sediments and provides a surface for algal growth which important for aquatic macroinvertebrates (Sass 2009). While it impacts these aspects considerably, one of the greatest benefits coarse woody habitat provides is habitat for fish species.

Coarse woody habitat has shown to be advantageous for fisheries in terms of providing refuge, foraging area as well as spawning habitat (Hanchin et al 2003). In one study, researchers observed 16 different species occupying coarse woody habitat areas in a Wisconsin lake (Newbrey et al. 2005). Bluegill and bass species in particular are attracted to this habitat type; largemouth bass stalk bluegill in these areas while the bluegill hide amongst the debris and often feed upon 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 habitat that was once found in Wisconsin lakes has disappeared. Prior to human establishment and development on lakes (mid to late 1800's), the amount of coarse woody habitat in lakes was likely greater than under completely natural conditions due to logging practices. However, with changes in the logging industry and increasing development along lake shorelands, coarse woody habitat has decreased substantially. Shoreland residents are removing woody debris to improve aesthetics or for recreational opportunities (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 pressured on lakes continue 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. Owners 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.
- 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.

Lake Mildred Shoreland Zone Condition

Shoreland Development

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

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 Lake Mildred, the development stage of the entire shoreline was surveyed during late summer of 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.

Lake Mildred has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 2.5 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 3.2-4). 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, 0.5 miles of urbanized and developed–unnatural shoreline were observed. If restoration of the Lake Mildred 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.

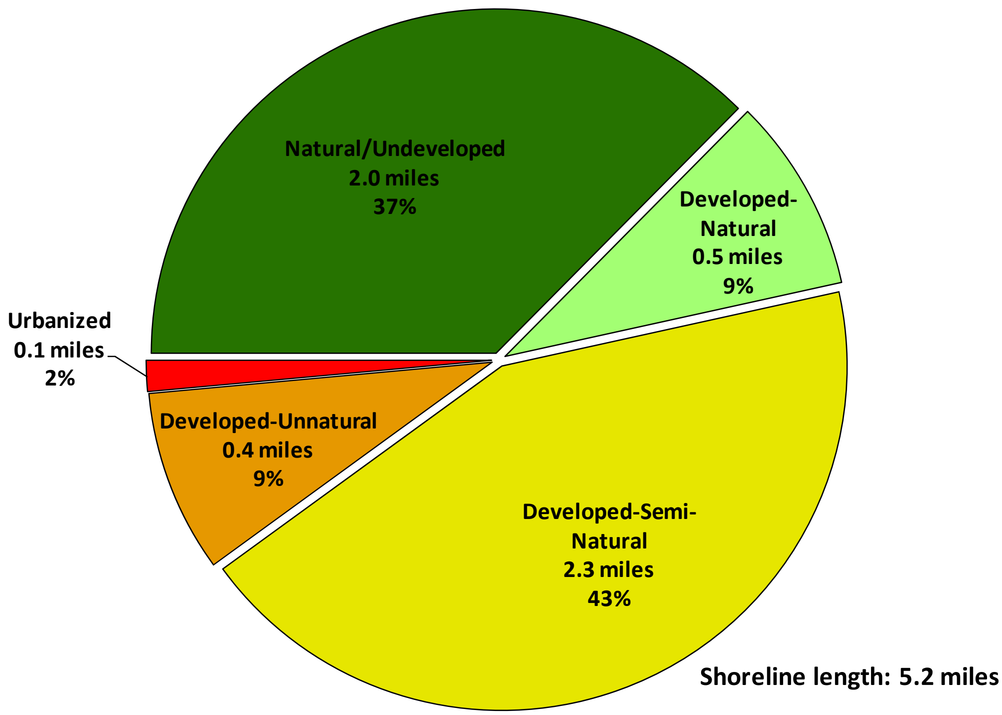

Figure 3.3-2. Lake Mildred shoreland categories and total lengths. Based upon an summer 2011 survey. Locations of these categorized shorelands can be found on Map 3.

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

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

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

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.

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. Please note that a WDNR permit may be required for a bottom 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 (*Phragmites australis*) and reed canary grass (*Phalaris arundinacea*). • Permitting process may require an environmental assessment that may take months to prepare. • Unselective.

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 Lake Mildred; 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 Lake Mildred, plant samples were collected from plots laid out on a grid that covered the entire lake. 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.

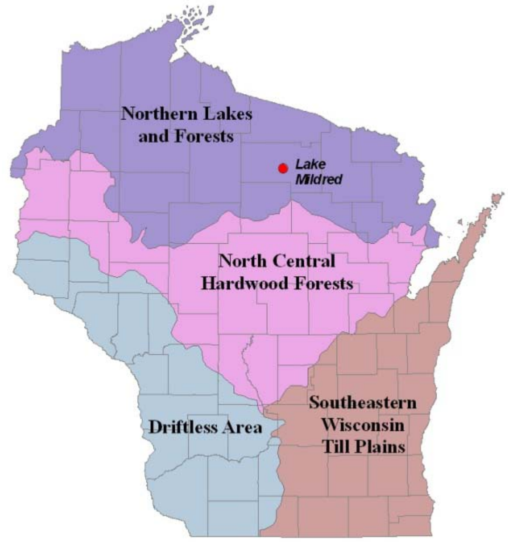

Figure 3.4-1. Location of Lake Mildred within the ecoregions of Wisconsin. After Nichols 1999.

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

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 Lake Mildred. 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.

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.

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 Lake Mildred 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 3.4-2). 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.

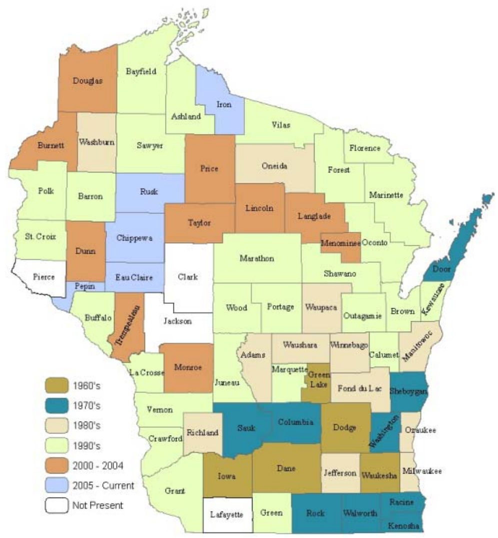

Figure 3.4-2. Spread of Eurasian water milfoil within WI counties. WDNR Data 2011 mapped by Onterra.

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 29, 2011, a survey was completed Lake Mildred 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 Lake Mildred or exists at an undetectable level.

The point intercept survey was conducted on Lake Mildred on July 21, 2011 by Onterra. While two crews completed this grid-based survey, an additional crew completed a community mapping survey by mapping the emergent and floating-leaf species on the lake at this same time. Additionally, a crew visited adjoining Clear Lake to search this waterbody for aquatic invasive species. No such species were found in Clear Lake, but several interesting native species were noted during this survey, including snail-seed pondweed (*Potamogeton bicupulatus*) and northeastern bladderwort (*Utricularia resupinata*). Both of these species are listed as rarely occurring on Wisconsin lakes. They were, however, found on both Clear Lake and Lake Mildred. During the point-intercept and aquatic plant mapping surveys, 33 species of plants were located in Lake Mildred (Table 3.4-1). 27 of these species were sampled during the point-intercept survey directly and are used in the analysis below, while six species were observed incidentally.

Table 3.4-1. Aquatic plant species located in Lake Mildred during July 2011 surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)	2011 (Onterra)
Emergent	Carex scoparia	Broom sedge	4	I
	Dulichium arundinaceum	Three-way sedge	9	X
	Eleocharis obtusa	Blunt spike-rush	3	I
	Juncus brevicaudatus	Narrow-panicle rush	6	I
	Juncus effusus	Soft rush	4	X
	Sagittaria sp.	Arrowhead sp.	N/A	I
	Scirpus pedicellatus	Stalked wool-grass	6	I
	Schoenoplectus subterminalis	Water bulrush	9	X
FL	Brasenia schreberi	Watershield	7	X
	Nuphar variegata	Spatterdock	6	I
	Nymphaea odorata	White water lily	6	X
FL/E	Sparganium angustifolium	Narrow-leaf bur-reed	9	X
	Sparganium natans	Little bur-reed	9	X
Submergent	Elatine minima	Waterwort	9	X
	Eriocaulon aquaticum	Pipewort	9	X
	Gratiola aurea	Golden pert	10	X
	Isoetes sp.	Quillwort species	N/A	X
	Lobelia dortmanna	Water lobelia	10	X
	Myriophyllum farwellii	Farwell's water milfoil	9	X
	Myriophyllum tenellum	Dwarf water milfoil	10	X
	Najas gracillima	Northern naiad	7	X
	Nitella sp.	Stoneworts	7	X
	Potamogeton praelongus	White-stem pondweed	8	X
	Potamogeton pusillus	Small pondweed	7	X
	Potamogeton bicupulatus	Snail-seed pondweed	9	X
	Potamogeton epihydrus	Ribbon-leaf pondweed	8	X
	Utricularia geminiscapa	Twin-stemmed bladderwort	9	X
	Utricularia intermedia	Flat-leaf bladderwort	9	X
	Utricularia resupinata	Northeastern bladderwort	9	X
	Utricularia vulgaris	Common bladderwort	7	X
	Utricularia gibba	Creeping bladderwort	9	X
SE	Eleocharis acicularis	Needle spikerush	5	X
	Juncus pelocarpus	Brown-fruited rush	8	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 littoral areas of Lake Mildred varies greatly. Data from the point-intercept survey indicate that approximately 47% of the sampling locations located within the littoral zone contained fine organic sediment (muck), 25% contained sand, and 28% contained rock (Figure 3.4-2 and Map 4).

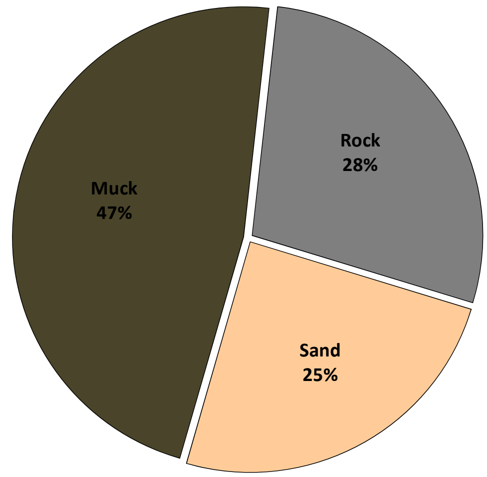

Figure 3.4-3. Lake Mildred proportion of substrate types within littoral areas. Created using data from July 2011 aquatic plant point-intercept survey.

Approximately 60% of the 658 point-intercept sampling locations fell within the maximum depth of aquatic plant growth, or littoral zone (19 feet). Of these 398 point-intercept locations, 144 of them (36%) contained aquatic vegetation. Map 5 shows that the majority of the aquatic vegetation in Lake Mildred is located within the shallow bays and near-shore areas. As discussed in the water quality section, the water clarity in Lake Mildred is relatively high which permits exceptional sunlight penetration and thus allows for aquatic plants to inhabit deeper areas of the lake. Figure 3.4-3 shows that the majority of the aquatic vegetation in Lake Mildred grows between one and ten feet, though several species grow out to a depth of 19 feet.

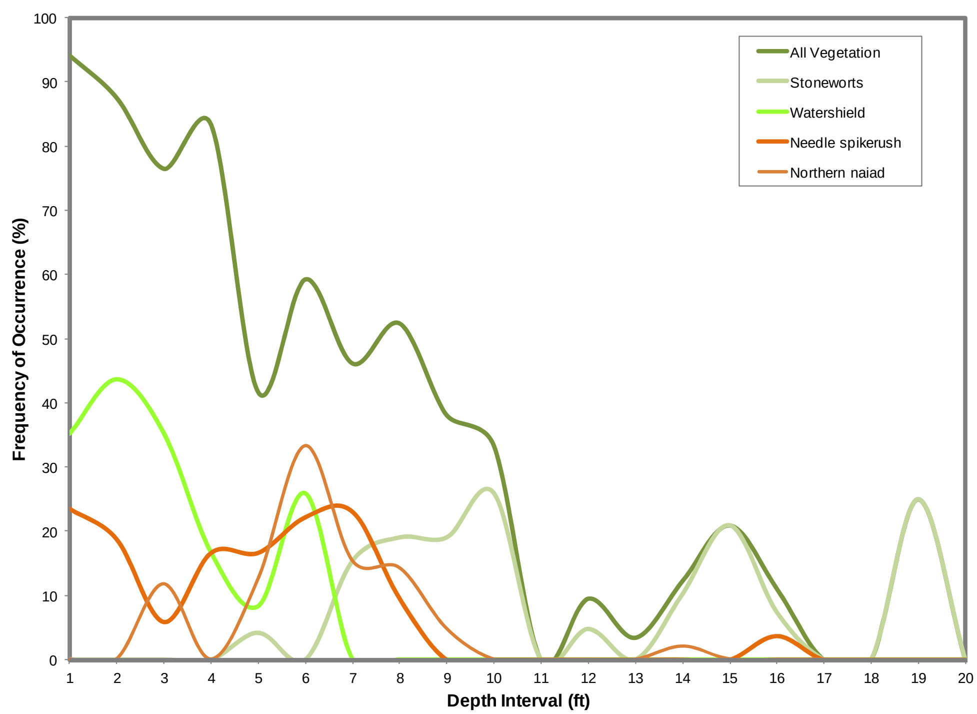

Figure 3.4-4. Frequency of occurrence at littoral depths for several Lake Mildred plant species. Created using data from a July 21, 2011 aquatic plant point-intercept survey.

Eurasian water milfoil, a common aquatic invasive plant in Wisconsin, was not found within Lake Mildred. Two milfoil species, dwarf-water milfoil (*Myriophyllum tenellum)*, and Farwell's water milfoil (*Myriophyllum farwellii*) were found in Lake Mildred though. Dwarf-water milfoil is morphologically much different from the other six milfoil species known to occur in Wisconsin. Farwell's water milfoil appears somewhat similar to Eurasian water milfoil, however there are several distinguishing factors that may be used to tell the two species apart. Eurasian water milfoil has whorled leaves around its stem, while Farwell's water milfoil has leaves arranged in an alternate, sub-alternate, or scattered fashion around the stem. Farwell's water milfoil also produces flowers within the axils of the leaves, while the flowers of many other milfoil species (including the Eurasian water milfoil) are emergent, and terminal inflorescences.

Aquatic plants can be placed in one of two general groups, based upon their form of growth and habitat preferences. These groups include the isoetid growth form and the elodeid growth form. Lake Mildred has both isoetid and elodeid species within its waters. Plants of the isoetid growth form are small, slow growing, and inconspicuous submerged plants. They often have evergreen leaves located in a rosette and are usually found growing in sandy soils within the near-shore areas of a lake (Boston and Adams 1987, Vestergaard and Sand-Jensen 2000). Some common isoetid species in Lake Mildred include brown-fruited rush, needle spikerush, and quillwort species. Submersed species of the elodeid growth form have leaves on tall, erect stems which grow upwards into the water column. Examples of Lake Mildred elodeid species include northern naiad, the pondweed species, and members of the stonewort genus.

Alkalinity is the primary water chemistry factor determining whether a lake is dominated by plant species of the isoetid or elodeid growth form (Vestergaard and Sand-Jensen 2000). Most elodeids are restricted to lakes of relatively higher alkalinity, as their carbon demand for photosynthesis cannot be met solely by the dissolved carbon dioxide (CO_2) present in the water, and they must acquire additional carbon through bicarbonate (HCO_3^-). While isoetids are able to grow in lakes of higher alkalinity, their short stature makes them poor competitors for light, and they are usually outcompeted and displaced by the taller elodeids. Thus, isoetids are most prevalent in lakes of low alkalinity where they can avoid competition from elodeids. However, in lakes with intermediate alkalinity levels, like Lake Mildred, often there is a mixed community of both, with isoetids inhabiting the shallow, sandy/rocky areas and elodeids thriving in the deeper areas of softer sediment.

Interestingly, the locations of isoetid and elodeid species within the lake were somewhat regional; isoetid species tend to be found within the eastern and central regions of the lake, while elodeid species are primarily found within the western-most basin of the lake (Map 6). The spatial distribution of these species classes show a relationship with the substrate type as well, where the isoetids are found in predominately sandy and rocky areas of the lake and elodeids in areas that are primarily mucky (Map 4 – sediment and Map 5 – species spatial distribution). There may be subtle differences in water chemistry between the larger basin of the lake and the western-most, somewhat isolated basin. This may or may not have an impact on the species present. However, given the information that is available, it can be said that substrate type is likely a strong factor in deciding where the isoetid and elodeid species are located within the lake. A third aquatic plant type, Characean plants (macro-algae plants such as Nitella sp.), were found primarily in deeper waters of the lake. As discussed below, this species is root-less and thus its growing locations is not governed by sediment types

Of the 27 native aquatic plants found in Lake Mildred during the point-intercept survey, members of the stonewort genus, watershield and needle spikerush were the most common. Nitella species, or stoneworts as they may be called, are actually a type of macro-algae rather than a vascular plant. Whorls of forked branches are attached to the “stems” of the plant, which are long, slender, smooth-textured algae. Because they lack roots, stoneworts remove nutrients directly from the water. Watershield (*Brasenia schreberi*) is a floating-leaf plant with green leaves that resemble the shape of a football. The leaves attach to a long purple stem directly in the middle of the underside, which also gives the plant a “shield” look. A thick coating of gelatinous slime covers the stem and leaf underside in younger plants. Watershield is utilized by fish for cover, by waterfowl as a food source, and even by humans occasionally for food (Native American groups have ate the nutrient rich tubers and the Japanese use young leaves as stems in salads). Needle spikerush (*Eleocharis accicularis*) is a brightly green colored member of the sedge family. This species can be distinguished from other spikerushes by its thread-like stems and tiny, sharply pointed spikelets. The plant is relatively small, reaching lengths up about six inches tall. Needle spikerush is common along shorelines, where they are highly adaptable to fluctuating water levels and help to stabilize shoreline sediments.

As previously mentioned, several species encountered on both Lake Mildred and Clear Lake during field surveys were of particular interest because of their rarity. Snail-seed pondweed (*Potamogeton bicupulatus*) is a small, fragile looking member of the pondweed group. It typically prefers shallow, acidic softwater lakes. Snail-seed pondweed has been extirpated in the state of Indiana, is endangered in Minnesota, and listed as threatened in the state of Michigan. In Wisconsin, this species is listed as a state special concern plant because of its rare occurrence.

Another rare plant, northeastern bladderwort (*Utricularia resupinata*) was found in Clear Lake and Lake Mildred as well. This plant belongs to a genus (*Utricularia* spp.) of carnivorous plants. These species have small bladders attached to fine filamentous leaflets. The bladders have a “trap door” surrounded by small hairs. When the hairs are touched, the trap door swings inward and the bladder inflates, sucking in water along with small organisms (the bladderwort’s prey). Enzymes are released inside the bladder to break down the prey’s proteins, and the nutrients are then absorbed by the plant. Northeastern bladderwort is identified by its small, delicate stems which stretch horizontally just below the soil or floating on the water. Between July and September, the plant will produce small, 5-parted purple flowers, from which its name is likely derived. Northeastern bladderwort is listed as a state special concern plant in Wisconsin.

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 stoneworts were found at 9% of the sampling locations in Lake Mildred, their relative frequency of occurrence is 15%. Explained another way, if 100 plants were randomly sampled from Lake Mildred, 15 of them would be of the stonewort genus. Looking at relative frequency of occurrence (Figure 3.4-5), 12 species comprise approximately 83% of the plant community in Lake Mildred, while an additional 15 species make up the remaining 17%.

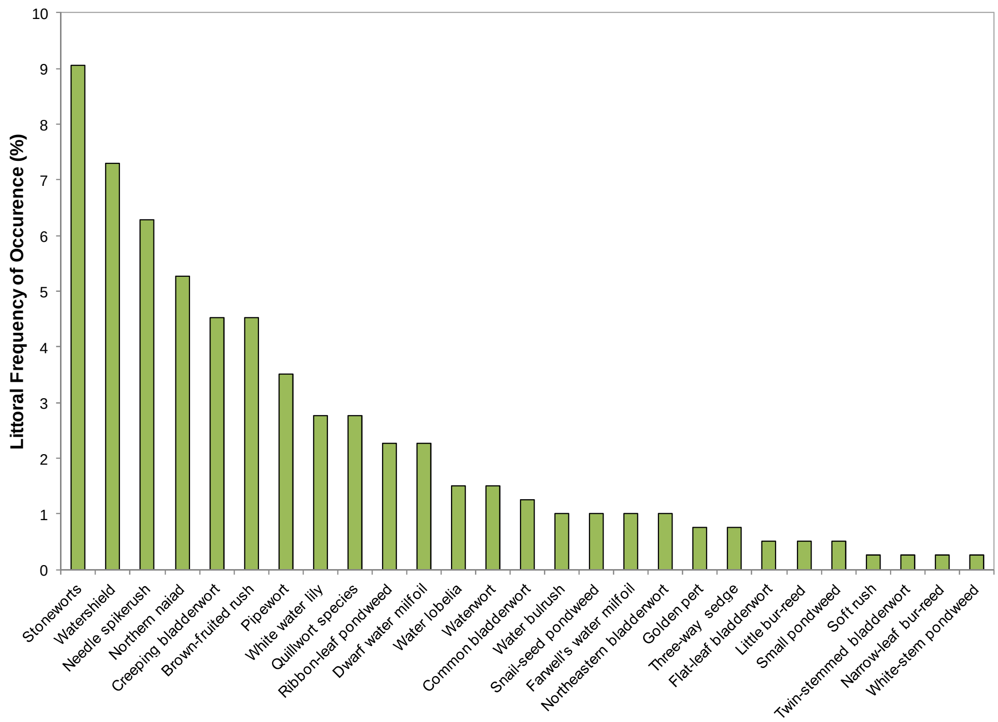

Figure 3.4-5 Lake Mildred aquatic plant littoral frequency of occurrence. Created using data from July 2011 surveys.

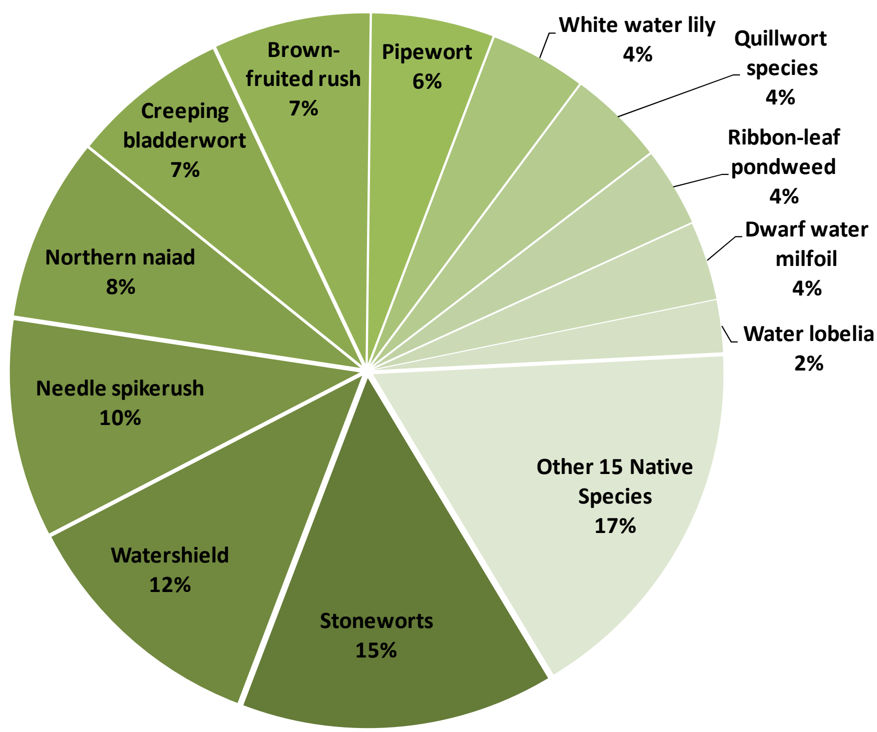

Figure 3.4-6 Lake Mildred relative plant littoral frequency of occurrence. Created using data from July 2011 surveys.

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 33 native aquatic plant species were located in Lake Mildred during the 2011 surveys, only 27 were sampled directly during the point-intercept survey. Figure 3.4-5 shows that the native species richness for Lake Mildred is above the Northern Lakes and Forests Ecoregion and Wisconsin State medians. The species that are present in Lake Mildred are indicative of very high-quality conditions. Data collected from the aquatic plant surveys show that the average conservatism value (8.2) is well above the Northern Lakes and Forest Lakes Ecoregion and Wisconsin State medians (Figure 3.4-6), indicating that the majority of the plant species found in Lake Mildred are considered sensitive to environmental disturbance and their presence signifies excellent environmental conditions.

Combining Lake Mildred's aquatic plant species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in an exceptionally high value of 42.4 (equation shown below); well above the median values for the ecoregion and state (Figure 3.4-6), and further illustrating the quality of Lake Mildred's plant community.

$$\text{FQI} = \text{Average Coefficient of Conservatism (8.2)} * \sqrt{\text{Number of Native Species (27)}}$$
$$\text{FQI} = 42.4$$

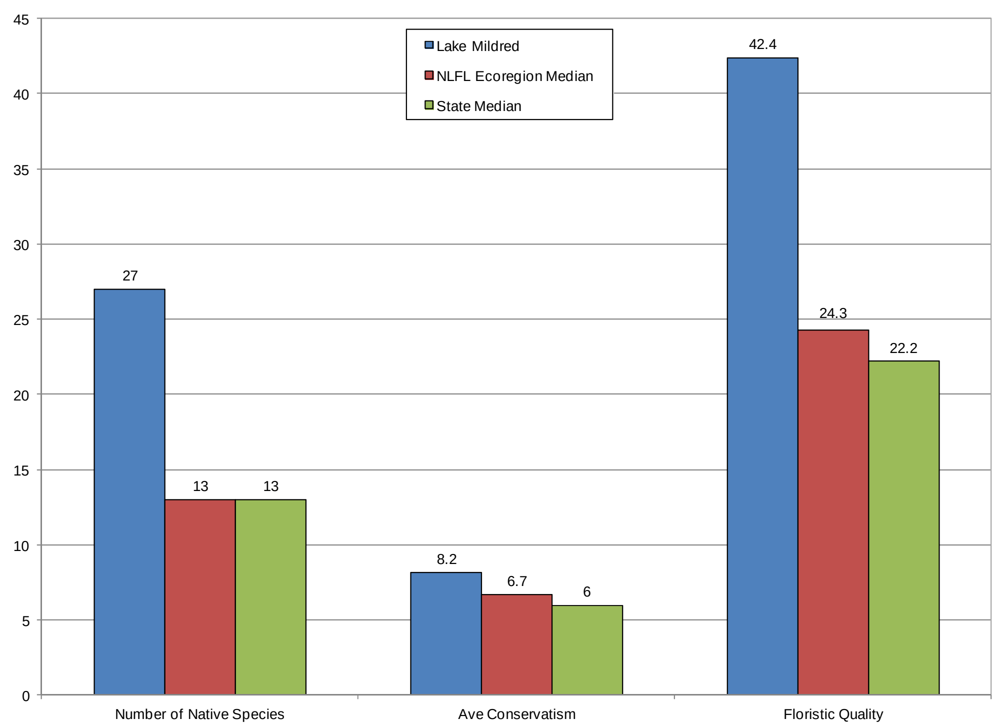

Figure 3.4-7. Lake Mildred Floristic Quality Assessment. Created using data from July 2011 surveys. Analysis following Nichols (1999) where NLFL = Northern Lakes and Forest Lakes Ecoregion.

Because Lake Mildred 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.

The aquatic plant community in Lake Mildred was found to be highly diverse, with a Simpson's diversity value of 0.93 (Figure 3.4-7). This value ranks above state and ecoregion upper quartiles. 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.

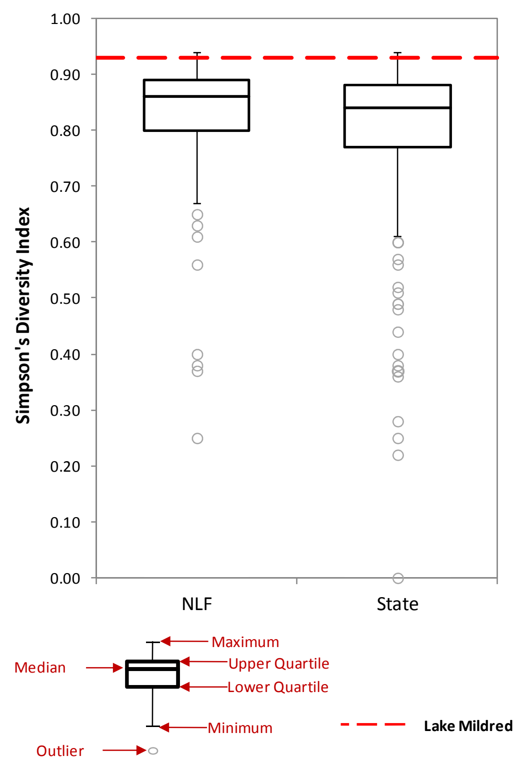

Figure 3.4-8. Lake Mildred species diversity index. Created using data from July 2011 aquatic plant surveys. Ecoregion data provided by WDNR Science Services.

The quality of Lake Mildred's plant community is also indicated by the high incidence of emergent and floating-leaf plant communities that occur in near-shore areas around the lake. The 2011 community map indicates that approximately 11.5 acres (6.7%) of the 172 acre-lake contain these types of plant communities (Table 3.4-2 and Map 7). Six floating-leaf and emergent species were located on Lake Mildred, 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. Lake Mildred acres of plant community types. Created from the July 2011 community mapping survey.

Plant Community	Acres
Emergent	<0.1
Floating-leaf	0.4
Mixed Floating-leaf and Emergent	11.1
Total	11.5

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 Lake Mildred. 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.

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 Lake Mildred. The goal of this section is to provide an incomplete overview of some of the data that exists, particularly in regards to specific issues (e.g. spear fishery, fish stocking, angling regulations, etc) that were brought forth by the LMPOA 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 2012A and 2012B).

Lake Mildred Fishery

Lake Mildred Fish Species and Fishing Activity

Based on data collected from the stakeholder survey (Appendix B), fishing was the second highest ranked important or enjoyable activity on Lake Mildred and Clear Lake (Question #15). Approximately 70% of these same respondents believed that the quality of fishing on the lake was either fair or good (Question #11); however, approximately 85% believe that the quality of fishing has remained the same or gotten worse since they have obtained their property (Question #13). Bluegill/sunfish and bass species were ranked as the fish species Lake Mildred and Clear Lake residents enjoy catching most (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 Lake Mildred 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 Lake Mildred with corresponding biological information Species list from WDNR surveys (WDNR, 2012). Biological information from 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)
Smallmouth Bass	*Micropterus dolomieu*	13	Mid May - June	Nests more common on north and west shorelines over gravel	Small fish including other bass, crayfish, insects (aquatic and terrestrial)
Walleye	*Sander vitreus*	18	Mid April - early May	Rocky, wavewashed shallows, inlet streams on gravel bottoms	Fish, fly and other insect larvae, crayfish
Yellow Bullhead	*Ameiurus natalis*	7	May - July	Heavy weeded banks, beneath logs or tree roots	Crustaceans, insect larvae, small fish, some algae
Yellow Perch	*Perca flavescens*	13	April - Early May	Sheltered areas, emergent and submergent veg	Small fish, aquatic invertebrates

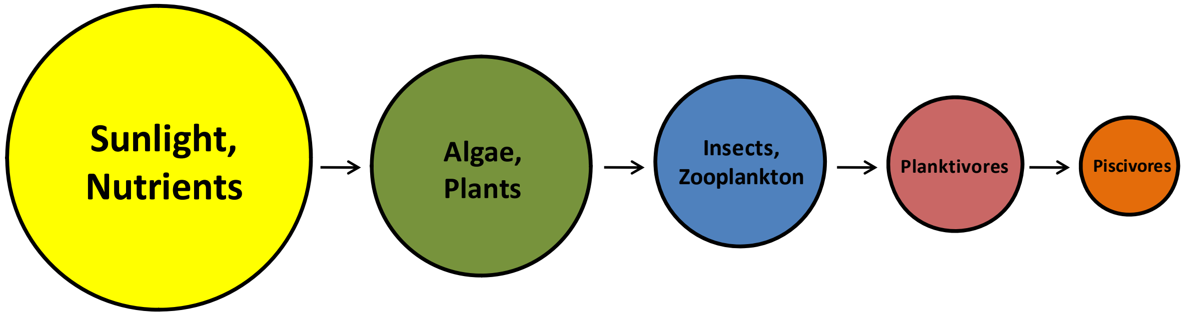

Figure 3.5-1. Aquatic food chain. Adapted from Carpenter et. al 1985.

As discussed in the Water Quality section, Lake Mildred is oligotrophic, meaning it has high water clarity, but a low amount of nutrients and thus low primary productivity. Simply put, this means it is difficult for the lake to support a large population of predatory fish (piscivores) because the supporting food chain is relatively small.

Native American Spear Harvest 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 3.5-1). Lake Mildred 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. Determining how many fish are able to be taken from a lake, either by spear harvest or angler harvest, is a highly regimented and dictated process. This highly structured procedure begins with an annual meeting between tribal and state management authorities. Reviews of population estimates are made for ceded territory lakes, and then a "total allowable catch" is established, based upon estimates of a sustainable harvest of the fishing stock (age 3 to age 5 fish). This figure is usually about 35% (walleye) or 27% (muskellunge) of the lake's known or modeled population, but may vary on an individual lake basis due to other circumstances. In lakes where population estimates are out of date by 3 years, a standard percentage is used. The total allowable catch number may be 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". Often, the biologists overseeing a lake cannot make adjustments due to the regimented nature of this process, so the total allowable catch often equals the safe harvest level. The safe harvest is a conservative estimate of the number of fish that can be harvested by a combination of tribal spearing and state-licensed anglers. The safe harvest is then multiplied by

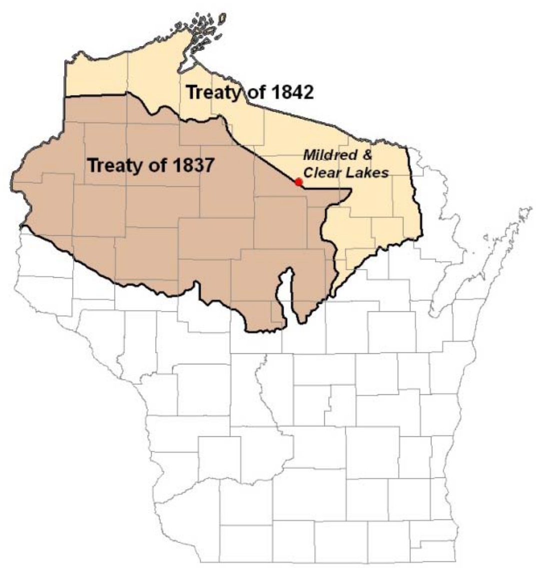

Figure 3.5-2. Location of Lake Mildred and Clear Lake within the Native American Ceded Territory (GLIFWC 2012A). This map was digitized by Onterra; therefore it is a representation and not legally binding.

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Lake Management Planning

the Indian communities claim percent. This result is called the declaration, 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 declaration and prevent over-fishing. Bag limits reductions may be increased at the end of May on lakes that are lightly speared. The tribes have historically selected a percentage which allows for a 2-3 daily bag limit for hook-and-line anglers (USDI 2007).

Spearers are able to harvest muskellunge, walleye, northern pike, and bass during the open water season; however, in practice walleye and muskellunge are the only species harvested in significant numbers, so conservative quotas are set for other species. The spear harvest is monitored through a nightly permit system and a complete monitoring of the harvest (GLIFWC 2010B). 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 declaration is determined each morning by 9 a.m. based on the data collected from the successful spearers. Harvest of a particular species ends once the declaration is met or the season ends. In 2011, a new reporting requirement went into effect on lakes with smaller declarations. Starting with the 2011 spear harvest season, on lakes with a harvestable declaration of 75 or fewer fish, reporting of harvests may take place at a location other than the landing of the speared lake.

Although Lake Mildred 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.

Lake Mildred Fishing Regulations

Because Lake Mildred 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 Lake Mildred. In 2013, no restrictive bag limits were set for Lake Mildred, meaning the statewide bag limit of five fish in a day is in place for Lake Mildred and Clear Lake. Table 3.5-3 displays the 2013-2014 regulations for species that may be found in LakeName. Please note that this table is intended to be for reference purposes only, and that anglers should visit the WDNR website (www. http://dnr.wi.gov/topic/fishing/regulations/hookline.html) for specific fishing regulations or visit their local bait and tackle shop to receive a free fishing pamphlet that would contain this information.

Table 3.5-2. WDNR fishing regulations for Lake Mildred, 2013-2014.

Species	Season	Regulation
Panfish	Open All Year	No minimum length limit and the daily bag limit is 25.
Largemouth and smallmouth bass	May 4, 2013 to June 14, 2013	Fish may not be harvested (catch and release only)
Largemouth and smallmouth bass	June 15, 2013 to March 4, 2014	The minimum length limit is 14" and the daily bag limit is 5.
Muskellunge and hybrids	May 25, 2013 to November 30, 2013	The minimum length limit is 40" and the daily bag limit is 1.
Northern pike	May 4, 2013 to March 2, 2014	No minimum length limit and the daily bag limit is 5.
Walleye, sauger, and hybrids	May 4, 2013 to March 2, 2014	The minimum length limit is 15" and the daily bag limit is 5.
Rock, yellow, and white bass	Open All Year	No minimum length limit and the daily bag limit is unlimited.

Lake Mildred Fisheries Management

The WDNR currently manages Lake Mildred as a bass and panfish lake. In a 2005 comprehensive survey of the lake, both largemouth and smallmouth bass were sampled in high numbers, though the number of larger (15 inches +) fish was fairly low, likely due to angler harvest and slow growth. Panfish species within the lake, primarily bluegill, black crappie and some yellow perch, exhibited low abundances and poor size structure. As previously discussed, in clear lakes with lower productivity it is often difficult to produce a large forage fish base because of the lack of nutrients and food for these fish species.

Walleye, northern pike and muskellunge were encountered in low numbers during the 2005 survey. Besides the low level of primary productivity in the lake, walleye are likely unable to support a viable population because of the limited amount of suitable spawning gravel in the lake. Walleye stocking records indicate no formal stocking of this species has occurred since the 1930's, however it is rumored that undocumented stocking occurred in the mid to late 1990's. Currently, Muskellunge Clubs Alliance stocks 190 large fingerling muskellunge in even-numbered years. More information on this 2005 WDNR survey, its results, and WDNR fisheries management recommendations can be found in Appendix F.

Lake Mildred Substrate Type and Fish Habitat

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

According to the point-intercept survey conducted by Onterra, 47% of the substrate sampled in the littoral zone on Lake Mildred was muck, 28% was found to be rocky, and the remaining 25% was 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.

During the drafting of the Lake Mildred and Clear Lake Stakeholder Survey, the Planning Committee and Onterra staff discussed the occurrence of fish cribs within Lake Mildred. Some lake residents had expressed concern over the presence of “homemade” fish cribs within the lake; specifically, the concern was regarding degradation of the unnatural materials into the water, and the safety of motorboats driving over the materials as well.

Several questions were drafted on the survey to solicit the opinions of all Lake Mildred and Clear Lake stakeholders on the issue. The majority of survey respondents (74%) felt the presence of these fish cribs, (from natural or man-made materials) were not causing any problems in the lake (Appendix B – Question #17). When asked if the LMPOA should work with the WDNR to remove fish cribs constructed with man-made materials from Lake Mildred, survey respondents were fairly divided; 43% responded “Yes”, 35% responded “No” and about 22% responded “Unsure”. About 48% of respondents indicated that habitat improvements for fish where needed however, while 21% were unsure and 27% felt these improvements were not necessary.

During the drafting of the Stakeholder Survey, and at the planning meeting, Onterra staff discussed the issue further. WDNR regulations require that a permit be obtained if residents wish to establish a fish crib or other habitat structure within a waterbody that is classified as an Area of Special Natural Resource Interest (ASNRI). Lake Mildred and Clear Lake are not categorized as ASNRI, so a permit is not needed to construct these habitat structures. However, for all habitat structures in all waterbodies, WDNR construction guidelines must be followed and a local fisheries biologist must be notified of where the structure resides. These guidelines may be found in Appendix G.

4.0 SUMMARY AND CONCLUSIONS

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

1) Collect baseline data to increase the general understanding of the Lake Mildred ecosystem.
2) Collect detailed information regarding native and non-native (if any) plant species within the lake.
3) Collect sociological information from Lake Mildred and Clear Lake stakeholders regarding their use of the lake and their thoughts pertaining to the past and current condition of the lake and its management.

The three objectives were fulfilled during the project and have led to a good understanding of the Lake Mildred ecosystem, the folks that care about the lakes, and what needs to be completed to protect and enhance them.

Through the studies conducted on Lake Mildred, it is clear that overall the ecosystem is in a very healthy condition. As discussed within the Water Quality Section, Lake Mildred's water quality is exceptional. The lake holds minimal nutrients – enough for some aquatic plant and limited algal production, but not nearly enough to cause significant problems or impairment. Secchi disk data collected through LMPOA volunteers and by Onterra staff in 2011 indicates that the lake has excellent clarity. In most years, this clarity ranges between 16 and 20 feet. Of course, some fluctuations exist in the dataset, however this are most likely attributable to fluctuations in annual environmental conditions. Understanding these fluctuations and any potential trends in the water quality of Lake Mildred can only be achieved through continued monitoring of the lake's water. Thus, the Implementation Plan that follows outlines a strategy to continue monitoring Lake Mildred.

A concerning aspect of the lake that was voiced by stakeholders throughout this planning project was the water level in Lake Mildred and Clear Lake. Both lakes are seepage lakes, meaning that they do not have stream tributaries feeding water to the lake; their primary sources of water include, surface water flow, groundwater, and direct deposition by precipitation. Seepage lakes typically have water levels that are controlled by the elevation of the groundwater, which is in turn controlled by the amount of precipitation that falls and soaks into the ground over long periods of time. During times of extended drought or a less than average rate of precipitation, the groundwater table lowers, which in turn means that the water level in a seepage lake will lower accordingly.

While a lower water level does not appeal to property owners or those trying to navigate the lake, this condition does not necessarily impact the lake in a negative manner. When the water recedes from a shoreline, loose sediment may consolidate. Additionally, new habitats may be created for smaller shoreline plants, shorebirds or fish species. In fact, some plants and animals depend upon fluctuating water levels for some or all of their life cycle and thrive under these conditions. In the long-term, the fluctuating water levels in a seepage lake such as Lake Mildred and Clear Lake enhance the ecosystem by increasing diversity.

The aquatic plant community found within the waters and along the shorelines of Lake Mildred was found to be of exceptional quality. The overall plant community holds many species that are indicative of undisturbed conditions. Two of these species, Snail-seed pondweed (*Potamogeton bicupulatus*) and northeastern bladderwort (*Utricularia resupinata*), are listed as being rarely found within Wisconsin lakes and are on the National Heritage Inventory's special concern list. A total of 33 species (sampled directly with a rake tow and incidentally observed) were found within Lake Mildred. The richness and diversity of the aquatic plant community in Lake Mildred is only achievable through having minimal human disturbance, excellent water quality, and many habitat types. The benefits Lake Mildred stakeholders may see from protecting this plant community include having diverse fish habitat, retaining excellent water quality, and providing competition against invasive plants that may happen to find their way into Lake Mildred.

During the multiple surveys that took place on Lake Mildred, no non-native aquatic plant species were discovered within the lake. A reconnaissance survey which took place on Clear Lake turned up no non-native aquatic plant species either. The LMPOA now has the important task of protecting their water and plant communities from various threats, of the most concerning may be that of aquatic invasive species. Aquatic invasive such as Eurasian water milfoil and curly-leaf pondweed have been discovered in many of Wisconsin's lakes.

During the management planning process, Onterra staff and the LMPOA Planning Committee discussed some of the challenges Lake Mildred and Clear Lake could be facing. The results of this discussion formed the framework of the Implementation Plan that follows this section. Lake Mildred is truly a healthy ecosystem, so the challenge for the LMPOA Planning Committee is not in fixing the lake, per se, but to ensure that the lake does not degrade from its current state. This is often a difficult undertaking as there is not a concrete issue for which volunteers to engage. The vague mission of protecting the lake is not as exciting as rallying against a defined threat, such as an invasive species introduction, poor water quality, or nuisance native plants. The importance in a protection-minded plan is to provide opportunities for education of lake stakeholders, which includes sharing the unique nature of the Lake Mildred ecosystem as well as ways to protect it. After all, educating stakeholders on the high quality of Lake Mildred is the best way to show them what truly is at stake.

5.0 IMPLEMENTATION PLAN

At the project Planning Meeting, the LMPOA Planning Committee discussed the results of the Management Plan studies with ecologists/planners from Onterra and closely examined Lake Mildred as well as the people who live around it. During this meeting, the Planning Committee examined the strengths and weaknesses of Lake Mildred and its stakeholders, as well as the opportunities and threats they face. As a result of this discussion, the LMPOA was able to identify goals for protecting and enhancing Lake Mildred.

The Implementation Plan presented below represents the path the LMPOA 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 in that it will be under constant review and adjustment depending on the condition of the lake, the availability of funds, level of volunteer involvement, and the needs of the stakeholders.

Management Goal 1: Increase Lake Mildred Property Owners Association's Capacity to Communicate with Lake Stakeholders

Management Action: Support an Education Committee to promote safe boating, water quality, public safety, and quality of life on Lake Mildred.

Timeframe: Begin 2013

Facilitator: Board of Directors to form Education Committee

Description: Education represents an effective tool to address issues that impact water quality such as lake shore development, lawn fertilization, and other issues such as air quality, noise pollution, and boating safety. An Education Committee will be created to promote lake protection through a variety of educational efforts.

Currently, the LMPOA distributes newsletters to association members biannually and has launched a website (www.lakemildred.com) which allows for great communication within the lake group. 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 and website 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 and developed by the committee.

In addition to creating regularly published association newsletter a variety of educational efforts will be initiated by the Education Committee. These may include educational materials, awareness events and demonstrations for lake users as well as activities which solicit local and state government support.

Example Educational Topics:

- Aquatic invasive species monitoring updates
- Boating safety and ordinances (slow-no-wake zones)
- Catch and release fishing
- Conforming and non-conforming structures
- Littering (particularly on ice)
- Noise, air, and light pollution
- Shoreland restoration and protection
- Septic system maintenance
- Fishing Rules
- Specific topics brought forth in other management actions

Action Steps:

1. Recruit volunteers to form Education Committee.
2. Investigate if WDNR small-scale Lake Planning Grant would be appropriate to cover initial setup costs.
3. The LMPOA Board will identify a base level of annual financial support for educational activities to be undertaken by the Education Committee.

Management Action: Raise riparian owners' awareness on lake shoreline condition.

Timeframe: Begin 2013

Facilitator: LMPOA volunteer

Description: As the Watershed Section discusses, the Lake Mildred watershed is in good condition. The shoreline of the lake is in good condition as well, holding significant portions of natural/undeveloped land and few areas of urbanized shoreline. Still, in order to help maintain the health of Lake Mildred, riparians must manage their shoreland properties to not impact but rather enhance the lake.

Education is the primary way in which this may be achieved. To reduce these impacts, the LMPOA will initiate an educational initiative aimed at raising awareness among shoreland property owners concerning their impacts on the lake. This will include newsletter articles and guest speakers at association meetings. Topics of educational items may include benefits of good septic system maintenance, methods and benefits of shoreland restoration, including reduction in impervious surfaces, and the options available regarding conservation easements and land trusts. Another topic of discussion would be the new shoreland area surrounding Lake Mildred and Clear Lake, which is there as a result of receding water levels. It is important that riparian property owners not disturb this sensitive zone by removing fallen trees, boulders, etc. Educational material pertaining to this issue may be found through a number of sources, such as the ones described within the Action Steps below.

Action Steps:

1. Recruit facilitator.
2. Facilitator gathers appropriate information from WDNR, UW-Extension, Oneida County Land and Water Conservation, Northwoods Land Trust and other sources.
3. Facilitator summarizes information for newsletter articles and recruits appropriate speakers for association meetings.

Management Goal 2: Monitor Current Water Quality Conditions

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

Timeframe: Continuation of current effort.

Facilitator: Board of Directors

Description: Monitoring water quality is an import 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 as of why the trend is developing.

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, a LMPOA volunteer currently collects Secchi disk clarity 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 once during the spring turnover and three times during the summer. 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).

It would be beneficial to have LMPOA volunteers collect water chemistry data as well as Secchi disk clarity data. The association will contact Sandra Wickman (715.365.8951) or the appropriate WDNR/UW Extension staff to enroll within the advanced monitoring program, receive the proper training and the necessary sampling materials. Stability will be added to the program by selecting an individual from the LMPOA to coordinate the lake's volunteer efforts and to recruit additional volunteers to keep the program fresh.

Action Steps:

1. Board of Directors recruits volunteer coordinator from association.
2. Coordinator contacts Sandra Wickman to enroll within CLMN's advanced monitoring program.
3. Coordinator directs water quality monitoring program efforts and recruits new volunteers.
4. Volunteers collect data and coordinator/volunteers report results to WDNR and to association members during annual meeting.

Management Goal 3: Maximize Fishery Resources and Fishing on Lake Mildred

Management Action: Work with fisheries managers to enhance the fishery.
Timeframe: Ongoing
Facilitator: Board of Directors
Description: The results of the stakeholder survey associated with this project show that Lake Mildred Lake stakeholders feel the fishery is fair to good, but has worsened with time (Appendix B). Fishing was ranked as the 2nd most enjoyable activity on the lake, which confirms its importance to stakeholders. While the LMPOA does not expect a trophy or highest quality fishery out of Lake Mildred, they would like it to reach its full potential.

Understanding the limitations and stresses on the Lake Mildred ecosystem is the first step in developing a solution to angler concerns. From here, realistic goals and actions may be developed. Lake Mildred is currently overseen by WDNR fisheries biologist John Kubisiak (715.365-8919). In order to keep informed of survey studies that are occurring on Lake Mildred, a volunteer from the LMPOA should contact Mr. Kubisiak at least once a year (perhaps during the winter months when field work is not occurring) for a brief summary of activities. Additionally, the LMPOA may discuss options for improving the fishery in Lake Mildred, which may include changes in angling regulations, habitat enhancements, or private stocking.

During the creation of the stakeholder survey, some stakeholders voiced concerns over unnatural fish structures that were placed within Lake Mildred. While these structures pose little threat to the ecosystem, they may become an eyesore for those that appreciate the lake's natural beauty. Additionally, they likely provide limited fish habitat, if any, compared to a natural structure, or at least one created from natural materials.

John Kubisiak is an expert in fisheries management and would be very helpful in assisting the LMPOA in creating additional fish structure, if enough interest and labor time was gathered. Specifically, the WDNR has guidelines for creating optimal fish structures (attached within Appendix F). It is recommended that Mr. Kubisiak be consulted for information as to what kind of structures would best suit a lake like Lake Mildred, and where they might be placed. Additionally, Mr. Kubisiak should be contacted if removal of unnatural fish structures is attempted, as a permit may be required to do this.

Action Steps:

1. See description above.

Management Goal 4: Prevent Aquatic Invasive Species Introductions to Lake Mildred and Clear Lake

Management Action: Continue Clean Boats Clean Waters watercraft inspections at Lake Mildred public access
Timeframe: Continue current effort
Facilitator: Board of Directors
Description: At this time, Lake Mildred and Clear Lake are believed to be free of Eurasian water milfoil and curly-leaf pondweed. The only exotic species known to exist in the system are the Chinese mystery snail. Although Chinese mystery snail has spread throughout the state of Wisconsin, it does not appear to have strong impacts on native snails, while little is known about other potential effects of this snail on a Wisconsin lake ecosystem. There is no known effective control method for this species at this time.

Members of the LMPOA have been trained on Clean Boats Clean Waters (CBCW) protocols and complete boat inspections at the public landings on a regular basis. Because this system is currently free of most exotic species, the intent of the boat inspections is to prevent additional invasives from entering the lake through its public access point. The goal would be to cover the landing during the busiest times in order to maximize contact with lake users, spreading the word about the negative impacts of AIS on our lakes and educating people about how they are the primary vector of AIS spread. In 2011, 22 boats were inspected and 34 people contacted during over 96 hours of watercraft inspections.

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. Members of association continue to periodically attend Clean Boats Clean Waters training session through the Oneida County AIS Coordinator (Michele Saduskas – 715.365-2750) to update their skills to current standards.
2. Training of additional volunteers completed by those trained during the summer of 2011.
3. Continue to conduct inspections during high-risk weekends
4. Continue to report results to WDNR and LMPOA
5. Promote enlistment and training of new of volunteers to keep program fresh.

Management Action: Coordinate annual volunteer monitoring for Aquatic Invasive Species
Timeframe: Begin summer 2012
Facilitator: Board of Directors
Description: In lakes without Eurasian water milfoil and other invasive species, early detection of pioneer colonies commonly leads to successful control and in cases of very small infestations, possibly even eradication. One way in which lake residents can spot early infestations of AIS is through conducting "Lake Sweeps" on their lake. During a lake sweep, volunteers monitor the entire area of the system in

which plants grow (littoral zone) annually in search of non-native plant species. This program uses an "adopt-a-shoreline" approach where volunteers are responsible for surveying specified areas of the system.

In order for accurate data to be collected during these sweeps, volunteers must be able to identify non-native species such as Eurasian water milfoil and curly-leaf pondweed. Distinguishing these plants from native look-a-likes is very important. Additionally, the collection of suspected plants is necessary. A specimen of the plant would need to be collected for verification, and if possible, GPS coordinates should be collected.

Action Steps:

1. Volunteers from LMPOA continue to update their skills by attending a training session conducted by WDNR/UW-Extension through the AIS Coordinator for Oneida County (Michele Saduskas – 715.365-2750).
2. Trained volunteers recruit and train additional association members.
3. Continue to complete lake surveys following protocols.
4. Continue to report results to WDNR and LMPOA.

6.0 METHODS

Lake Water Quality

Baseline water quality conditions were studied to assist in identifying potential water quality problems in Lake Mildred (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 Lake Mildred's drainage area using U.S.G.S. topographic survey maps and base GIS data from the WDNR. The watershed delineation was then transferred to a Geographic Information System (GIS). These data, along with land cover data from the National Land Cover Database (NLCD – Fry et. al 2011) were then combined to determine the watershed land cover classifications. These data were modeled using the WDNR's Wisconsin Lake Modeling Suite (WiLMS) (Panuska and Kreider 2003)

Aquatic Vegetation

Curly-leaf Pondweed Survey

Surveys of curly-leaf pondweed were completed on Lake Mildred during a June 29, 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 Lake Mildred to characterize the existing communities within the lake and include inventories of emergent, submergent, and floating-leaved aquatic plants within them. The point-intercept method as described in the Wisconsin Department of Natural Resource document, Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry, and Analysis, and Applications (WDNR PUB-SS-1068 2010) was used to complete this study on July 21, 2011. A point spacing of 32 meters was used resulting in approximately 658 points.

Community Mapping

During the species inventory work, the aquatic vegetation community types within Lake Mildred (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 LMPOA.

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