Lake Ellwood

Florence County, Wisconsin

Comprehensive Lake Management Plan

October 2011

Sponsored by:

Lake Ellwood Association, Inc.

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Lake Management Planning

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

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INTRODUCTION

Lake Ellwood, Florence County, is a 132-acre seepage lake with a maximum depth of 25 feet and mean depth of 15 feet. The outlet from Lake Ellwood flows into the Pine River about a mile and a half upstream from the Menominee River. The Pine River is not known to contain Eurasian water milfoil.

Eurasian water milfoil was first discovered in the summer of 2004. In July 2005, WDNR research conducted a point-intercept survey on Lake Ellwood and confirmed the presence of the exotic species and determined that hybrid milfoil occurred in the lake. Like many lakes in northern Wisconsin, invasive species establishment threatens the health and beauty of the ecosystem. Lake Ellwood is known to harbor rusty crayfish and Eurasian water milfoil (hybrid). Members of the Lake Ellwood Association (LEA) have coordinated 2,4-D treatments aimed at reducing the spread and density of Eurasian water milfoil hybrid as well as hand-removal operations by volunteer snorkelers and scuba divers.

The association's battle with EWM helped the group to realize that a lake management plan was needed to effectively guide their future treatments and other control methods around the lake. During the planning process, numerous management actions were developed aimed at helping the association achieve the following three main management goals: 1) increase LEA's capacity to communicate effectively with lake stakeholders, and 2) maintain current water quality conditions, 3) control aquatic invasive species within Lake Ellwood.

The management plan that has resulted from this project is truly the combination of scientific study and the sociologic aspects of Lake Ellwood and its stakeholders. The results of those studies not only lead to better management decisions, but also act as a reference point for future studies. The implementation plan found near the end of the document will act as the guide for the LEA as they continue their advocacy for management and protection of their lake.

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. Stakeholders were also informed about how their use of the lake's shorelands and open water areas impact the lake. Stakeholder input regarding the development of this plan was obtained through communications and meetings with the Lake Ellwood Association (LEA) and via a stakeholder survey. A description of each stakeholder participation event can be found below, while supporting materials can be found in Appendix A.

Newsletters and Special Mailings

Early in August, 2008, a special mailing was sent to association members announcing the Kick-off Meeting and explaining the important components that would be discussed at the meeting. This mailing also called for volunteers to serve on a newly formed planning committee to help guide the management.

A project update was written in October 2008 that summarized the Kick-off Meeting, discussed the progress of the management plan, and provided some preliminary data relating to that year's Eurasian water milfoil treatment. The article also reiterated the importance for people to complete and send in their stakeholder surveys.

Kick-off Meeting

On July 16, 2008 the LEA held a special meeting to inform association members and other interested parties about the lake management planning project the association was undertaking. This public meeting was attended by 31 interested stakeholders. During the meeting, Tim Hoyman, an ecologist with Onterra, presented information about lake eutrophication, native and non-native aquatic plants, the importance of lake management planning, and the goals and components of the Lake Ellwood management planning project. It was anticipated that the management plan would largely focus on Eurasian water milfoil; therefore, the history of Eurasian water milfoil treatments on Lake Ellwood was discussed.

Stakeholder Survey

During October 2008, a seven-page, 26-question survey was mailed to 90 Lake Ellwood stakeholders. The mailing included all riparian property owners and all off lake members of the LEA. Approximately 64% of the surveys were returned (58 surveys) and those results were entered into an Onterra -provided spreadsheet by LEA planning committee members. The data were summarized and analyzed by Onterra for use at the planning meeting 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.

Planning Committee Meeting

On November 14, 2008 Tim Hoyman of Onterra met with 5 members of the LEA Planning Committee for a little over 4½ hours. All study components including, Eurasian water milfoil treatment results, aquatic plant inventories, water quality analysis, watershed modeling, and the stakeholder survey were presented and discussed. Eurasian water milfoil control was presented as the primary concern of the planning committee.

Management Plan Review and Adoption Process

In December 2008, a draft of the Lake Ellwood Management Plan was supplied to the WDNR and the LEA Planning Committee. Comments were received from the planning committee within a few weeks after the draft report was made available.

The WDNR provided written comments to the draft management plan on September 5, 2011. This report reflects the integration of WDNR and LEA comments. The final report will be reviewed by the LEA Board of Directors and a vote to adopt the management plan will be held during the association's next annual meeting.

RESULTS & DISCUSSION

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, not all chemical attributes collected may have a direct bearing on the lake's ecology, but may be more useful as indicators of other problems. Finally, water quality values that may be considered poor for one lake may be considered good for another because judging water quality is often very 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 analysis 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 ecology 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. Six 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 analysis is elaborated on below.

Judging the quality of lake water can be difficult because lakes display problems in many different ways. 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. To complete this task, three water quality parameters are focused upon within this document:

Phosphorus is a 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.

Comparisons with Other Datasets

Lillie and Mason (1983) is an excellent source for comparing lakes within specific regions of Wisconsin. They divided the state's lakes into five regions each having lakes of similar nature or apparent characteristics. Florence County lakes are included within the study's Northeast Region (Figure 1) and are among 243 lakes randomly picked from the region that were analyzed for water clarity (Secchi disk), chlorophyll-*a*, and total phosphorus. These data along with data corresponding to statewide natural lake means, historic, current, and average data from Lake Ellwood are displayed in Figures 2-5. 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, collected at a depth of 3 feet below the surface, 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.

Figure 1. Location of Lake Ellwood within the regions utilized by Lillie and Mason (1983).

Apparent Water Quality Index

Water quality, like beauty, is often in the eye of the beholder. A person from southern Wisconsin that has never seen a northern lake may consider the water quality of their lake to be good if the bottom is visible in 4 feet of water. On the other hand, a person accustomed to seeing the bottom in 18 feet of water may be alarmed at the clarity found in the southern lake.

Lillie and Mason (1983) used the extensive data they compiled to create the *Apparent Water Quality Index* (WQI). They divided the phosphorus, chlorophyll-*a*, and clarity data of the state's lakes in to ranked categories and assigned each a "quality" label from "Excellent" to "Very Poor". The categories were created based upon natural divisions in the dataset and upon their experience. As a result, using the WQI as an assessment tool is very much like comparing a particular lake's values to values from many other lakes in the state. However, the use of terms like, "Poor", "Fair", and "Good" bring about a better understanding of the results than just comparing averages or other statistical values between lakes. The WQI values corresponding to the phosphorus, chlorophyll-*a*, and Secchi disk values for Lake Ellwood are displayed on Figures 2-4.

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. However, through the use of a *trophic state index* (TSI), a 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.

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.

Carlson (1977) presented a trophic state index that gained great acceptance among lake managers. Because Carlson developed his TSI equations on the basis of association among water clarity, chlorophyll-*a*, and total phosphorus values of a relatively small set of Minnesota Lakes, researchers from Wisconsin (Lillie et. al. 1993), developed a new set of relationships and equations based upon the data compiled in Lillie & Mason (1983). This resulted in the Wisconsin Trophic State Index (WTSI), which is essentially a TSI calibrated for Wisconsin lakes.

The WTSI is used extensively by the WDNR and is reported along with lake data collected by Citizen Lake Monitoring Network volunteers. The methodology is also used in this document to analyze the past and present trophic state of Lake Ellwood.

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 is going to need 16 of each ingredient. If he is short two eggs, he will only be able to make three cakes even if he has sufficient amounts of the other ingredients. In this scenario, the eggs are the limiting nutrient (ingredient).

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

*Temperature and Dissolved Oxygen Profiles**

Temperature and dissolved oxygen profiles are created simply by taking readings at different water depths within a lake. Although it is a simple procedure, the completion of several profiles over the course of a year or more provides a great deal of information about the lake. Much of this information concerns 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.

*Temperature and dissolved oxygen profiles were not consistently collected as a part of this project. The information provided under this heading is strictly for the knowledge of the reader.

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.

Lake Ellwood Water Quality Analysis

Unfortunately, very little historic water quality data exists for Lake Ellwood, so it is impossible to complete any sort of long-term trend analysis. This is unfortunate because having an understanding of how the lake may be changing leads to sounder management decisions. According to the results of the stakeholder survey, roughly 95% of respondents consider the water quality of Lake Ellwood to be fair to excellent; however, there is belief among stakeholders that the lake's water quality has degraded as shown by over 48% of the stakeholder survey respondents stating that the water quality has gotten moderately to severely worse since they have owned their property. On the contrary, roughly the same percentage believes that the water quality has stayed the same or gotten slightly better. In the end, it is difficult to tell if the respondents are purely thinking about lake *water* quality or if they are thinking of the quality of the *lake*, which would include other factors like changes in sediment structure in a swimming area, appearance of native plants, and of course aquatic invasive species infestations. Regardless, the lack of historic data precludes determining if the lake's water quality is degrading, staying the same, or improving.

While there is a lack of historic water quality data for the lake, sufficient information was collected as a part of this project to examine the current water quality of Lake Ellwood (the full dataset is located in Appendix C). As described above, three water quality parameters are of most interest; total phosphorus, chlorophyll *a*, and Secchi disk transparency. Total phosphorus data from Lake Ellwood are contained in Figure 2. Examination of these data indicates that the total phosphorus level of Lake Ellwood is low, especially when compared to other lakes in the region and within the state. While all values would be considered to be within the good to very good range, there are only minor fluctuations of the phosphorus concentrations between years within the lake. It should be noted that there is not sufficient data to detect trends as water quality within a lake normally fluctuates from year-to-year and is largely dependent on precipitation and water levels. These fluctuations are discussed more below in regards to water clarity.

As with the phosphorus data, little historic chlorophyll *a* data exists for Lake Ellwood (Figure 3). However, the data that do exist follows the normal phosphorus/chlorophyll *a* relationship in that the low phosphorus values within Lake Ellwood have lead to incredibly low chlorophyll *a* values. In addition, Ellwood's chlorophyll *a* values are well below state and regional means and correspond with very good readings in the WQI.

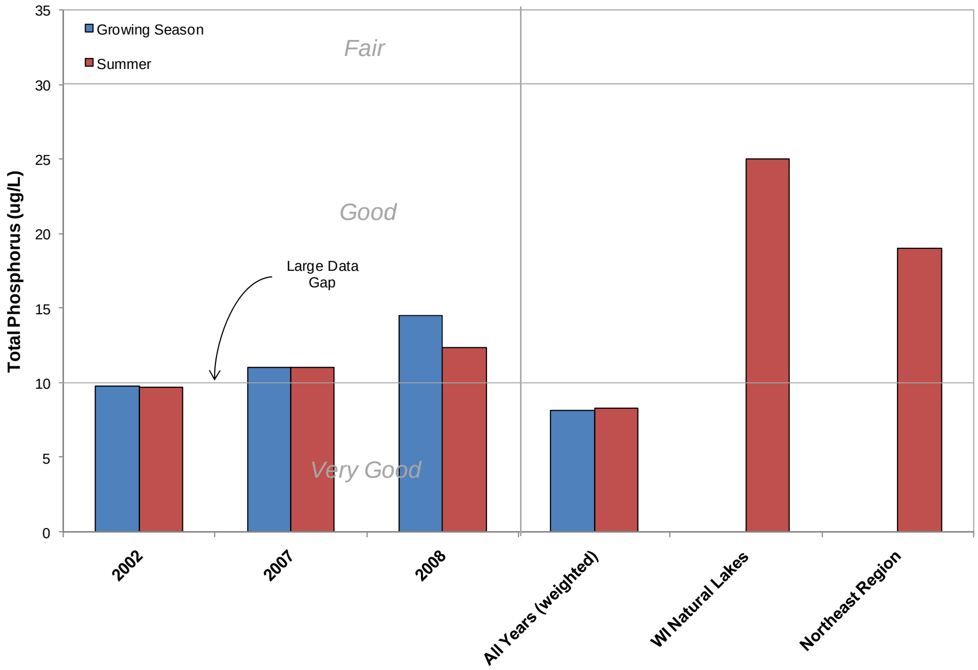

Figure 2. Lake Ellwood total phosphorus concentrations. Mean values calculated with summer and growing season surface sample data. Water Quality Index values adapted from Lillie and Mason (1983).

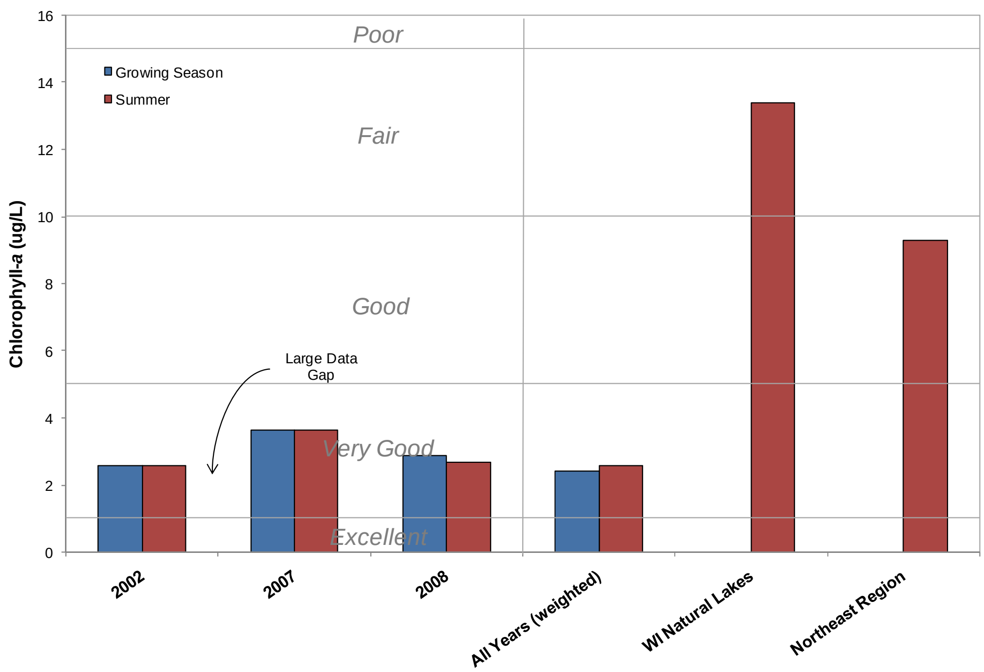

Figure 3. Lake Ellwood chlorophyll-*a* concentrations. Mean values calculated with summer and growing season surface sample data. Water Quality Index values adapted from Lillie and Mason (1983).

Fortunately, there is a solid Secchi disk clarity dataset from Lake Ellwood that dates back to 1994 (Figure 4). All of the averages from Lake Ellwood surpass those of the ecoregion and the state and fall within the very good range of the WQI. As alluded to above, there really is no trend towards improved or degraded water quality within the dataset and as with most lakes, the clarity of Lake Ellwood fluctuates from year-to-year.

In summary, the limited historic data and those collected as a part of the project, all indicate that the water quality of Lake Ellwood has seen minor levels of fluctuation over the course of the past decade, but all indicate that the water quality within the lake is good to very good. The primary reason for this level of water quality is the watershed that drains to the lake. That aspect of the Lake Ellwood ecosystem is discussed in detail within the watershed section.

Figure 4. Lake Ellwood Secchi disk transparency values. Mean values calculated with summer and growing season sample data. Water Quality Index values adapted from Lillie and Mason (1983).

Lake Ellwood Trophic State

Figure 5 displays the Wisconsin Trophic State Index (WTSI) (Lillie et al. 1993) values calculated from average surface levels of chlorophyll-*a*, total phosphorus, and Secchi disk transparencies measured during the summer months in Lake Ellwood. The WTSI values indicate that the lake's productivity ranges from upper oligotrophic to moderately mesotrophic. Being that the WTSI values are calculated with the same parameters discussed above, it is not surprising that the trophic state indices for the lake follow the same general patterns.

Limiting Plant Nutrient of Lake Ellwood

Midsummer nitrogen and phosphorus concentrations collected during 2008 were 550 μg/L and 12 μg/L, respectively. These figures yield a nitrogen to phosphorus ratio of 46:1, indicating that Lake Ellwood is strongly phosphorus limited.

Internal Nutrient Loading in Lake Ellwood

Sufficient data were not collected as a part of this project to truly determine if internal loading is a significant source of nutrients within Lake Ellwood. However, as discussed in the watershed section, there is no evidence that there are unaccounted sources of phosphorus to the lake; therefore, internal nutrient loading is likely not a significant source of phosphorus to Lake Ellwood at this time.

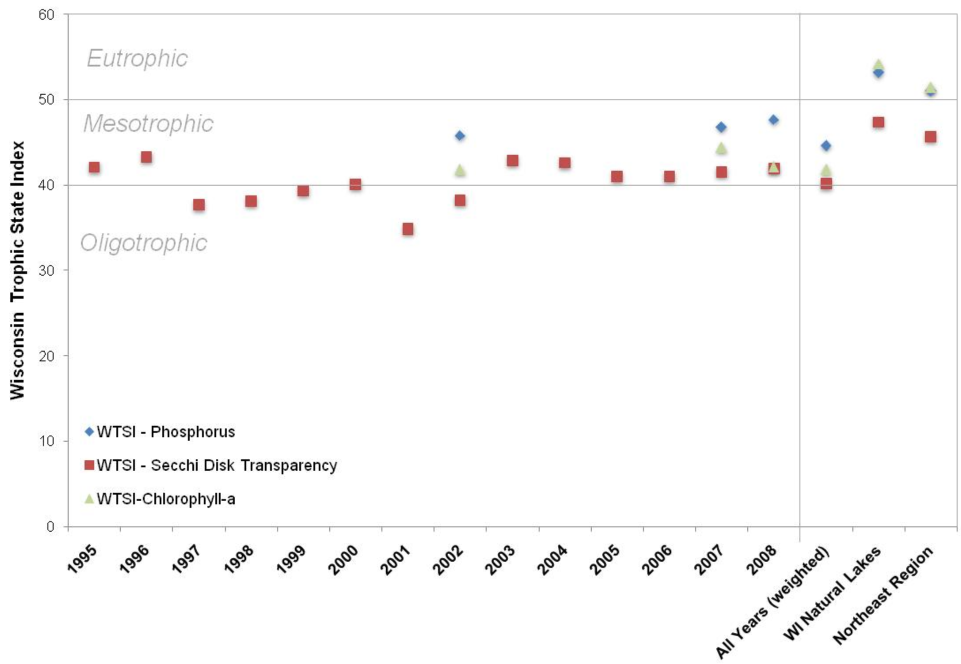

Figure 5. Lake Ellwood Wisconsin Trophic State Index values. Values calculated with summer month surface sample data using Lillie et al. (1993).

Additional Water Quality Data Collected at Lake Ellwood

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 Ellwood'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 et al. 2004). The pH in of Lake Ellwood during the growing season was found to be slightly alkaline with a value of 8.3, and falls within the upper end of the normal range for Wisconsin Lakes.

Alkalinity is a lake's capacity to resist fluctuations in pH by neutralizing or buffering against inputs such as acid rain. The main compounds that contribute to a lake's alkalinity in Wisconsin are bicarbonate (HCO_3^-) and carbonate (CO_3^-), which neutralize hydrogen ions from acidic inputs. These compounds are present in a lake if the groundwater entering it comes into contact with minerals such as calcite ($CaCO_3$) and/or dolomite ($CaMgCO_3$). A lake's pH is primarily determined by the amount of alkalinity. Rainwater in northern Wisconsin is slightly acidic naturally due to dissolved carbon dioxide from the atmosphere with a pH of around 5.0. Consequently, lakes with low alkalinity have lower pH due to their inability to buffer against acid inputs. The alkalinity was measured from Lake Ellwood on May 12, 2008 and found to be 98.5 (mg/L as $CaCO_3$), indicating that the lake has a substantial capacity to resist fluctuations in pH and has a low sensitivity to acid rain.

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 Ellwood's pH of 8.3 falls within the high end 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 Ellwood was found to be 22.2 mg/L, falling within the optimal range for zebra mussels. Lake Ellwood is also determined to be "suitable" for zebra mussel invasion by Wisconsin AIS Smart Prevention website (www.aissmartprevention.wisc.edu/).

Watershed Analysis

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 are 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 will be decreased. In fact, if the phosphorus load is reduced greatly, changes in lake water quality may be noticeable, (e.g. reduced algal abundance and better water clarity) and may even be enough to cause a shift in the lake's trophic state.

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

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

A reliable and cost-efficient method of creating a general picture of a watershed's affect on a lake can be obtained through modeling. The WDNR created a useful suite of modeling tools called the Wisconsin Lake Modeling Suite (WiLMS). Certain morphological attributes of a lake and its watershed can be 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 useful in validating modeled phosphorus loads to the lake in question and modeling alternate land cover scenarios within the watershed. Finally, if specific information is available, WiLMS will also estimate the significance of internal nutrient loading within a lake and the impact of shoreland septic systems.

Lake Ellwood has approximately 1,675 acres of land draining to it (Map 2), which yields a watershed to lake area ratio of 12:1. The ratio would be considered moderate and indicate that if issues occurred within the watershed, the size of it would likely not overcome the benefits brought on by making changes within it. However, at this time, that is not a concern with Lake Ellwood's watershed as the vast majority (81%) of its acreage is currently forested (Figure 6) , with the remaining terrestrial areas being primarily in wetland and a small amount comprised of mixed agriculture and pasture/grass (Map 2). The only land cover type that may be of concern would be the mixed agriculture which occupies only 4% of the total watershed.

WiLMS modeling utilizing the land cover types and acreages found in Figure 6 results in an estimated annual phosphorus load of 214 lbs for Lake Ellwood. Just over half of the phosphorus entering the lake results from runoff originating from forested lands within the watershed (Figure 7). That source is followed by mixed agriculture (24%) and atmospheric fallout upon the lake's surface (16%).

The annual phosphorus load to Lake Ellwood is fairly minimal, which is to be expected for a lake of this size with a large amount of forested land within its watersheds. With this is mind, it is important to focus efforts of restoration on the most vulnerable area of the watershed, the immediate shoreland zone. When a lake's shoreline is developed, the increased impervious surface, removal of natural vegetation, installation of septic systems, and other human practices can severally increase nutrient loads to the lake while degrading important habitat. Limiting these anthropogenic (man-made) affects on the lake is important in maintaining the current high quality of the lake's water and habitat.

Overall, the watershed of Lake Ellwood is in very good condition and is delivering a minimal amount of phosphorus to the lake. In fact, the estimate described above of 214 lbs/year is likely high as that amount of phosphorus would result in higher concentrations of in-lake phosphorus than actually occur in Lake Ellwood. This leads to the conclusion that there is minimal phosphorus entering the lake from its watershed and that other sources, such as faulty septic systems and internal cycling of nutrients, add little if any phosphorus to the lake.

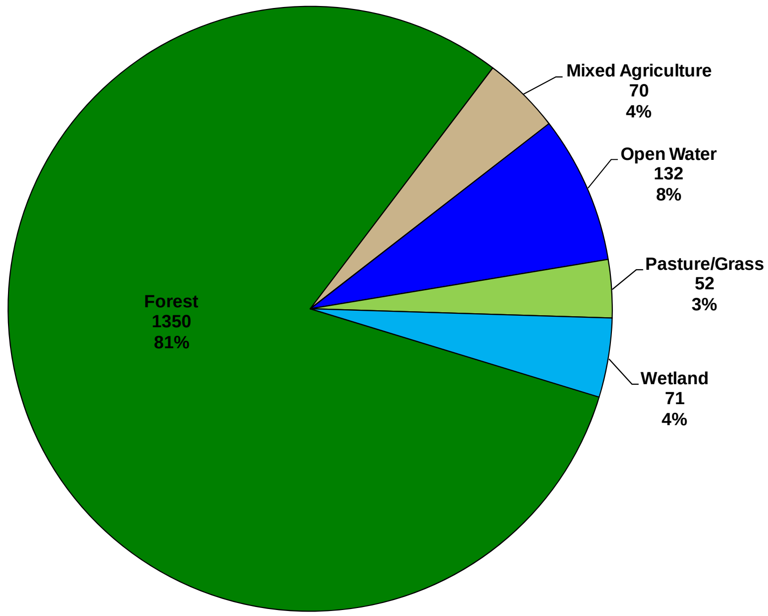

Figure 6. Lake Ellwood watershed land cover types in acres. Based upon Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND) (WDNR 1998).

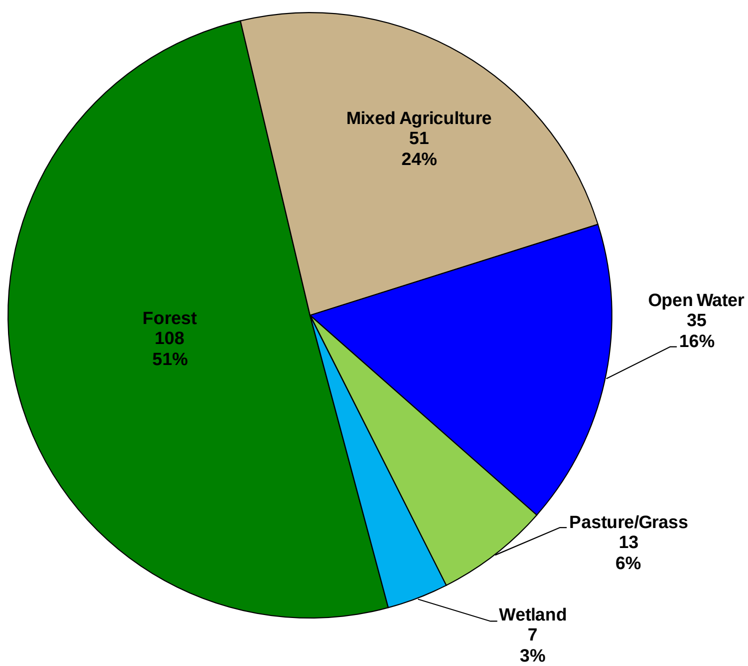

Figure 7. Lake Ellwood watershed phosphorus loading in pounds. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Aquatic Plants and the Lake Ecosystem

Although some lake users consider aquatic macrophytes to be "weeds" and a nuisance to the recreational use of the lake, they are actually an essential element in a healthy and functioning lake ecosystem. It is very important that the 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 numbers of predator fish and 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.

Analysis of 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, like variable water levels or negative, like increased shoreland development or the introduction of an exotic species, the plant community will respond. Plant communities respond in a variety of ways; there may be a loss of one or more species, certain life forms, such as emergents or floating-leaf communities may disappear from certain areas of the lake, or there may be a shift in plant dominance between species. With periodic monitoring and proper analysis, these changes are detectable and provide critical information for management decisions.

As described in more detail in the methods section, two aquatic plant surveys were completed on Lake Ellwood. The first appeared strictly for curly-leaf pondweed, and the second inventoried all aquatic species found in the lake. 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.

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.

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 Ellwood, 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, relative frequency of occurrence is used to describe how often each species occurred relative to the other plants. 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 that value was described 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

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 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.

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 Ellwood is compared to lakes in the same ecoregion and in the state (Figure 8).

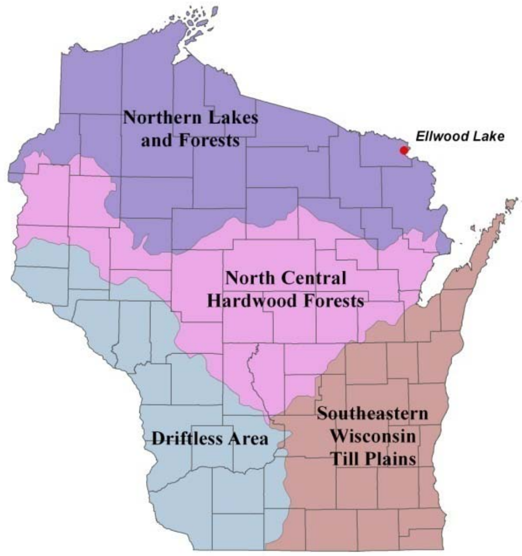

Figure 8. Location of Lake Ellwood within the ecoregions of Wisconsin. After Nichols 1999.

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 (see equation below).

$$\text{FQI} = \text{Average Coefficient of Conservatism (6.2)} * \sqrt{\text{Number of Native Species (6)}}$$
$$\text{FQI} = 15.1$$

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 completely visible from the surface; therefore, mapping of submergent communities is more difficult and often impossible.

2005 Point-intercept Survey Results

In 2005, the WDNR completed an aquatic plant survey on Lake Ellwood utilizing the point-intercept method as described in "Appendix B" of the Wisconsin Department of Natural Resource (WDNR) document, Aquatic Plant Management in Wisconsin - Draft, (April 20, 2006). The survey identified seven aquatic plants from Lake Ellwood. In 2008 Onterra completed additional surveys on the lake including a curly-leaf pondweed survey, a community mapping survey, and numerous Eurasian water milfoil treatment monitoring surveys. An additional 5 plant species were located during these surveys giving Lake Ellwood a species richness of 12 aquatic plants (Table 1). Only one species, Eurasian water milfoil hybrid is considered non-native and invasive in Wisconsin. This hybrid is a cross between northern water milfoil (native) and Eurasian water milfoil (non-native).

Table 1. Aquatic plant species located in Lake Ellwood during the 2005 point-intercept survey and 2008 aquatic plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)
Submergent	*Chara sp.*	Muskgrasses	7
	*Elodea canadensis**	Common waterweed	3
	Myriophyllum spicatum/sibiricum Hybrid	Eurasian/Northern Milfoil Hybrid	Exotic
	Najas flexilis	Slender naiad	6
	Potamogeton amplifolius	Large-leaf pondweed	7
	*Potamogeton gramineus**	Variable pondweed	7
	Potamogeton illinoensis	Illinois pondweed	6
	*Potamogeton praelongus**	White-stem pondweed	8
	Potamogeton richardsonii	Clasping-leaf pondweed	5
	*Stuckenia pectinata**	Sago pondweed	3
	Vallisneria americana	Wild celery	6
E	*Polygonum amphibium**	Water smartweed	5
	*Typha latifolia**	Cattail	1

E = Emergent
* = Incidental

Muskgrasses and slender naiad (Figure 9) are the most abundant plants within Lake Ellwood, together accounting for over 71% of the relative frequency of plants found within the lake. The relative uneven distribution of these two species throughout the lake (relative frequency) contributes to Lake Ellwood's low diversity (Simpson's = 0.72). Other common species that occur throughout much of the lake include Illinois pondweed, wild celery, clasping-leaf pondweed and large-leaf pondweed (Figure 9). During the survey in 2005, Eurasian water milfoil hybrid was the 7th most abundant plant.

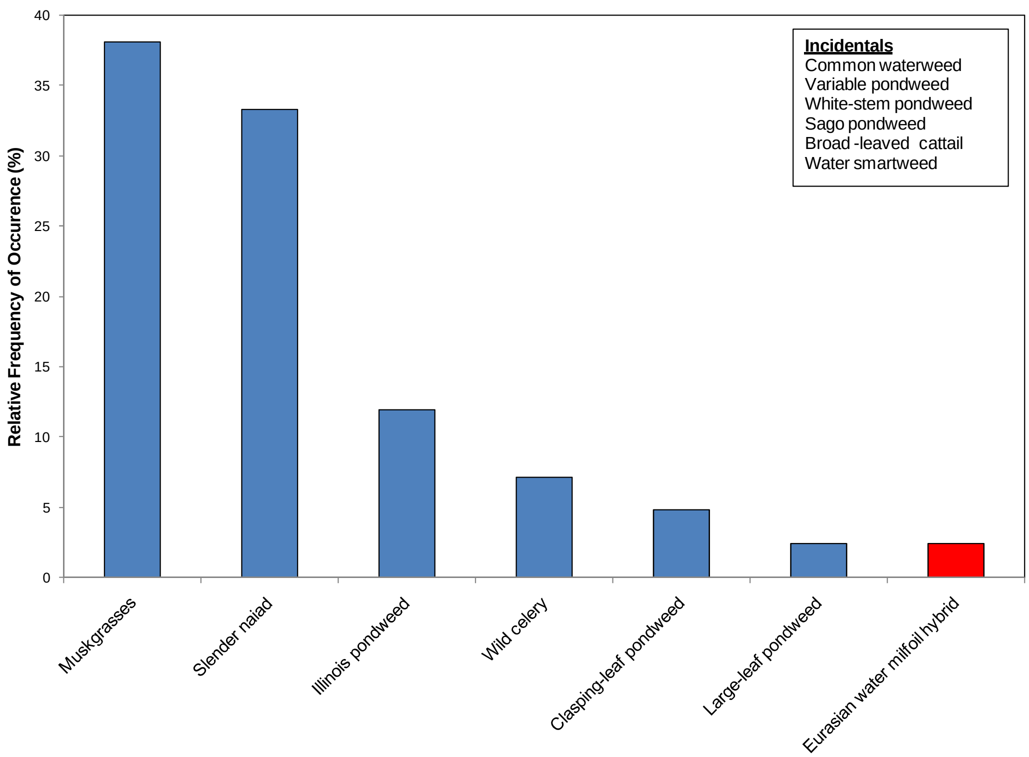

Figure 9. Lake Ellwood aquatic plant occurrence analysis of 2005 survey data. Exotic species indicated with red.

Median Value This is the value that roughly half of the data are smaller and half the data are larger. A median is used when a few data are so large or so small that they skew the average value to the point that it would not represent the population as a whole.

Based solely on the point-intercept plant survey, Lake Ellwood contains less aquatic species than the state and ecoregion medians. The Lake Ellwood average conservatism values are lower than the ecoregion medians, but higher slightly higher than the state median. This indicates that many of the species present in the lake are indicative of a disturbed system. Combining the number of species with the plant community is depauperate as evidenced by the low floristic quality and low index of diversity (Figure 10). The quality is also indicated by the low incidence of emergent and floating leaf plant communities that occur in only two areas of the lake (Map 3).

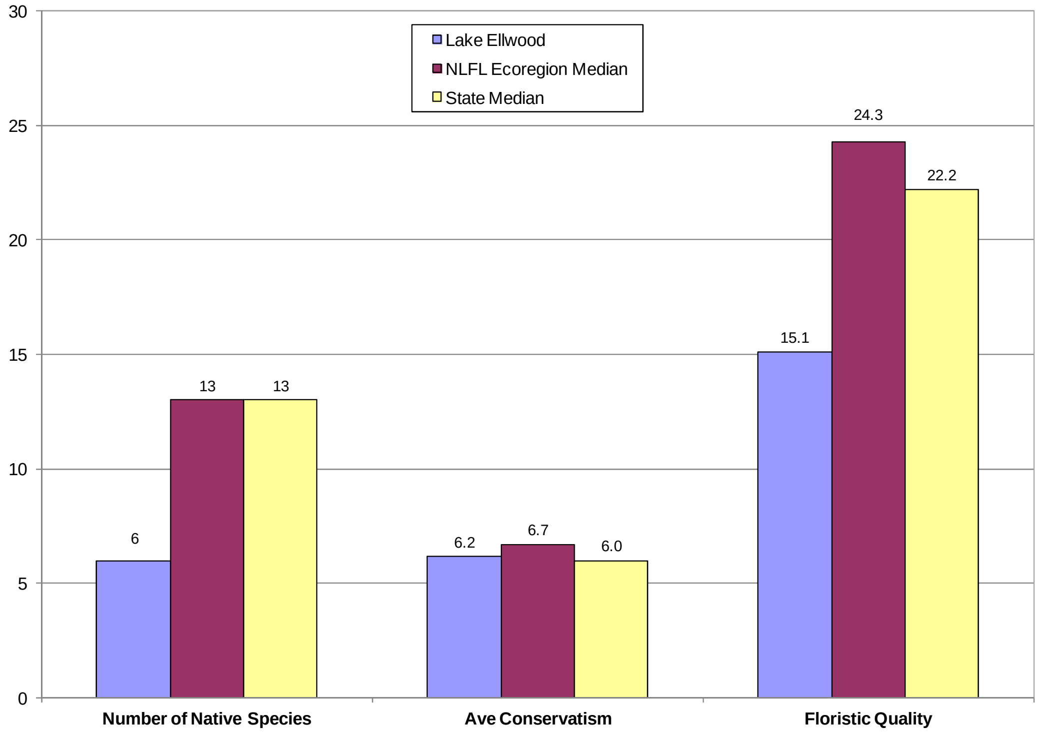

Figure 10. Lake Ellwood Floristic Quality Assessment of 2005 survey data. Analysis following Nichols 1999.

As discussed in the water quality section, Lake Ellwood is a low-productivity system that does not have the ability to support a large plant biomass. While the plant population of Lake Ellwood is not species rich and contain plants indicative of a slightly disturbed system, the plants that are present are considerably valuable to support the ecosystem. Common waterweed is a species that is not usually rooted and is commonly found at the outer margins of the littoral area. Muskgrasses are a group of macro-algae that do not contain a true root system and form dense carpets along the lake's bottom holding sediments in place. This plant is often found in high abundances in lakes that contain large amounts of marl. Large-leaf pondweed, sometimes called *musky cabbage* by anglers, provides valuable habitat for ambush predator fish. Wild celery is a turbidity tolerant species that is a premier food source for ducks, marsh birds, shore birds, and muskrats.

It is perplexing that this exotic species is able to proliferate so well in a system with such a low potential for plant biomass. Arguably most important, the native plant species present within the lake have the ability to ward off the threats of invasive species. A well-established plant community makes establishment of pioneer invasive species difficult. Similar to tilling up an area in an urban lawn, pioneer species like dandelion and thistles are the first to colonize. On a lake, these pioneer species are aggressive non-native species like Eurasian water milfoil.

On Lake Ellwood, motorboats with greater than a 25 horsepower motor are the most common watercraft (Appendix B, Question #8) and waterskiing and motor boating are the 3rd and 5th, respectively, most important or enjoyable activities (Appendix B, Question #9). These activities have the potential to negatively impact a lake ecosystem. Many studies have documented the adverse affects of motorboat traffic on aquatic plants (e.g. Murphy and Eaton 1983, Vermaat and de Bruyne 1993, Mumma et al. 1996, Asplund and Cook 1997). In all of these studies, lower plant biomasses and/or declines and higher turbidity were associated with motorboat traffic.

Along with intense recreational use, developed shorelines also can greatly impact the health of native plant communities. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines. The cumulative effect of riparians altering the important near-shore habitat on Lake Ellwood may be a reason for its depauperate plant community.

Although it is not clear when rusty crayfish first arrived to Lake Ellwood, humans were most likely the vector of the infestation. Rusty crayfish are known to nearly decimate established plant communities on a lake-wide basis on many lakes in the state. Exotic plant infestation following the disturbance caused by rusty crayfish has likely given this exotic plant an advantage on many lakes across the state and may have occurred on Lake Ellwood. Unfortunately, not much is known about the rusty crayfish infestation within Lake Ellwood. Anecdotal reports from LEA members believe that aquatic plant populations on the lake are greater than they ever have been.

Non-native Aquatic Plants

Although the Lake Ellwood Association realized the importance of understanding the lake ecosystem past its plant community and how that understanding would lead to a more comprehensive management plan, they were spurred into the planning process because of the known threats of invasive species. The initial goal of this project was to complete a management plan that would address the infestation of Eurasian water milfoil hybrid that occurred within the lake. Aquatic invasive species were the highest ranked factor that is negatively impacting the lake (Appendix B, Question #14) and most concerning issue facing the Lake (Appendix B, Question #15) according to the stakeholder survey.

Curly-leaf Pondweed

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 almost immediately following ice-out, giving the plant a significant jump on native vegetation. 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.

A meander survey was completed on June 30, 2008 in search of this invasive plant. No curly-leaf pondweed was observed during this study and it is concluded that curly-leaf pondweed is most likely not present in the lake and if it is present, it is at an undetectable level.

Eurasian water milfoil

Eurasian water-milfoil is an invasive species, native to Europe, Asia and North Africa, that has spread to most Wisconsin counties (Figure 11). Eurasian water-milfoil is unique in that its primary mode of propagation is not by seed. It actually spreads mostly 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.

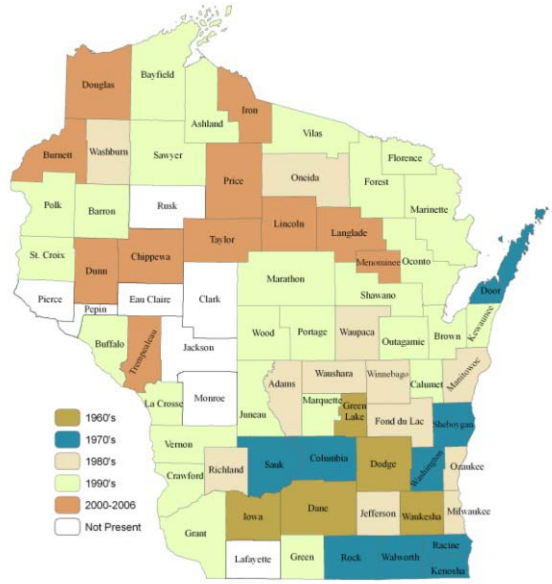

Figure 11. Spread of Eurasian water milfoil within WI counties. WDNR Data 2006 mapped by Onterra.

Eurasian water milfoil hybrid was first discovered in the summer of 2004 and ever since the Lake Ellwood Association has been acting to keep it under control. Efforts have included hand-removal by an association-organized youth group and chemical treatments completed by a licensed applicator. Formal monitoring of the treatments was not completed; however, anecdotal accounts indicate that the chemical treatments produced uncertain results while the hand-removal was more promising.

In July 2005, WDNR research conducted a point-intercept survey on Lake Ellwood and confirmed the presence of the exotic species and determined that hybrid milfoil occurred in the lake. The point-intercept survey was completed only weeks after an herbicide treatment, so the survey results may not accurately represent the true nature of the infestation.

As a part of this project, the 2007 and 2008 herbicide treatments of Eurasian water milfoil were monitored according to current WDNR protocols (April 2007) to provide analysis of treatment efficacy and to satisfy the chemical application permit issued by the WDNR. Herbicide treatments are highly supported by members of the LEA, as only 9% of stakeholder respondents were not at least moderately supportive of the use of herbicides on the lake (Appendix B, Question #18). Some of the following text was integrated and modified from the treatment report detailing the 2007 treatment.

After numerous correspondences with members of the Lake Ellwood Association (LEA), a sketched map of known Eurasian water milfoil hybrid locations was provided by the LEA to Onterra. Using Geographic Information System (GIS) software, the map was digitized and made into GIS native shapefile format. This resulted in a preliminary treatment area of 36.7 acres that was used to obtain a conditional chemical application permit from the WDNR (Map 4). Then in May, these areas were surveyed to refine the treatment areas. The most dense areas were mapped and the heaviest areas were recommended to be treated with 2,4-D at 150 pounds/acre (Map 5). The dosage was increased from 100 pounds/acre due to the history of ineffectiveness at that dosage on Lake Ellwood. It is perceived that this ineffectiveness is attributed to the relatively great depths to which the Eurasian water milfoil hybrid is found in this system. We provided the necessary data to the applicator, Schmidt's Aquatic Plant Control, and an application of Navigate (2,4-D) was completed on May 29, 2007 at 150 lbs/acre. The winds were light (0-5 mph) and the water temperature was 16.6°C (62°F). The applicator did note that many of the Eurasian water milfoil hybrid plants were covered with calcium at the time of the treatment.

Determining the success or failure of chemical treatments on Eurasian water milfoil hybrid is often a difficult task because the criteria used in determining success or failure is ambiguous. Most people involved with Eurasian water milfoil hybrid management, whether professionals or laypersons, understand that the eradication of Eurasian water milfoil hybrid from a lake, or even a specific area of a lake, is nearly, if not totally, impossible. Most understand that achieving control is the best criteria for success. During the surveys reported on here, two different methods of evaluation were used to understand the level of control that was achieved by the chemical treatment. A qualitative assessment was determined for each treatment site by comparing detailed notes of pre- and post treatment observations and spatial data collected with a sub-meter GPS datacollector. A quantitative assessment of the treatment was also made by collecting data at 38 point-intercept sample locations before and after the treatment. At these locations, Eurasian water milfoil hybrid presence and rake fullness was documented as well as water depth and substrate type. Native plant abundances were also determined at each plot during the pre- and post treatment surveys; however, these data are not discussed here because comparisons between early spring samples and summer samples are not valid due to the lifecycles of these species.

Pretreatment Survey – May 23, 2007

The purpose of this survey was to refine the treatment areas used in the conditional permit to more accurately and effectively coordinate the control method. Full sun and low wind made conditions ideal for locating Eurasian water milfoil hybrid. Much Eurasian water milfoil hybrid was located and many of the plants were covered with calcium. Two separate areas were proposed for treatment (Map 5).

Site 1-07 Eurasian water milfoil hybrid was difficult to observe from the surface, so transects taken perpendicularly towards the colony utilizing a submerged video camera were used to locate the extents of the colony. As the edge was located buoys were placed, allowing the colony to be mapped using the GPS technology described above. Of the 18 point-intercept locations sampled, 44% contained Eurasian water milfoil hybrid (Figure 12).

Site 2-07 Although Eurasian water milfoil hybrid was more easily observed from the surface, this location was mapped in a fashion similar to Site 1. 50% of the 20 point-intercept locations sampled contained Eurasian water milfoil hybrid (Figure 12).

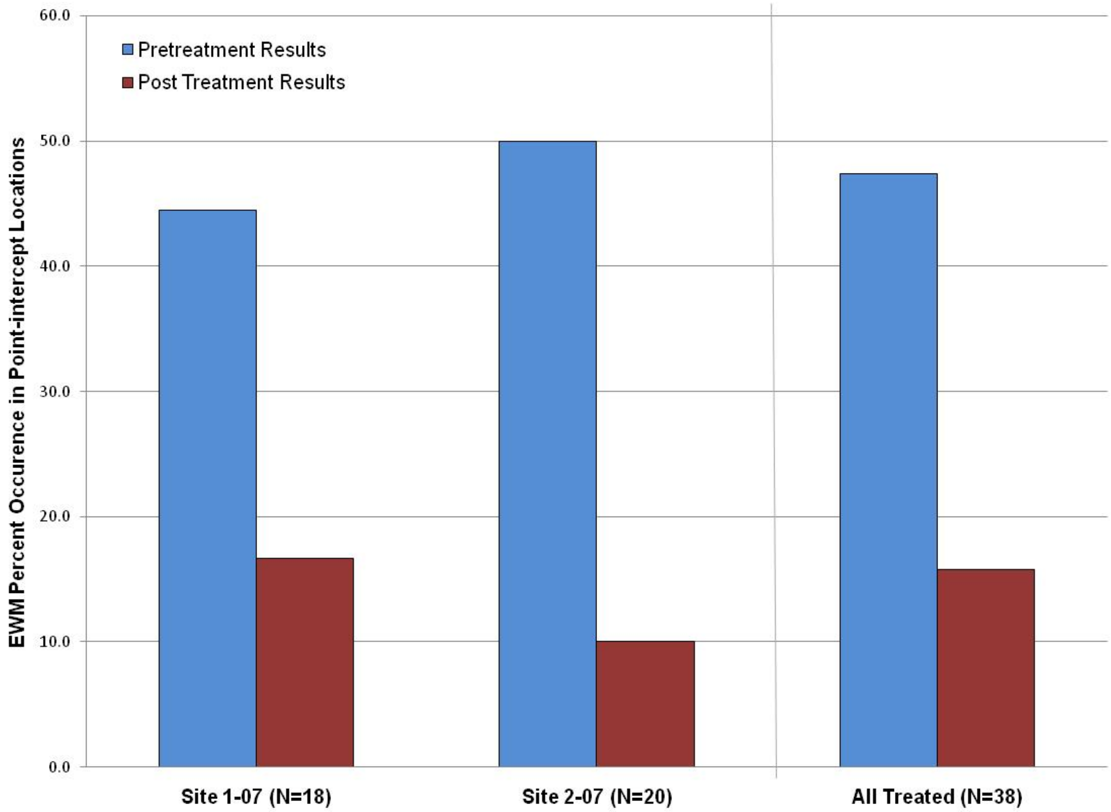

Figure 12. Eurasian water milfoil hybrid percent occurrence monitoring the 2007 treatment Pretreatment survey occurred in May 2007 and post treatment survey occurred in July 2007.

Post Treatment Survey – July 26, 2007

During this survey, all treatment areas were visited to determine the efficacy of the chemical application. All point-intercept sample locations were re-visited and data were collected in the same manner as during the pretreatment survey. Water clarity was good and plants could be observed growing in 10 feet of water. The entire littoral zone of the lake was searched and Eurasian water milfoil hybrid was mapped for future management activities (Map 6).

Site 1-07 A few small remnant colonies of Eurasian water milfoil hybrid were observed in this treatment area (Map 6). Two colonies straddle a shallow area between the mainland and the island and the third colony is very tight to the shoreline on the west side of the island growing in about a foot of water. Aside from these locations, no other Eurasian water milfoil hybrid was located within Site 1. 16.7% of the 18 point-intercept locations contained Eurasian water milfoil hybrid.

Site 2-07 Almost no Eurasian water milfoil hybrid was observed growing in this treatment area. A few plants were observed just lakeward from the treatment (Map 6). Only 2 (10%) of the 20 point-intercept locations contained Eurasian water milfoil hybrid after the treatment.

2007 Conclusions and recommendations

Before the treatment, 47% of the point-intercept locations contained Eurasian water milfoil hybrid and less than 16% contained Eurasian water milfoil hybrid after the treatment (Figure 13). A rake fullness rating of 1-3 was used to determine abundance of the Eurasian water milfoil hybrid at each location. Figure 13 displays the number of point-intercept locations exhibiting each of the rake fullness ratings. The figure shows that of the 17 locations that contained Eurasian water milfoil hybrid before the treatment, 65% had a rake fullness rating of 1. These data suggest a relatively light density of Eurasian water milfoil hybrid plants within the treatment area and may be a reason why the treatment was so effective. The post treatment survey yields only 5 sample locations containing Eurasian water milfoil hybrid, all but one of them displaying a rake fullness rating of 1.

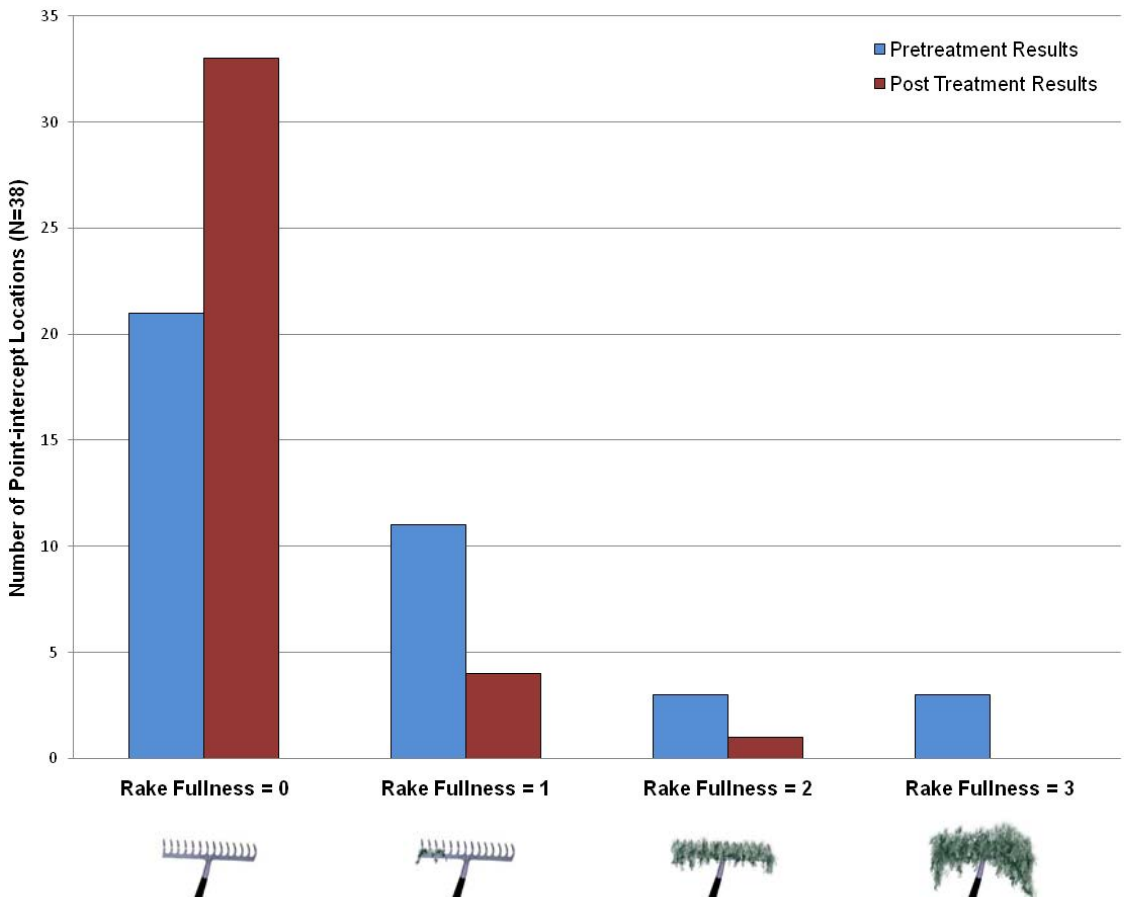

Figure 13. Eurasian water milfoil hybrid rake fullness distribution monitoring the 2007 treatment. Pretreatment survey occurred in May 2007 and post treatment survey occurred in July 2007.

It is perceived that the level of control achieved from the chemical treatments conducted on Lake Ellwood was high. However, additional areas of Eurasian water milfoil hybrid were located around the lake with the highest densities located in the northeast corner and near the mouth of a small bay along the western shoreline (Map 6). During the winter of 2007-2008, a treatment strategy of 22.5 acres was devised (Map 7) and was used to create a conditional treatment permit for 2008.

Pretreatment Survey – June 4 & 11, 2008

Using the proposed treatment areas from the conditional permit as focus areas, the purpose of the June 4 field survey was to refine an prioritize the treatment areas. The LEA understood the importance of formulating a treatment plan that attacked all areas on the lake; however budget constraints made prioritization necessary. The survey results indicated that all areas warranted treatment, but because I-08 and H-08 were in high traffic areas, they should be the primary targets of the treatments. Onterra ecologists had reservations about treating either A-08 or B-08 without treating the other. It was theorized that the untreated area would serve as a near-by source population where re-colonization of the exotic species would occur at a rapid pace. However, the LEA decided to treat A-08 because of the many residences in that part of the lake, and leave B-08 untreated until funds became available (Map 7).

On June 11, 2008, point-intercept sub-sample locations were visited within the treatment areas to evaluate treatment effectiveness. As figure 14 shows, considerable amounts of Eurasian water milfoil hybrid was located within the treatment areas.

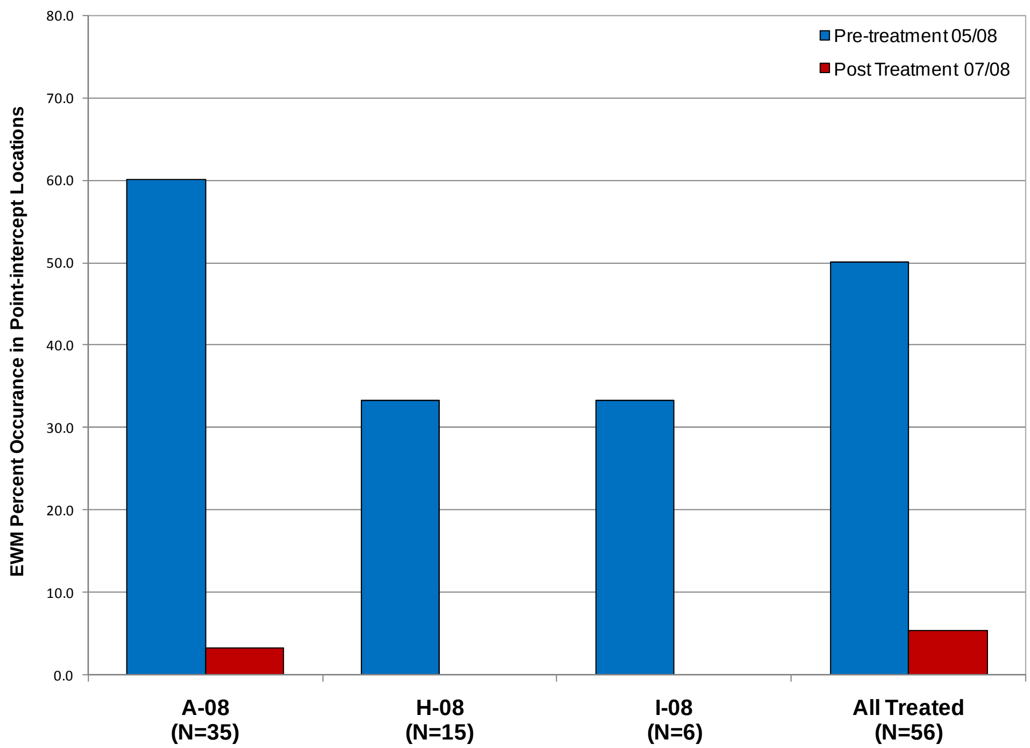

Figure 14. Eurasian water milfoil hybrid percent occurrence monitoring the 2008 treatment

Post Treatment Survey – July 22 and August 15, 2008

On July 22, all point-intercept sub sample locations were visited in the same manner as the previous surveys. Of the 56 sample locations visited within the treatment areas, 28 (50%) contained Eurasian water milfoil hybrid before the treatment and only 3 (5.4%) contained the exotic after the treatment. All three of the locations that contained Eurasian water milfoil hybrid were located near the center of Site A-08 where the infestation was the heaviest. Of these three locations, only one contained a rake fullness rating of 2 and none were rating of 3 (Figure 15).

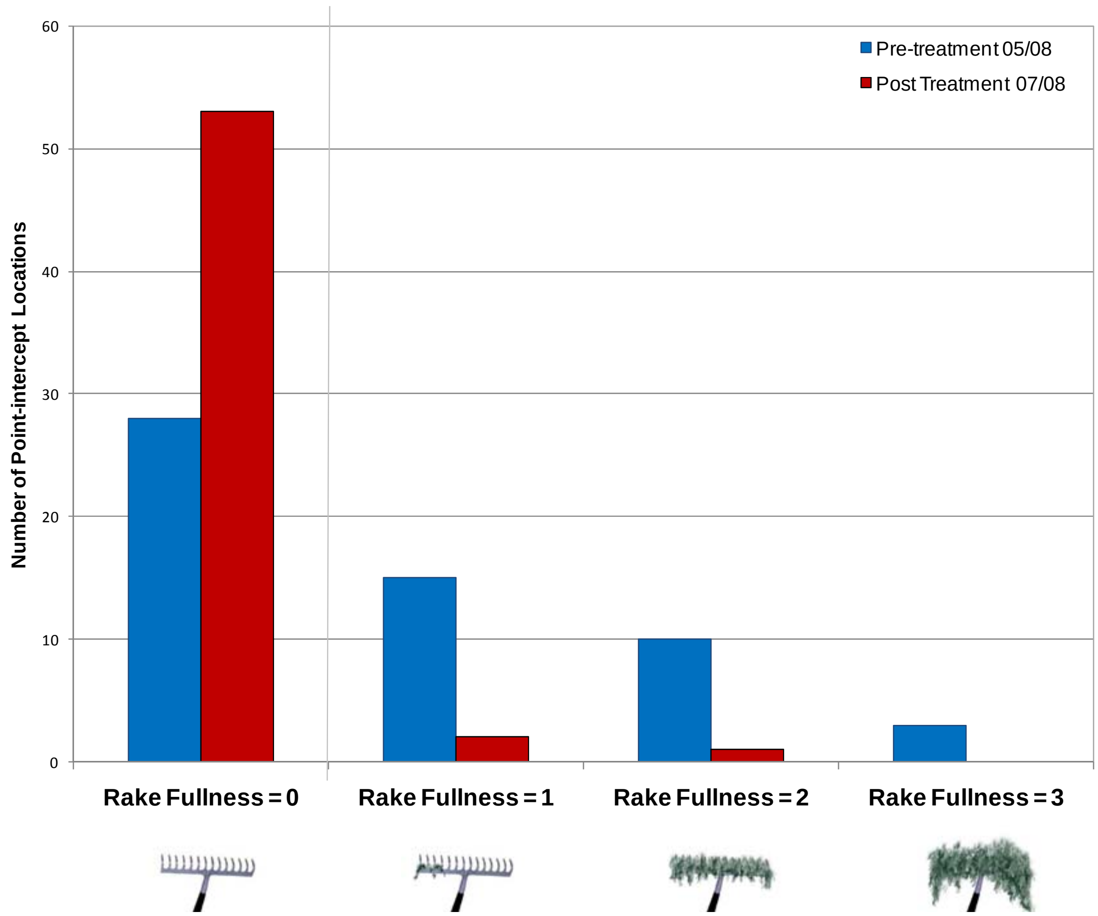

Figure 15. Eurasian water milfoil hybrid rake fullness distribution monitoring the 2008 treatment.

As previously stated, due to the life cycles of our native and non-native plants, comparing data between May and mid-summer needs to be understood in the context that these plants are at different stages in their growth. In May, many native plants have only begun growing and in August, they are at their peak growth (biomass). Although Eurasian water milfoil starts growing earlier than the native plants, their biomass considerably increases between May and July. Theoretically, if no treatment occurred, percent occurrence and rake fullness would increase over the course of the summer.

In 2007, many point-intercept sub-sample locations were sampled on Lake Ellwood that were not contained within that year's treatment scenario. This is a product of the difficulties in timing field work and coordinating a treatment strategy with the lake group, the WDNR, and the applicator. In order to not under represent a treatment area with sub-sample locations, numerous *potential* point-intercept samples are taken. Opportunistically integrating this data has allowed for 2007 peak-biomass to 2008 peak-biomass Eurasian water milfoil comparisons to be made surrounding the 2008 treatments. Essentially, the July 2007 data serves as the pretreatment data and the July 2008 data as the post treatment. Site A-08 (Map 7) had the largest representation of these points (N=24). An approximate 73% reduction in occurrence of the exotic species was observed within this treatment site document that a successful treatment occurred on Lake Ellwood in 2008 (Figure 16).

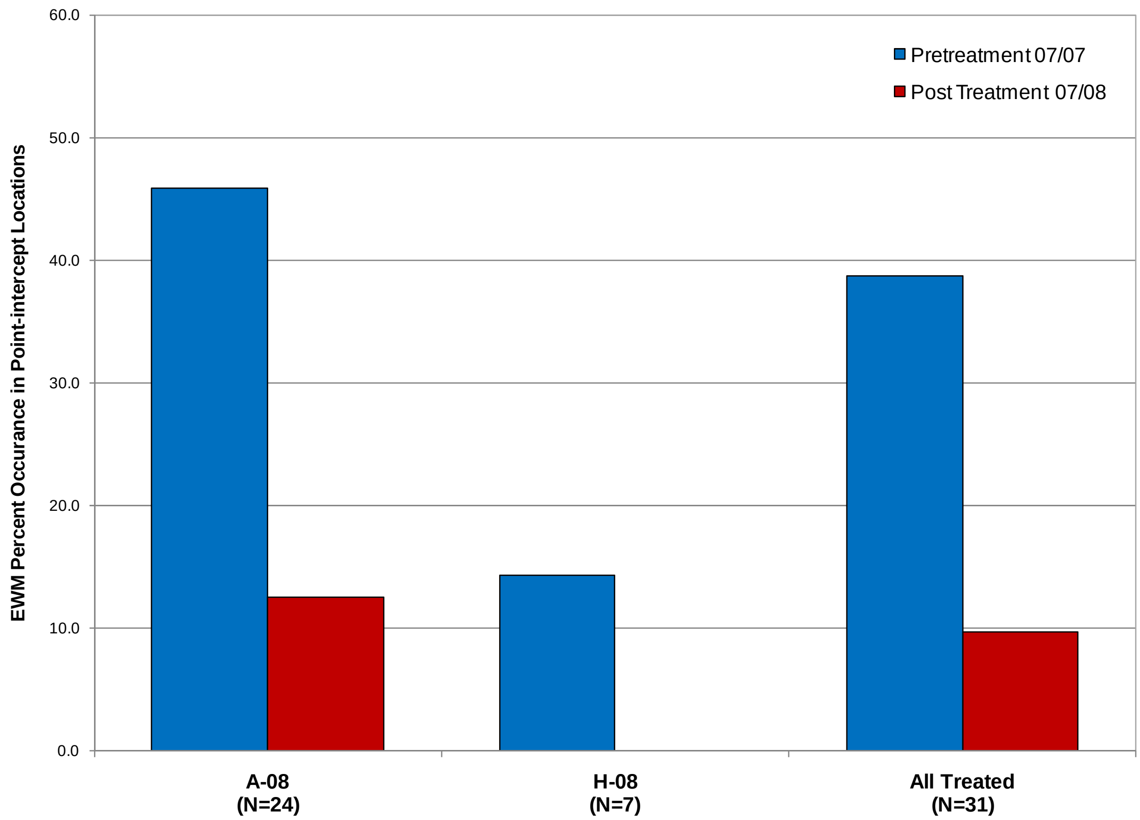

Figure 16. Eurasian water milfoil hybrid percent occurrence monitoring the 2008 treatment using peak-biomass data.

On August 15, 2008 all Eurasian water milfoil occurrences were mapped (Map 8). Formerly Site B-08, A-09 is a primary treatment area for 2009. Many Eurasian water milfoil locations were documented within this treatment area, some of which were observed to be highly dominant. B-09 and C-09 are treatment areas surrounding exotic occurrences that were part of the 2007 treatment areas. D-09 encompasses many single plants located within this highly developed portion of the lake. E-09 and F-09 contain H-08, I-08 and between. While the 2008 treatment was effective at controlling the large colonies, isolated occurrences occur and an aggressive strategy within this area is suggested since it is near the public boat landing and a high-use bay.

While A-08 showed exceptional treatment results, the longevity of treatment success is not understood at this time on Lake Ellwood. Having a depauperate plant community, Eurasian water milfoil as a highly invasive pioneer species with a nearby source population (A-09) likely will recolonize this area relatively quickly. It is important for the LEA to be prepared for this scenario as to avoid future roadblocks to whole-lake management of this invasive species.

Special Note: Ongoing treatments have been occurring since this draft was written in December 2008. This information is provided within the 2009-2011 annual treatment reports. The final treatment acreages are included as the following: 2009 – 13.1 acres (Map 9), 2010 – 2.3 acres (Map 10), and 2011 – 9.5 acres (Map 11).

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. Although current fish data were not collected, the following information was compiled based upon data available from the WDNR (WDNR 2007).

Table 2. Gamefish present in the Lake Ellwood with corresponding biological information (Becker, 1983).

Common Name	Scientific Name	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
Black Crappie	*Pomoxis nigromaculatus*	7	May - June	Near *Chara* or other vegetation, over sand or fine gravel	Fish, cladocera, insect larvae, other inverts
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 pikes, 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 (ter. and aq.)
Rock Bass	*Ambloplites rupestris*	13	Late May - Early June	Bottom of course sand or gravel, 1cm-1m deep	Crustaceans, insect larvae, and other inverts
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 (aq. and ter)
Walleye	*Sander vitreus*	18	Mid April - early May	Rocky, wavewashed shallows, inlet streams on gravel bottoms	fish, fly and other insect larvae, crayfish
Yellow Perch	*Perca flavescens*	13	April - early May	Sheltered areas, emergent and submergent veg	Small fish, aquatic invertebrates

Based on data collected from the stakeholder survey fishing was the fourth highest ranked important or enjoyable activity on Lake Ellwood (Appendix B, Question #9). Approximately 40% of these same respondents believed that the quality of fishing on Lake Ellwood was either fair or poor (Appendix B, Question #6) and over 83% believe that the quality of fishing has remained the same or gotten worse since they have obtained their property (Appendix B, Question #7).

Table 2 shows the popular game fish and Table 3 shows the non-game fish that are present in Lake Ellwood. Management actions that have taken place and will likely continue on Lake Ellwood according to this plan include herbicide applications to control EWM. In the future, these applications will occur in May when the water temperatures are below 60°F. It is important to understand the effect the chemical has on the spawning environment which is to remove broad-leaf (dicot) submergent plants that are actively growing at these low water temperatures. Yellow perch is one species that could be affected by early season herbicide applications, as the treatments could eliminate nursery areas for the emerged fry of these species.

Table 3. Non-gamefish present in the Lake Ellwood with corresponding biological information (Becker, 1983).

Common Name	Scientific Name	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
Blunt-nosed Minnow	*Pimephales notatus*	3	May - August	Sand or gravel shoals, few cm - 2.5 m	Diatoms, filamentous algae, insect larvae/adults, planktonic organsisms
Iowa Darter	*Etheostoma exile*	4	Late April - Mid June	Along lake or stream shores with slow moving current	Amphipods, chironomids and other invertebrates
Common Shiner	*Notropis cornutus*	4	Late May - Late July	Over gravel, also uses nests of other fish species	Plant matter, invertebrates, occasionally other fish
Johnny Darter	*Etheostoma nigrum*	3	April - June	Shallow waters of lakes with large rocks, logs, mussel shells	Aquatic invertebrates and insect larvae
White Sucker	*Catostomus commersoni*	8	April - Early May	Swift water or rapids, occasionally over gravel in lakes	Fish, fish eggs, plants, mollusks, insects, crustaceans and protazoans

Table 4. Fish stocking data available from the WDNR from 1973 to 2002 (WDNR 2007).

Year	Species	# Stocked	Age Class	Ave Length (inches)
1973	Smallmouth Bass	6,000	Fingerling	3.0
1998	Northern Pike	600	Large Fingerling	7.4
1998	Northern Pike	650	Small Fingerling	7.3
1999	Northern Pike	600	Large Fingerling	7.6
2000	Northern Pike	600	Large Fingerling	7.5
2001	Northern Pike	600	Large Fingerling	7.4
2002	Northern Pike	500	Large Fingerling	8.2

Approximately 22,400 square miles of northern Wisconsin was ceded to the United States by the Lake Superior Chippewa tribes in 1837 and 1842. Lake Ellwood is located just outside the ceded territory; therefore, there is not a regulated spear fishery by Native Americans on Lake Ellwood. There are also no special fishing regulations listed by the WDNR for Lake Ellwood. Motor trolling is not permitted in Florence County and therefore Lake Ellwood.

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

The three objectives were fulfilled during the project and have lead to a good understanding of the Lake Ellwood ecosystem, the folks that care about the lake, and what needs to be completed to protect and enhance it.

Three primary aspects of the Lake Ellwood ecosystem were studied as a part of this management planning project; the system's water quality, its native and non-native aquatic plant community, and the watershed that supplies much of system's water. In general, the studies indicate that the lake is in exceptionally good health. The paragraphs that follow cover the highlights of the studies that were completed and further, they elaborate on the conclusions that were drawn from them.

The Lake Ellwood watershed is largely composed of forested areas. In fact, over 80% of the watershed's 1,675 acres contain forest cover. Forests export very little phosphorus and other pollutants within runoff as most of precipitation that falls on them infiltrates the ground. Having so much of the lake's drainage basin in forest cover means that little phosphorus enters the system via runoff. Modeling of the lake's watershed indicates that its annual phosphorus load is small and at 214 lbs annually and that this low annual phosphorus load leads to the outstanding water quality apparent within the lake as discussed below.

Current data collected from Lake Ellwood indicates that its water quality is superior to most lakes in the state and northeast region. Unfortunately, long-term trend analysis that would lead to an understanding of how Ellwood's water quality has changed over the years was precluded by the nearly complete absence of historic data. Still, the fact remains that Lake Ellwood's nutrient levels are currently quite low and as a result the water remains quite clear. Degradation of water quality is of great concern among Lake Ellwood stakeholders as over 36% of stakeholder survey respondents rated it as one of their top three concerns about the lake (Appendix B, Question 15).

As described above, the high quality of Ellwood's lake water is largely the result of the high quality of the water that arrives from its drainage basin. This means that the lake is very sensitive to increases in nutrient loads, and the most likely source for those increases occurs in the lake's immediate shoreland watershed. In other words, continued impacts in the shoreland areas of the lake will most likely result in higher nutrient loads entering the lake and those higher loads will first be seen in decreased water clarity. These impacts include further shoreland development, overcutting of trees, fertilizer use, faulty septic systems, and increases in impervious surfaces. Control of these impacts is required to maintain the water quality and habitat value within the lake.

Numerous plant surveys were completed on Lake Ellwood in order to better understand the native and exotic plant communities that exist within it. The results of these surveys are used as a baseline for future studies and lead to more effective management strategies.

Analysis of the plant survey results indicates that the aquatic plant community of Lake Ellwood is quite depauperate. This is evidenced by low floristic quality, low species diversity, low species richness, and a lack of floating-leaf and emergent species in and around the lake. The cause of this state is not completely clear as no historic plant-related data exists for the lake. It is likely that the lack of a more species rich and diverse plant community is likely caused by the combination of two factors; the lake's oligotrophic/mesotrophic nature and the amount disturbance it endures. Typically in lakes like Lake Ellwood that have lower productive natures, the aquatic plant community is more heavily comprised of isoetid forms of aquatic plants. These small, slow-growing, inconspicuous turf-like and/or rosette species have unique adaptations which allow them to thrive in these types of systems. However, no isoetid species were observed in Lake Ellwood.

As discussed in the water quality section, Lake Ellwood is considered a relatively unproductive lake as evidenced by low phosphorus concentration, minimal algal abundance, and excellent water clarity. Ellwood's unproductiveness may extend to its macrophytic plant community and exhibits itself in a lack of plant biomass. However, there is reliable anecdotal information that suggests Ellwood's level of plant biomass has increased in the past few decades. So, the problem may not be only a lack of plants, but more a lack of quality plants.

In the end, the largest impact to the lake is likely the disturbance caused by continued shoreland development and recreational use of the lake. Frankly, at just 132 acres, Ellwood is a small lake with an almost fully developed shoreline and endures a great deal of high-speed motor boating activity. Boats with 25 hp or greater motors are the most prevalent watercraft on the lake (Appendix B, Question 8) and water skiing/tubing is the third most important or enjoyable activity on Lake Ellwood (Appendix B, Question 9). These disturbances may be the primary causes for the lake's depauperate plant population. As mentioned above, anecdotal data suggests that there is a higher abundance of native plant species in Lake Ellwood now than there was historically. This information leads to the conclusion that there are sufficient nutrients available to support aquatic plant growth within the lake.

The lack of quality plant communities in Lake Ellwood is actually not an issue in itself because it will not *lead* to the degradation of the lake. However it is an issue because it is not able to help *prevent* the degradation of the lake. An unproductive lake with little plant growth is not an unhealthy lake; in fact most natural lakes start out that way. However, a lake that is able to support plant growth, but supports a community of very low diversity and quality is unhealthy. In addition that lake is much more susceptible to the competition brought on by exotic plants such as Eurasian water milfoil and curly-leaf pondweed and that is the exact situation Lake Ellwood is currently facing.

At this time, hybrid Eurasian water milfoil occurs in many areas of Lake Ellwood. In fact, it has been located at one time or another in just about every area of the lake, which leads to the conclusion that at least most areas of the lake under 15-feet of water will support the plant's growth. Combining that fact with the knowledge that there is basically no native plant competition against Eurasian water milfoil creates great concern that if left unchecked, it could develop a monoculture that would occupy most of the littoral area of the lake. At that point its abundance could reach nuisance levels and impact all forms of recreation on the lake, including boating, fishing, swimming, and nature viewing.

Studies completed in 2007 and 2008 suggest that if completed properly and at sufficient dose, 2,4-D applications are able to keep Eurasian water milfoil under control in Lake Ellwood. Integrating that technique with organized hand-harvesting efforts and possibly biological techniques, shows great promise in keeping Eurasian water milfoil under control within Lake Ellwood.

IMPLEMENTATION PLAN

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

Management Goal 1: Increase Lake Ellwood Association's Capacity to Communicate Effectively with Lake Stakeholders

Management Action: Develop association website

Timeframe: Begin 2009

Facilitator: Planning Committee to form Education Committee

Prospective Funding: WDNR Small –scale Lake Management Planning Grant

Description: The LEA is motivated to create a website for the association where information, such as this management plan, could be posted along with fostering unity amongst association members. The website will be constructed in an easy-to-use format to ensure stakeholders of all levels of computer literacy will have access to the information posted.

Action Steps:

1. Recruit volunteers to form Education Committee.
2. Recruit volunteer or hire professional with web site building experience
3. Facilitators gather appropriate information relating to website development and event organization.

Management Goal 2: Maintain Current Water Quality Conditions

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

Timeframe: Ongoing

Facilitator: Board of Directors

Description: Currently monitoring of water quality is conducted by a LEA volunteer through the Citizens Lake Monitoring Network's advanced protocol. It is important to continue this monitoring as early discovery of negative trends may lead to the reason as to why the trend is developing. The volunteer monitoring of the water quality is a large commitment and new volunteers may be needed in the future as the volunteer's level of commitment changes. It is the responsibility of the facilitator to coordinate new volunteers as needed. Note: as a part of this program, the data collected are automatically added to the WDNR database and available through their Surface Water Integrated Monitoring System (SWIMS) by the volunteer.

Action Steps:

Please see description above.

Management Action: Reduce phosphorus and sediment loads from immediate watershed.

Timeframe: Begin 2009

Facilitator: Education Committee

Description: Lake Ellwood has a moderately small watershed draining to it and as a result, the impacts that are most controllable at this time originate along the lake's immediate shoreline. These sources include faulty septic systems, the use of phosphorus-containing fertilizers, shoreland areas that are maintained in an unnatural manner, and impervious surfaces. To reduce these impacts, the LEA will initiate an educational initiative aimed at raising awareness among shoreland property owners concerning their impacts on the lake. Educational information will be available on the website, sent to association members as a part of their newsletter or within a special mailing, and/or provided at association events like the annual meeting.

Topics of educational items may include benefits of good septic system maintenance, methods and benefits of shoreland restoration, including reductions in impervious surfaces. Projects that include shoreline condition assessment and restoration activities will be better qualified to receive state funding in the future. These activities could be completed as an amendment to this management plan and would be appropriate for funding through the WDNR small-scale Lake Planning Grant program. Ecologically high-value areas delineated during the survey would also be selected for protection, possibly through conservation easements or land trusts (www.northwoodslandtrust.org).

Action Steps:

1. Recruit facilitators
2. Facilitators summarize educational material collected from WDNR, UW-Extension, and County Land Conservation sources for the creation of informative materials
3. Facilitators disperse materials to stakeholders

Management Goal 3: Control Aquatic Invasive Species within Lake Ellwood

Management Action: Initiate Clean Boats Clean Waters watercraft inspections at Lake Ellwood Public Boat Landing.

Timeframe: 2009

Facilitator: Planning Committee

Description: Although Lake Ellwood already contains Eurasian water milfoil, it is still important to minimize the chance that other AIS be introduced into the system and that existing AIS are not transported to other waterbodies. To that end, the

LEA will initiate a WDNR Clean Boats/Clean Waters watercraft inspection program at the Lake Ellwood public access.

Action Steps:

1. Members of association attend Clean Boats Clean Waters training session during spring or summer 2009
2. Training of additional volunteers completed by those trained during 2009.
3. Begin inspections during high-risk weekends
4. Report results to WDNR and LEA.
5. Promote enlistment and training of new of volunteers to keep program fresh.

<u>Management Action:</u> Coordinate annual volunteer monitoring of Aquatic Invasive Species
Timeframe: Start 2009
Facilitator: Planning Committee
Description: In lakes without Eurasian water milfoil, early detection of pioneer colonies commonly leads to successful control and in cases of very small infestations, possibly even eradication. Even in lakes where these plants occur, monitoring for new colonies is essential to successful control. Although the intensity of Eurasian water milfoil in Lake Ellwood requires professionally conducted surveys, Eurasian water milfoil occurrences mapped by the volunteers will be used as supplemental information for the professional monitoring efforts.

Action Steps:

1. Recruit volunteers to conduct field surveys
2. Retain consultant to coordinate monitoring strategy
3. Obtain WDNR grant
   a. Purchase GPS unit for association
   b. Consultant trains volunteers on GPS use and data collection
   c. Consultant trains volunteers on native/non native species identification
   d. Volunteers transfer data to consultant for integration and graphical representation

<u>Management Action:</u> Control Eurasian water milfoil infestation on Lake Ellwood using herbicide applications.
Timeframe: Initiate 2009
Facilitator: Planning Committee with professional help as needed
Description: As described in the Aquatic Plant section and elaborated upon within the Summary and Conclusions, Lake Ellwood is believed to currently contain approximately 30 acres of Eurasian water milfoil. At this time, the most feasible method of control is herbicide applications, specifically, early-spring treatments with 2,4-D. The responsible use of this technique is well supported by Lake Ellwood stakeholders as indicated by approximately 84% of stakeholder survey respondents indicating that they are at least moderately supportive of an herbicide control program (Appendix B, Question #18).

Treatment success of granular 2,4-D at 150 lbs/acre was documented in 2007 and 2008 on moderate density colonies of Eurasian water milfoil. Further, areas treated in 2007 were found to contain only limited occurrences of EWM in 2008.

The objective of this management action is not to eradicate Eurasian water milfoil from Lake Ellwood, as that would be impossible. The objective is to bring Eurasian water milfoil down to more easily controlled levels. In other words, the goal is to reduce the amount of Eurasian water milfoil in Lake Ellwood to levels that would only require spot treatments to keep the exotic under control. To complete this objective efficiently, a cyclic series of steps is used to plan and implement the treatment strategies. The series includes:

1. A lakewide assessment of Eurasian water milfoil completed while the plant is at peak biomass (July or August).
2. Creation of treatment strategy for the following spring.
3. Verification and refinement of treatment plan immediately before treatments are implemented.
4. Completion of treatments.
5. Assessment of treatment results (summer after treatment).

Once Step 5 is completed, the process would begin again that same summer with the completion of a peak biomass survey. The survey results would then be used to create the next spring's treatment strategy.

Obviously, monitoring is a key aspect of the cycle, both to create the treatment strategy and monitor its effectiveness. The monitoring would also facilitate the "tuning" or refinement of the treatment strategy as the control project proceeds. It must be remembered, that this portion of the management plan (control plan) would be intended to span approximately 5 years, before it would need to be updated to account for changes within the ecosystem. The ability to tune the treatment strategies is important because it would allow for the most effective results to be achieved within the plan's life span.

Two types of monitoring would be completed to determine treatment effectiveness; 1) quantitative monitoring using WDNR protocols, and 2) qualitative monitoring using observations at individual treatment sites and on a treatment wide basis. Results of both of these monitoring strategies would be used to create the subsequent treatment strategies. The quantitative strategies include sampling plants, both Eurasian water milfoil and native species, at predetermined locations (points) within treatment areas, while the qualitative monitoring includes the determination of Eurasian water milfoil abundance based upon a continuum of density. The density continuum ranges from non-detectable levels of Eurasian water milfoil to what is considered a monoculture where Eurasian water milfoil is essentially the only plant that exists in the area. Both monitoring types would be completed before and after the treatments (pretreatment surveys and post treatment surveys). Comparing the monitoring results from the pretreatment and post treatment surveys would determine the effectiveness of the treatment on a site-by-site basis and on a treatment wide basis. Finally, a lakewide plant survey (point-intercept survey) would be completed after this management action is completed (5 years) to determine the effectiveness of the intense control program.

Success Criteria

Determining the effectiveness of the treatment program is impossible unless specific success criteria (goals) are set before beginning the program. For this control program, the criteria would be evaluated at three levels

1. Treatment area (site specific)
2. Annual treatment (treatment wide)
3. Control program

Treatment Area

Qualitatively, a successful treatment on a particular site would include a reduction of Eurasian water milfoil density as demonstrated by a decrease in density rating.

Quantitatively, a successful treatment on a specific-site level would include a significant reduction in Eurasian water milfoil frequency following the treatments as exhibited by at least a 50% decrease in Eurasian water milfoil frequency from the pre- and post treatment point-intercept sub-sampling. In other words, if the Eurasian water milfoil frequency of occurrence before the treatment was 40%, the post treatment frequency would need to be 20% or lower for the treatment to be considered a success for that particular site. Further, there would be a noticeable decrease in rake fullness ratings within the fullness categories of 2 and 3.

Annual Treatment

Qualitatively, success would be achieved annually when 75% of the treatment areas are reduced by a density rating (as described above). Similar to the site specific evaluation, annual treatment success would be observed when a 50% decrease in Eurasian water milfoil frequency from the sub-sampling occurs. Preferably, there would be no rake tows completed during the post treatment surveys exhibiting a fullness of 2 or 3.

Control Program

At the end of the project, it is hoped that no Eurasian water milfoil colonies would exist over *density=1*. Ecological function of a particular area is thought to be greatly reduced when Eurasian water milfoil becomes the dominant plant which corresponds to a *density=1* rating.

The control program would be quantitatively evaluated by recompleting the whole-lake point-intercept survey at the end of the project and observing a reduction in frequency of Eurasian water milfoil.

Control Program Specifics

This control program is anticipated to span 5 treatment years. Although it is very difficult, if not impossible, to accurately estimate how many acres of Eurasian water milfoil will need to be treated for some number of years in the future, it is obviously needed for budgeting purposes. Based upon the Eurasian water milfoil surveys completed in recent years and the results of recent treatments, a conservative estimate of treatment acreages is listed below. It is conservative in anticipation of some areas requiring treatment for multiple years to reduce densities as discussed in the success criteria.

Project Year	Treatment Year	Estimated Acreage
2009	1	32
2010	2	32
2011	3	20
2012	4	15
2013	5	10

Project Funding Assistance

Funds from the Wisconsin Department of Natural Resources Aquatic Invasive Grant Program will be sought to partially fund this control program and other elements of this management plan. Specifically, funds would be applied for under the Established Infestation Control Project classification.

Action Steps:

1. Retain qualified professional assistance to develop a specific project design utilizing the cyclic series of steps discussed above.
2. Apply for a WDNR Established Infestation Control Grant based on developed project design.
3. Initiate control plan
4. Revisit control plan in 5 years
5. Update management plan to reflect changes in control needs and those of the lake ecosystem.

Management Action: Monitor native and non-native aquatic plants on a lake wide basis in Lake Ellwood.

Timeframe: Initiate 2013

Facilitator: Planning Committee with professional help as needed

Description: Much of the discussion within the study results pertaining to treatment effectiveness revolve around monitoring that was completed in and near the known locations of Eurasian water milfoil colonies, of which the majority are treatment areas. Although repeating these surveys at specific times of the year can lead to an understanding of how the native and non-native plant communities are reacting to the treatments, that data can only be used to make those determinations within the treatment areas and cannot be extrapolated to the effects on the entire lake. This is especially true of the non-target (native) plants. To determine the effects of the control program on a lake wide basis, a survey must be completed that inventories the lake's entire plant community.

The crux of this action will be the repeat completion of the whole lake point-intercept survey completed in 2005. The data collected during the 2013 survey will be compared with the 2005 data with the intent of determining the success of the control plan on a lake wide basis and the impact of it on the native plant community of Lake Ellwood.

Action Steps:

Please see description above.

METHODS

Lake Water Quality

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

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

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

♦ indicates samples collected as a part of the Citizen Lake Monitoring Network.
● indicates additional samples collected as a part of the grant funded project.

Aquatic Vegetation

Curly-leaf Pondweed Survey

Surveys of curly-leaf pondweed were completed on Lake Ellwood during a June 30, 2008 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 Ellwood to characterize the existing communities within the lake and include inventories of emergent, submergent, and floating-leaved aquatic plants within them. The point-intercept method as described in

"Appendix C" of the Wisconsin Department of Natural Resource document, Aquatic Plant Management in Wisconsin, (April, 2005) was used to complete this study on July 19, 2005 by the WDNR. A point spacing of 40 meters was used resulting in approximately 321 points.

Community Mapping

On August 15, 2008 the aquatic vegetation community types within Lake Ellwood (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.

Watershed Analysis

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

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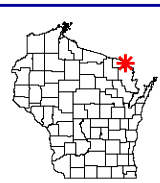
Wisconsin Department of Natural Resources – Bureau of Fisheries Management. 2007. Fish Stocking Summaries. Available at: http://infotrek.er.usgs.gov/wdnr_public. Last accessed November 2008.

500

Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads & Hydro: WDNR
Orthophotography: NAIP, 2010
Map date: October 27, 2011



Project Location in Wisconsin

Legend

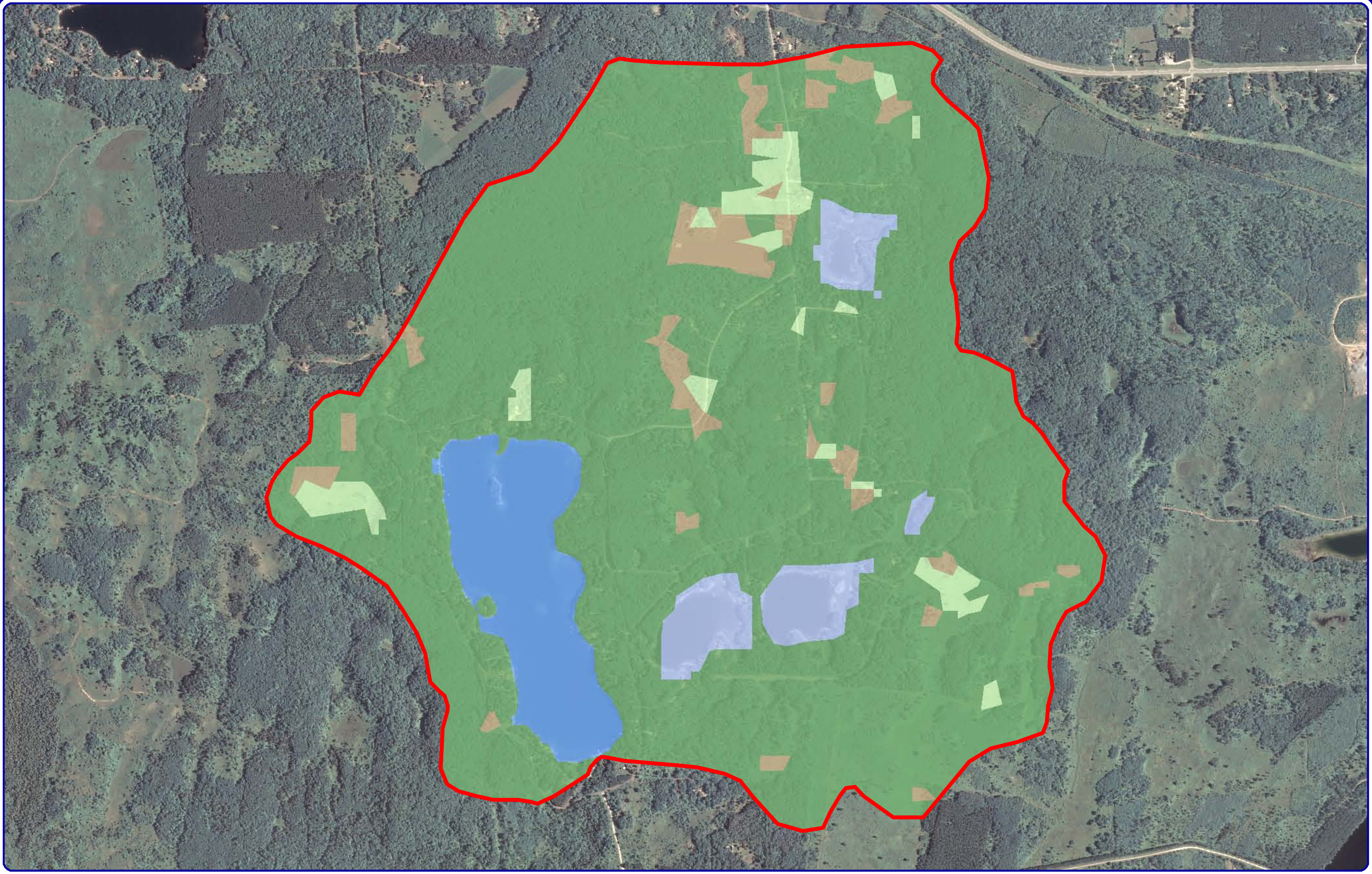
- Lake Ellwood
- Water Quality Sampling Location
- Public Boat Landing

Map 1

Lake Ellwood

Florence County, Wisconsin

Project Location & Water Quality Site



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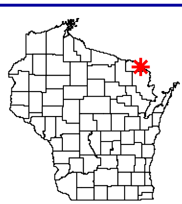
Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Watershed: WDNR and Onterra
Landcover: WISCLAND
Hydro: WDNR
Orthophotography: NAIP, 2010
Map Date: October 27, 2010


Project Location in Wisconsin

Legend

Watershed Boundary

Land Cover Types

- Pasture/Grass
- Forest
- Open Water
- Wetland
- Mixed Agriculture

Map 2

Lake Ellwood

Florence County, Wisconsin

Watershed and Land Cover Types

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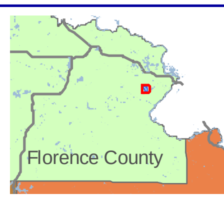
Onterra LLC
Lake Management Planning

135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads & Hydro: WDNR
Orthophotography: NAIP 2005
Aquatic Plant Survey: Onterra, 2008
Map Date: November 6, 2008



Extent of large map shown in red.

Legend

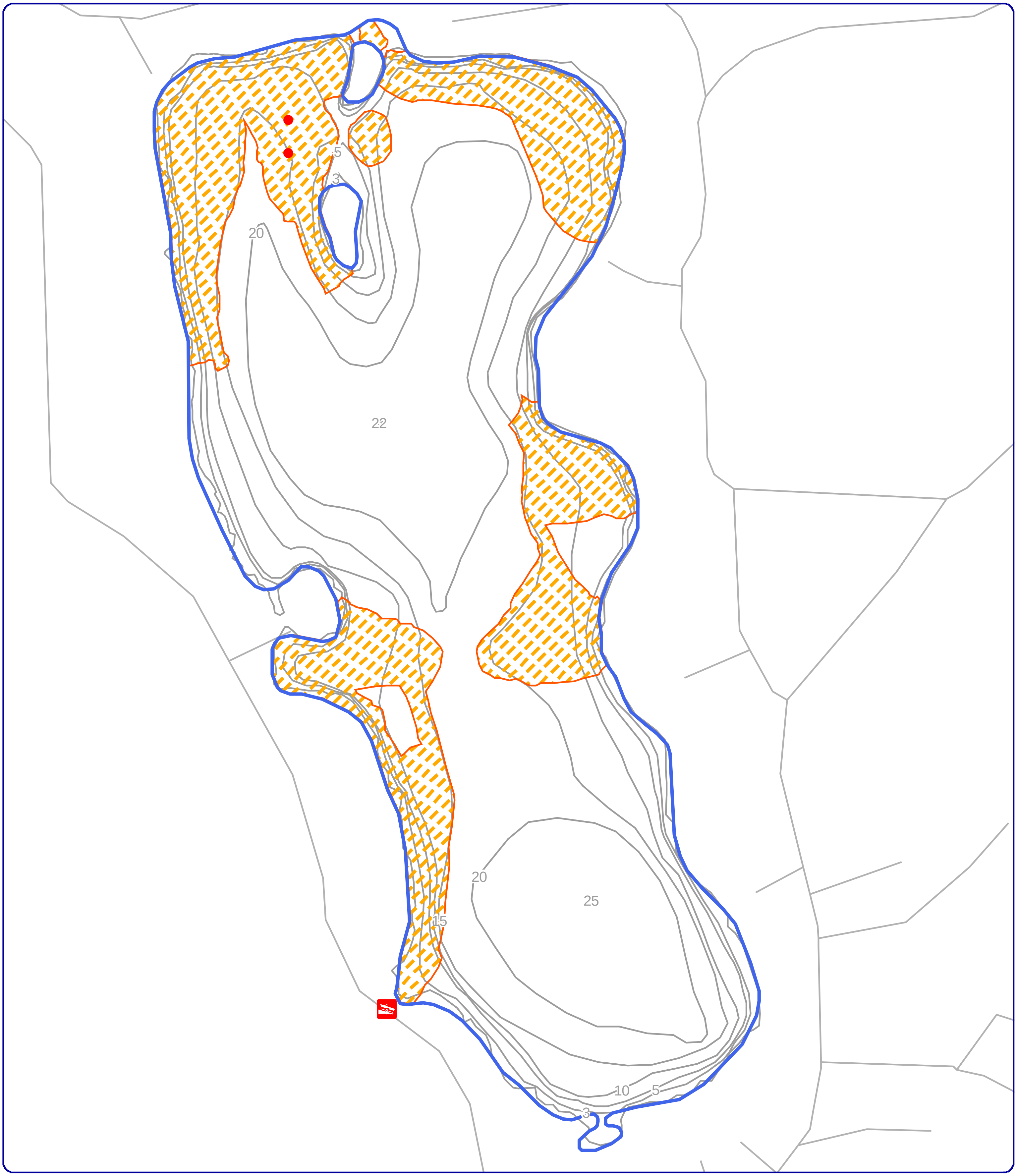
Small Plant Communities

- Emergent
- Floating-leaf

***Note:** Eurasian Water Milfoil displayed on separate map.*

Map 3
Ellwood Lake
Florence County, Wisconsin

Aquatic Plant Communities



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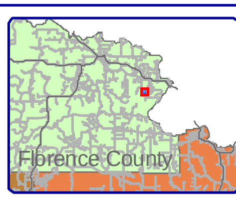
480

Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Point-intercept Survey: WDNR
EWM Areas: K. Person, LEA 2006
Roads & Hydro: WDNR
Bathymetry: WDNR
Map date: March 15, 2007



Extent of large map shown in red.

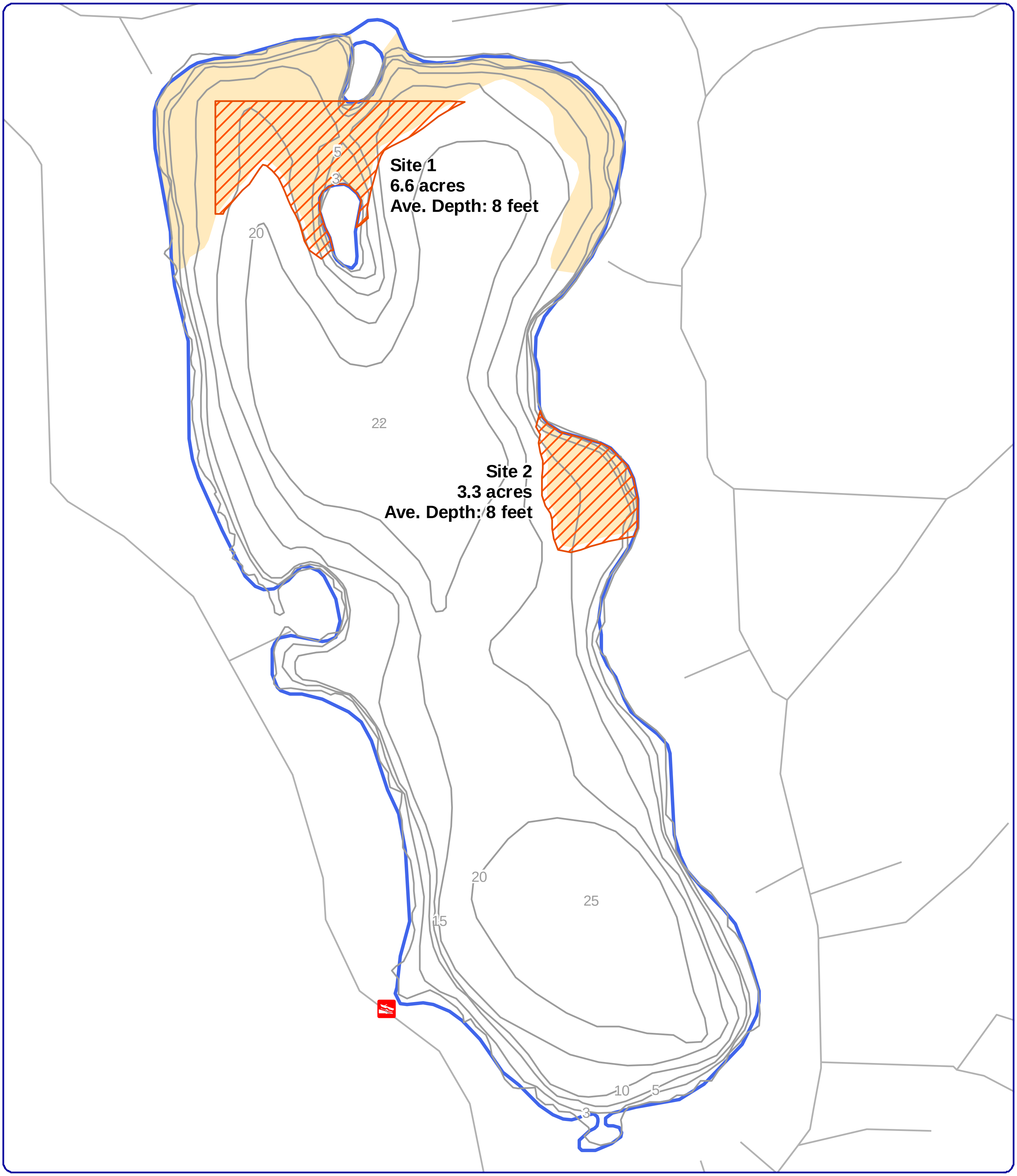
Legend

LEA Supplied EWM Areas 2006 (36.7 Acres)

Point-intercept Location Containing EWM (2005)

Map 4
Lake Ellwood
Florence County, Wisconsin

2007 Conditional Permit Map



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W E
S
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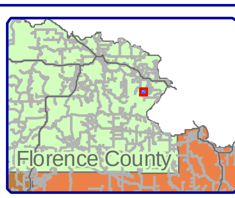
Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
EWM Survey: Onterra 05/07
Roads & Hydro: WDNR
Map date: May 29, 2007



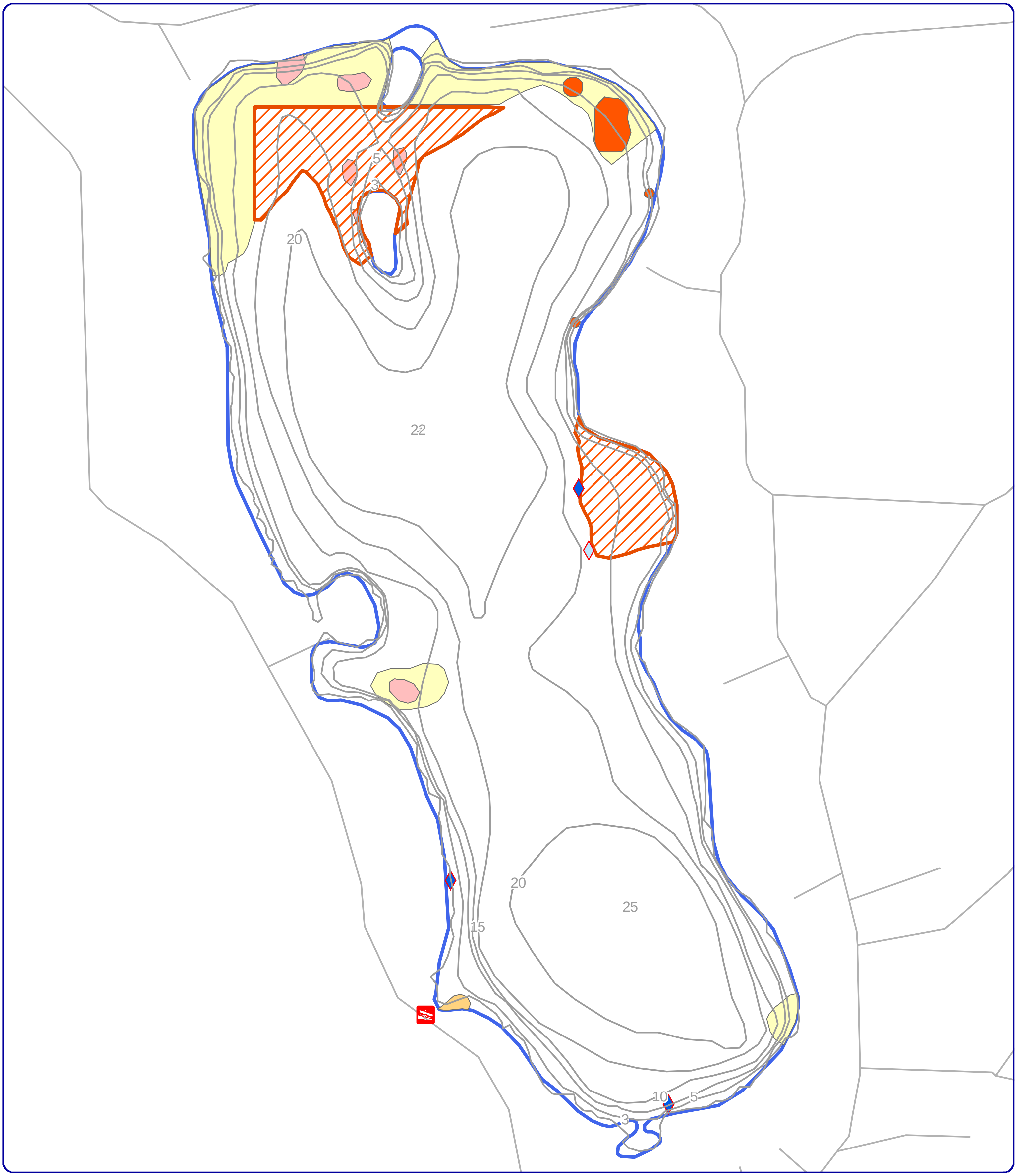
Extent of large map shown in red.

Legend

Proposed Treatment Area at 150 lbs/acre (9.9 acres)

May 2007 Densest Areas

Map 5
Lake Ellwood
Florence County, Wisconsin
2007 Final Treatment Areas

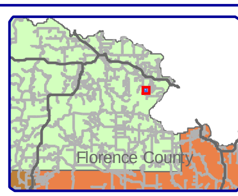


N
W E
S

500
Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads & Hydro: WDNR
Aquatic Plants: Onterra, LLC
Bathymetry: WDNR
Map date: October 1, 2007



Extent of large map shown in red.

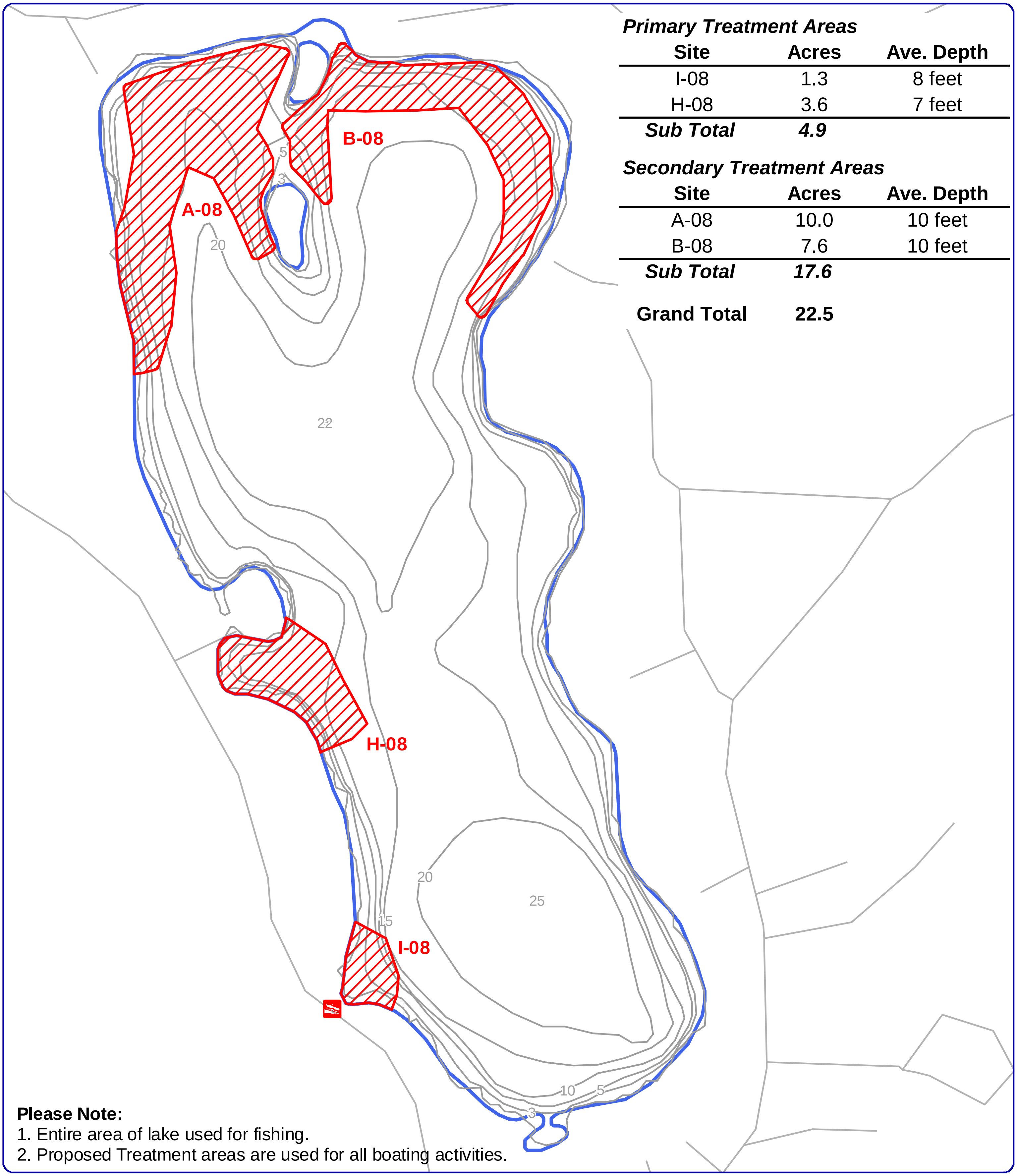
Legend

2007 Chemical Treament Site

EWM Small Colony
- Clumps
- Few Plants

EWM Large Colony
- Highly Scattered
- Scattered
- D=1
- D=2
- D=3

Map 6
Lake Ellwood
Florence County, Wisconsin
2007 Peak Biomass EWM Survey Results



Primary Treatment Areas

Site	Acres	Ave. Depth
I-08	1.3	8 feet
H-08	3.6	7 feet
Sub Total	***4.9***	

Secondary Treatment Areas

Site	Acres	Ave. Depth
A-08	10.0	10 feet
B-08	7.6	10 feet
Sub Total	***17.6***	

Grand Total **22.5**

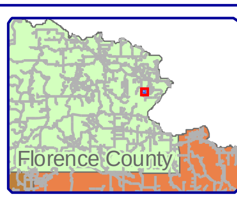
Please Note:
1. Entire area of lake used for fishing.
2. Proposed Treatment areas are used for all boating activities.

N W E S

480
Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
EWM Survey: Onterra, 2008
Roads & Hydro: WDNR
Map date: June 5, 2008



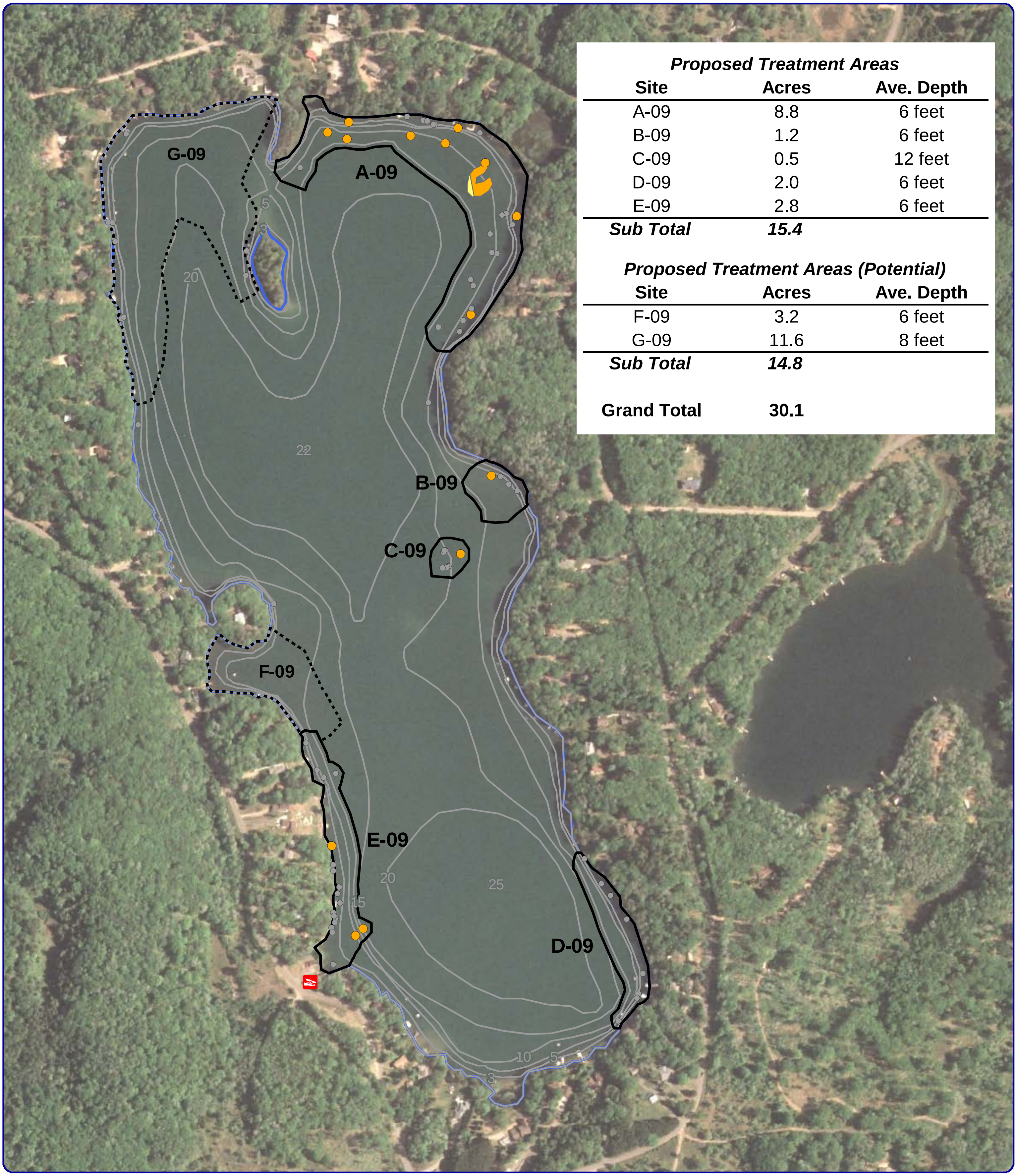
Extent of large map shown in red.

Legend

Recommended EWM Treatment Area

Map 7
Lake Ellwood
Florence County, Wisconsin

2008 Recommended Treatment Areas



Proposed Treatment Areas

Site	Acres	Ave. Depth
A-09	8.8	6 feet
B-09	1.2	6 feet
C-09	0.5	12 feet
D-09	2.0	6 feet
E-09	2.8	6 feet
Sub Total	***15.4***	

Proposed Treatment Areas (Potential)

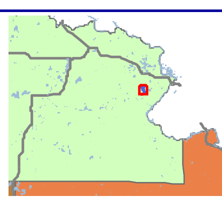
Site	Acres	Ave. Depth
F-09	3.2	6 feet
G-09	11.6	8 feet
Sub Total	***14.8***	
Grand Total	**30.1**	

N W E S

550
Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads & Hydro: WDNR
Orthophotography: NAIP 2005
Aquatic Plant Survey: Onterra, 2008
Map Date: November 6, 2008

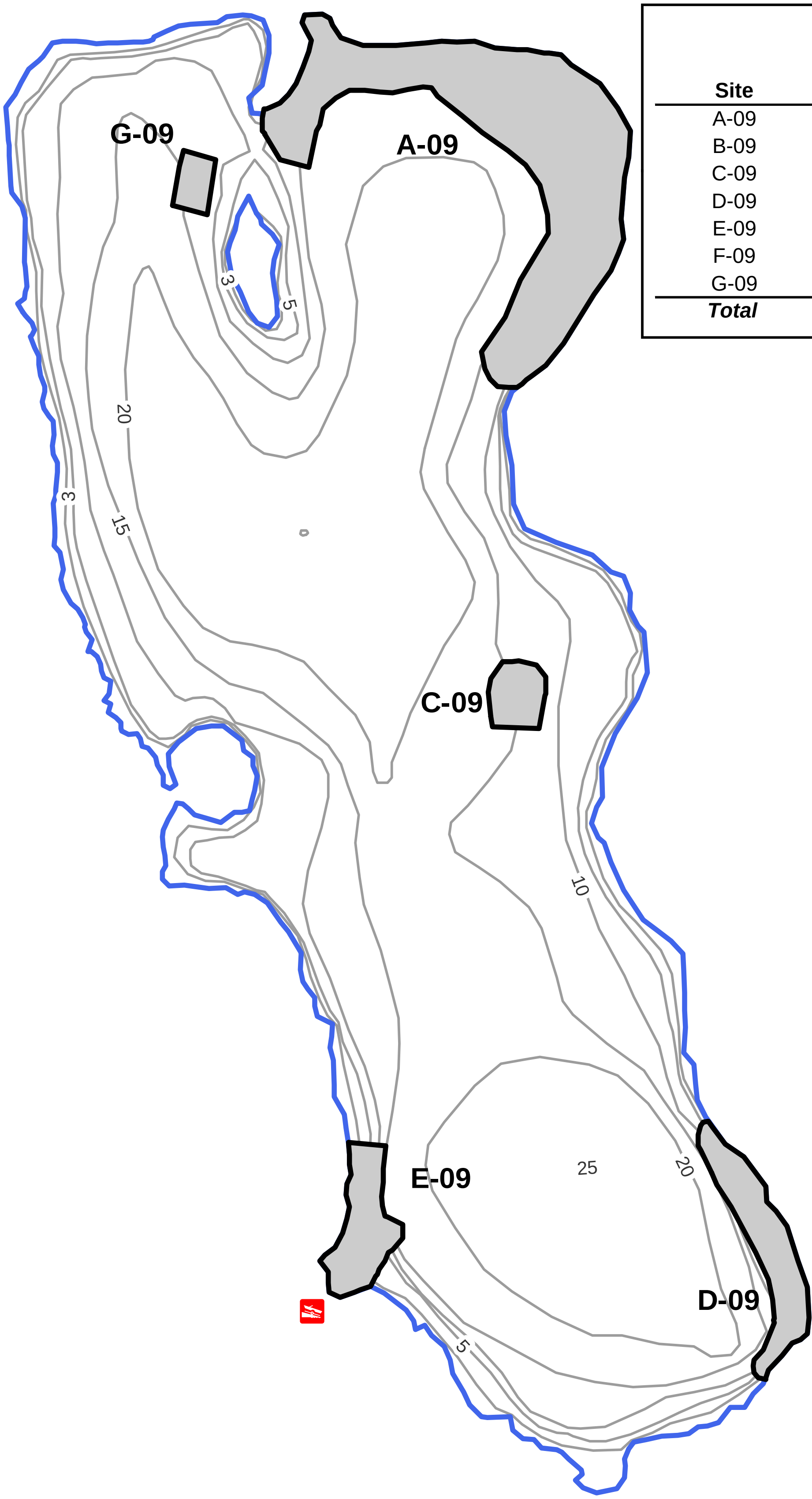

Extent of large map shown in red.

Legend
2009 Proposed Treatment Areas
2009 Proposed Treatment Areas (Potential)
Summer 2008 EWM Densities
Single or Few Plants
Clump of Plants
Highly Dominant
Dominant

Map 8
Ellwood Lake
Florence County, Wisconsin
2009 Proposed EWM Treatment Areas

Site	Conditional Permit Acres	Final Permit Acres	Ave. Depth
A-09	8.8	8.9	7 feet
B-09	1.2	Removed	
C-09	0.5	0.7	11 feet
D-09	2.0	1.8	6 feet
E-09	2.8	1.3	7 feet
F-09	3.2	Removed	
G-09	11.6	0.4	8 feet
Total	***30.1***	***13.1***	

Treatment Areas - 150 lbs/acre

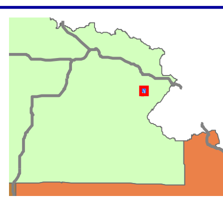


500
Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:

Roads & Hydro: WDNR
Aquatic Plant Survey: Onterra, 2008-09
Map Date: May 26, 2009



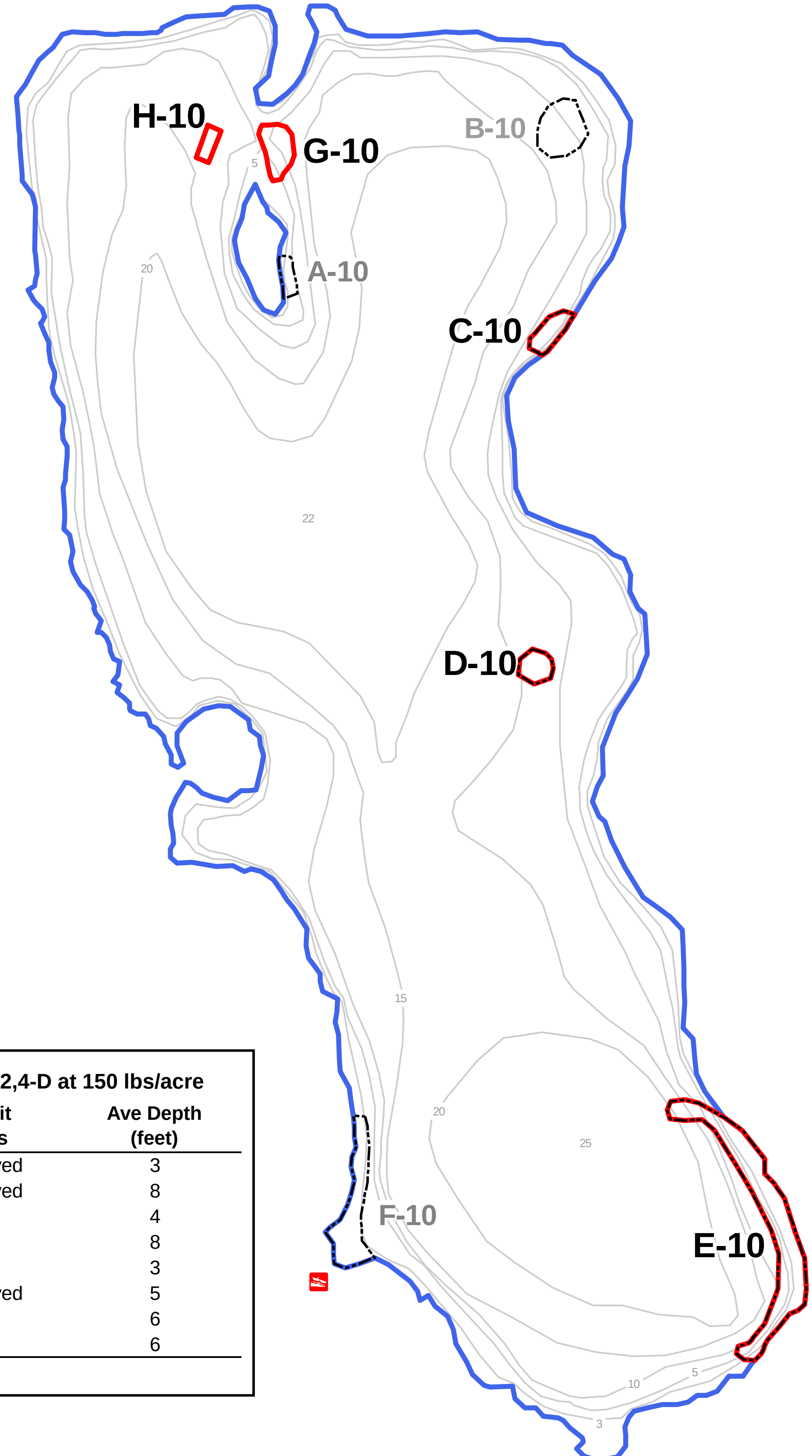
Extent of large map shown in red.

Legend

Final Treatment Area

Map 9
Ellwood Lake
Florence County, Wisconsin

2009 Final EWM Treatment Areas



2010 Final Treatment Areas - Granular 2,4-D at 150 lbs/acre

Site	Conditional Acres	Permit Acres	Ave Depth (feet)
A-10	0.1	Removed	3
B-10	0.5	Removed	8
C-10	0.2	0.2	4
D-10	0.2	0.2	8
E-10	1.5	1.5	3
F-10	0.6	Removed	5
G-10	-	0.3	6
H-10	-	0.1	6
Total	**3.1**	**2.3**	

Please Note:
1. Entire area of lake used for fishing.
2. Proposed Treatment areas are used for all boating activities.

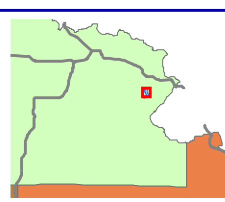
N W E S

500

Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads & Hydro: WDNR
Orthophotography: NAIP 2005
Aquatic Plant Survey: Onterra, 2009
Map Date: May 3, 2010

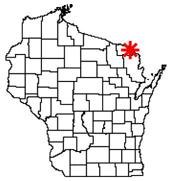


Extent of large map shown in red.

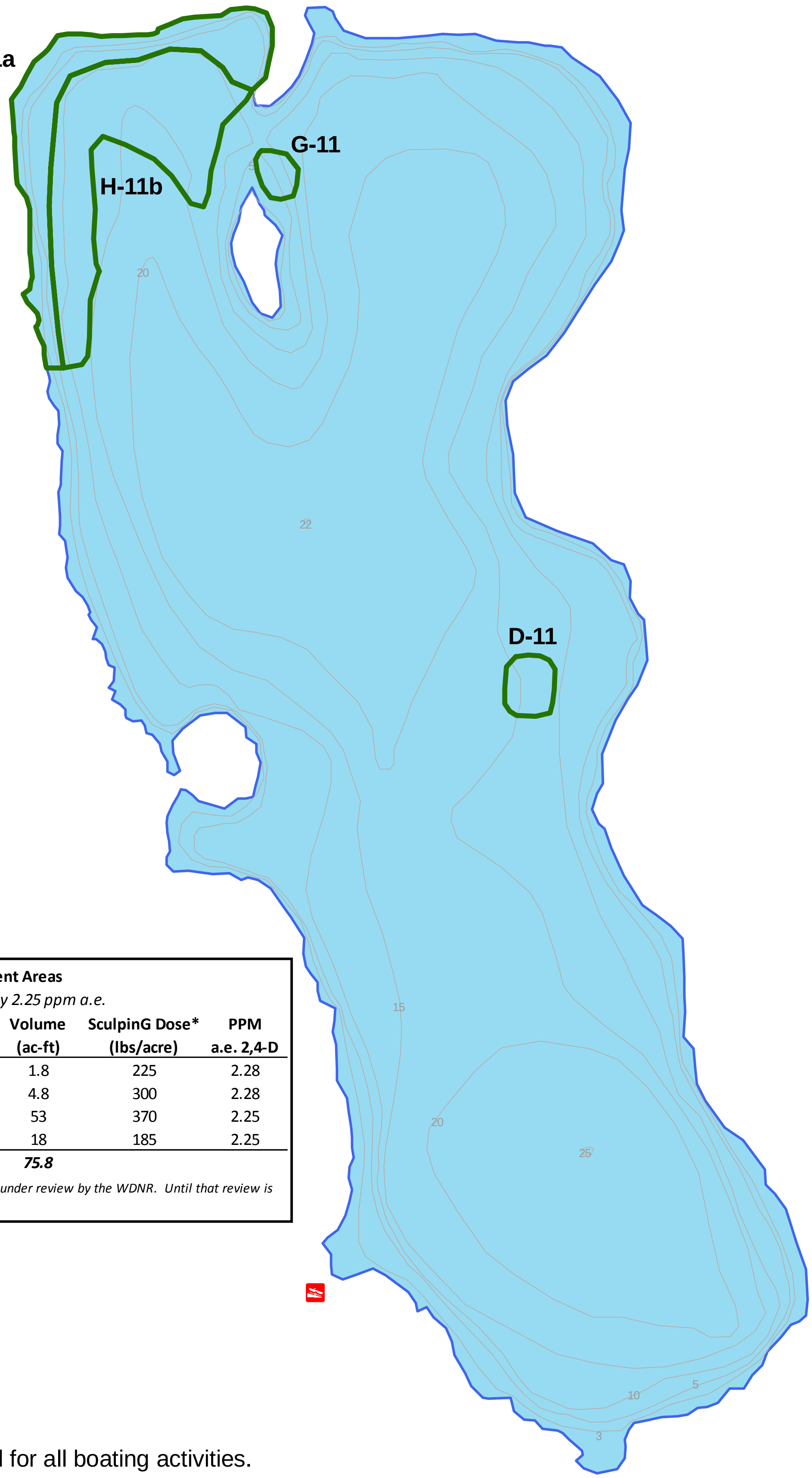
Legend
2010 Final Treatment Areas
2010 Conditional Treatment Areas

Map 10
Ellwood Lake
Florence County, Wisconsin

2010 Final EWM Treatment Areas



Project Location in Wisconsin



2011 Final EWM Treatment Areas

Granular 2,4-D at approximatley 2.25 ppm a.e.

Site	Proposed Acres	Permit Acres	Ave. Depth (feet)	Volume (ac-ft)	SculpinG Dose* (lbs/acre)	PPM a.e. 2,4-D
G-11	0.6	0.3	6	1.8	225	2.28
D-11	0.3	0.6	8	4.8	300	2.28
H-11b	1.5	5.3	10	53	370	2.25
H-11a		3.6	5	18	185	2.25
Total	***1.8***	***9.5***		***75.8***		

**Use of Sculpin G to control EWM within Wisconsin lakes is currently under review by the WDNR. Until that review is completed, the use of Sculpin G may not be permitted by the WDNR.*

Please Note:

1. Entire area of lake used for fishing.
2. Proposed Treatment areas are used for all boating activities.

500

Feet

Legend

2011 Final Treatment Areas

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads & Hydro: WDNR
Aquatic Plant Survey: Onterra, 2011

Map Date: May 22, 2011

Filename: Ellwood_T2011_Perm1.mxd

Map11

Ellwood Lake

Florence County, Wisconsin

2011 Final EWM Treatment Areas

A

APPENDIX A

Public Participation Materials

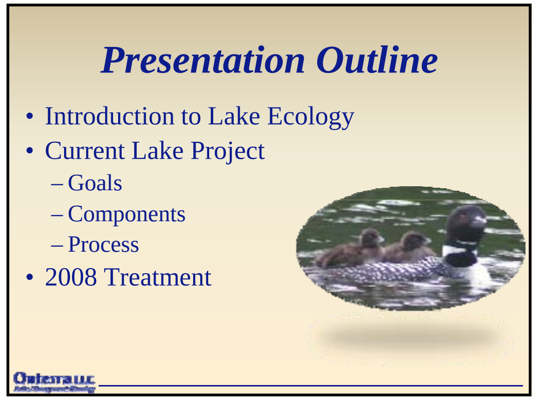
Lake Ellwood
Management Planning Project
Kick-Off Meeting
August 16, 2008 - 9:00 AM
Town of Florence Center – 749 Central Ave., Florence, WI

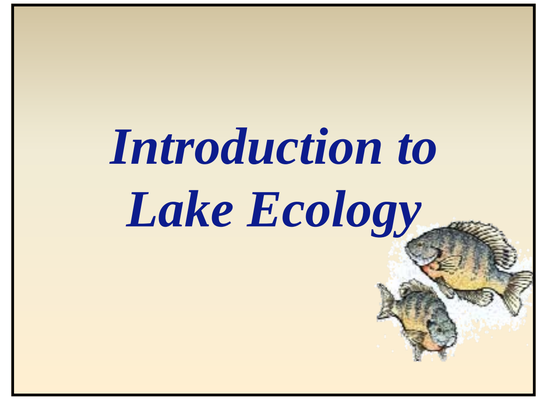
Aquatic ecologist, Tim Hoyman, speaks to a lake group in Waushara County about their lake management plan. Public participation will be integral part of the Lake Ellwood project.

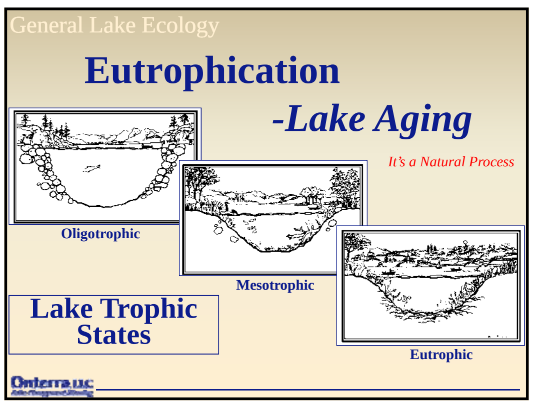
The Lake Ellwood Association has received two grants totaling over $16,000 from the Wisconsin Department of Natural Resources to partially fund the completion of a comprehensive management plan for Lake Ellwood. The design for the management plan has been finalized and approved by the WDNR and includes two primary objectives: 1)the completion of an in-depth study including multiple plant surveys, water quality sampling, and watershed investigations; and 2) the completion of a realistic management plan for the lake and its watershed. Most of the studies will be completed during this spring, summer and fall. The tasks associated with the analysis of the data will be completed during the fall and winter. The project will also incorporate opportunities for stakeholder education and input, which are both very important components of all lake management planning efforts. The first opportunity for your participation in the process will be at the Project Kick-off Meeting to be held on Saturday, August 16th at 9:00 am at the Town of Florence Center.

Onterra, LLC, a lake management planning firm out of De Pere, has been hired to lead the project. During the meeting Tim Hoyman, an Aquatic Ecologist with Onterra, will describe the project and its importance. His presentation will include a description of the project's components, a quick course on general lake ecology, and a breakdown of how the Associations's Planning Committee will be involved in the plan's completion. So, please plan on attending the meeting and do not hesitate to ask questions or make comments.

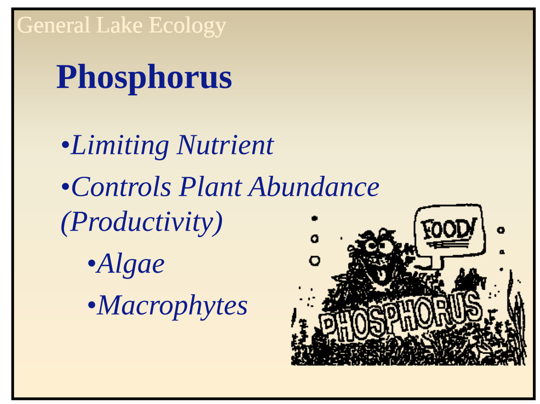

Lake Ellwood Association
Lake Ellwood
Management Planning Project
Kick-off Meeting
August 16, 2008
Tim Hoyman, CLM
Aquatic Ecologist
Onterra LLC


Presentation Outline
• Introduction to Lake Ecology
• Current Lake Project
– Goals
– Components
– Process
• 2008 Treatment
Onterra LLC


Introduction to Lake Ecology


General Lake Ecology
Eutrophication
-Lake Aging
It's a Natural Process
Oligotrophic
Mesotrophic
Eutrophic
Lake Trophic States
Onterra LLC


General Lake Ecology
Cultural Eutrophication
Accelerated eutrophication caused by human activity.
Onterra LLC

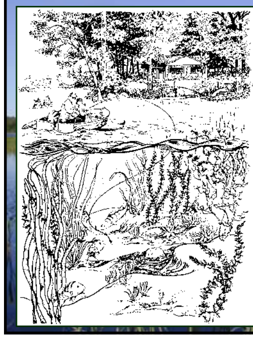

General Lake Ecology
Phosphorus
•Limiting Nutrient
•Controls Plant Abundance (Productivity)
•Algae
•Macrophytes
FOOD!
PHOSPHORUS

General Lake Ecology

Aquatic Plants (macrophytes)

- *Native Plants*
- *Exotic Plants (non-native)*

Native Aquatic Plants



- Base of the Food Web
- Cover (not only fish)
- Nursery
- Sediment Stabilization

General Lake Ecology

Non-native Aquatic Plants

Curly-leaf Pondweed

Onterra LLC

General Lake Ecology

Non-native Aquatic Plants

Eurasian Water Milfoil

Onterra LLC

General Lake Ecology

Consequences of Exotics

- Competition with Natives
  - Monotypic Community
- Decreased Recreational Value
- Decreased Property Value

Onterra LLC

Current Lake Project

Lake Ellwood Management Plan

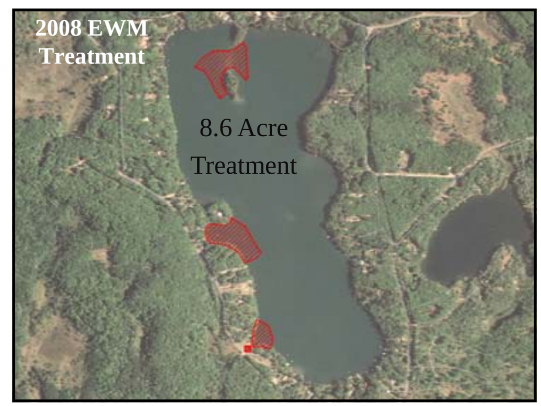

Current Project
Study and Plan Goals
•Collect & Analyze Data
•Construct Long-Term & Useable Plan
A goal without a plan
is just a wish.

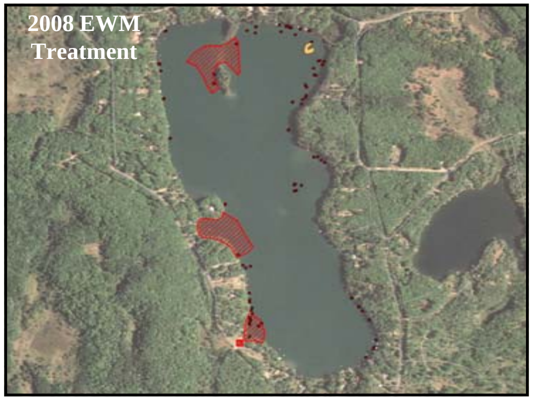

Current Project
Study Components
•Public Participation
•Watershed Modeling
•Water Quality
•Aquatic Vegetation
•Curly-leaf Survey
•Comprehensive Survey
•Plan Development


Current Project
Your Participation is Important to the Success of this Project


Current Project
Planning Process
Planning Committee
•Study Results (including a stakeholder survey)
•Conclusions & Initial Recommendations
•Management Goals
•Management Actions
•Timeframe
•Facilitator(s)
Implementation Plan


2008 EWM
Treatment


2008 EWM
Treatment
8.6 Acre
Treatment


2008 EWM
Treatment


Thank You
Tim Hoyman
thoyman@onterra-eco.com
Many of the graphics used in this presentation were supplied by:
Wisconsin
Lakes
Partnership
Extension
WISCONSIN
DEPT. OF NATURAL RESOURCES
Onterra LLC

Lake Ellwood Management Planning Project Update
October 2008

Submitted By:
Tim Hoyman, Aquatic Ecologist
Onterra, LLC

The Lake Ellwood Management Planning Project is moving forward as scheduled. Since spring, several project-related tasks have been completed, including pre- and post treatment monitoring of the spring 2008 treatments, the continued collection of water quality samples, an aquatic plant community mapping survey, a project kick-off meeting, and the mailing of a stakeholder survey.

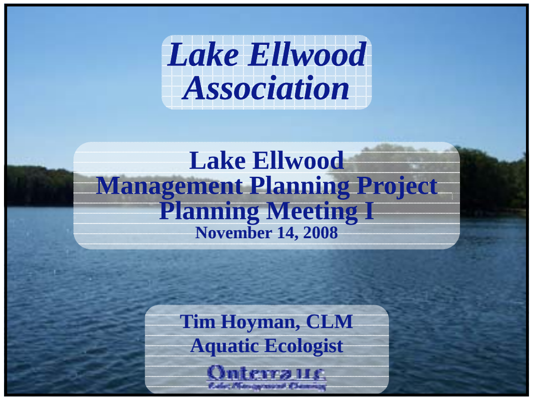
During May, approximately 14.2 acres of Eurasian water milfoil (EWM) were treated by Schmidt's Aquatic Plant Control, Inc. The treatment plan was created by Onterra, LLC, the lake management planning firm hired by the Lake Ellwood Association (LEA) to assist in the completion of the management plan and the EWM treatments. Surveys conducted before and after the treatment indicate that it was quite successful at controlling EWM within the lake. Still, several areas of the lake will require treatment during 2009, especially an area on the northeast shore of the lake where a dense colony of EWM remains. The size of the treatment slated for 2009 will be determined soon and incorporated within the completed management plan.

Water quality samples have been collected from Lake Ellwood through the cooperative efforts of Onterra ecologists and a volunteer from the lake, Mr. Bill Collard. The samples are sent to the Wisconsin State Laboratory of Hygiene for analysis. The results of the analysis will be a key component in the development of the lake management plan as they will lead to a better understanding of the lake's chemical attributes and its capacity to produce plant biomass. These data will also build upon the historic water quality dataset for the lake and allow for analysis of long-term trends as a part of this and future projects.

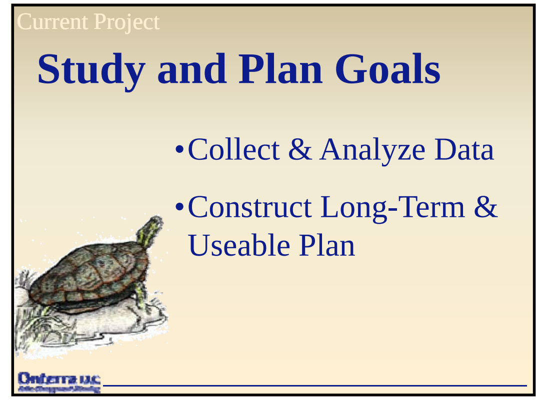
On August 16th, a project kick-off meeting was held in Florence to inform interested people about the management project and how they can be involved in it. Tim Hoyman, an Aquatic Ecologist with Onterra conducted a presentation that included an introduction to lake ecology and management, and outline of the different components and tasks that will be included as a part of the project, and a description of the process that will be used to create a customized management plan for Lake Ellwood. Tim also answered numerous questions brought up by the 31 meeting participants.

Following the general meeting, Tim met with a sub-committee of the LEA created to assist Onterra in the completion of the Lake Ellwood Management Plan. The *Planning Committee* consists of 9 members making up a cross-section of Lake Ellwood stakeholders. The committee will work closely with Onterra in the development of the plan and act as the focus group for the LEA. The first task the Planning Committee has undertaken is the mailing of the stakeholder survey completed by Onterra for the Lake Ellwood project. Information from the returned survey will be instrumental in the completion of the Lake Ellwood Management Plan; therefore it is extremely important that each Ellwood stakeholder that receives the survey completes it and drops it in the mail by October 17th.

During the coming months, Onterra will be analyzing the data that has been collected during the many surveys and studies that have been completed as a part of this project. Once the analyses are complete and their preliminary conclusions and recommendations are formulated, Onterra ecologists will again meet with the Lake Ellwood Planning committee to begin creating the management plan. The first draft of the plan should be completed around December 1st.

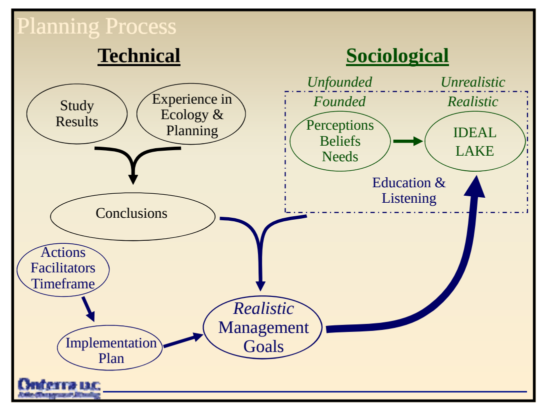

Lake Ellwood Association
Lake Ellwood
Management Planning Project
Planning Meeting I
November 14, 2008
Tim Hoyman, CLM
Aquatic Ecologist
Onterra LLC


Presentation Outline
• Current Lake Project Overview
• Planning Process
• Planning Project Study Results
– Watershed
– Water Quality
– Aquatic Plants
– EWM Treatment
• Preliminary Conclusions
• Discussion
• Management Goals
Onterra LLC


Current Project
Study and Plan Goals
•Collect & Analyze Data
•Construct Long-Term & Useable Plan
Onterra LLC


Current Project
Study Components
•Public Participation
Stakeholder Survey Distributed
•Watershed Modeling
Competed - Onterra
•Water Quality
Citizens Lake Monitoring Network & Onterra
•Aquatic Vegetation
•Curly-leaf Survey
Completed 2008 - None Found
•Comprehensive Survey
Completed 2005 - WDNR
•Treatment Monitoring
Pre & Post Completed (T2008)
•Plan Development
Onterra LLC


The Planning Process
…it's not as easy as you may think.


Planning Process
Technical
Sociological
Study Results
Experience in Ecology & Planning
Conclusions
Unfounded
Unrealistic
Founded
Realistic
Perceptions Beliefs Needs
IDEAL LAKE
Education & Listening
Actions Facilitators Timeframe
Implementation Plan
Realistic Management Goals
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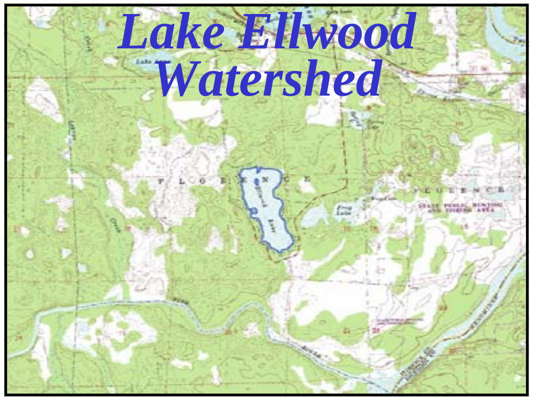
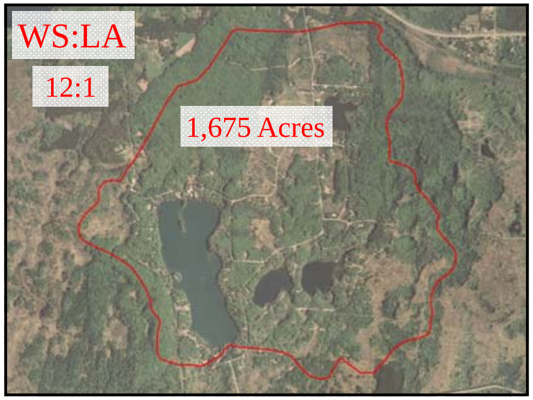
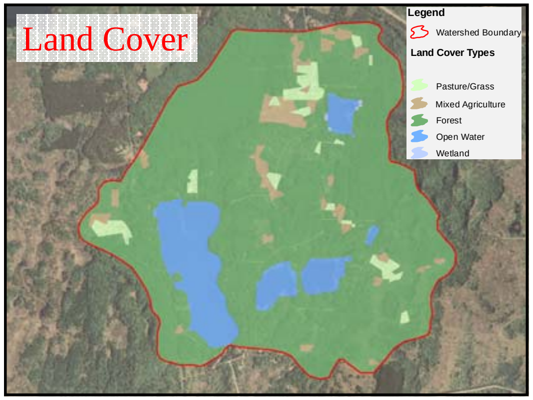
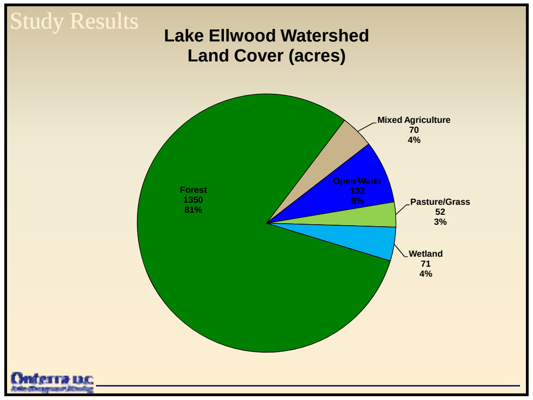
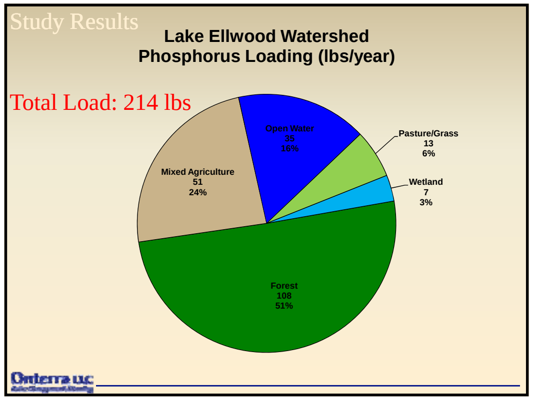

Lake Ellwood
Watershed

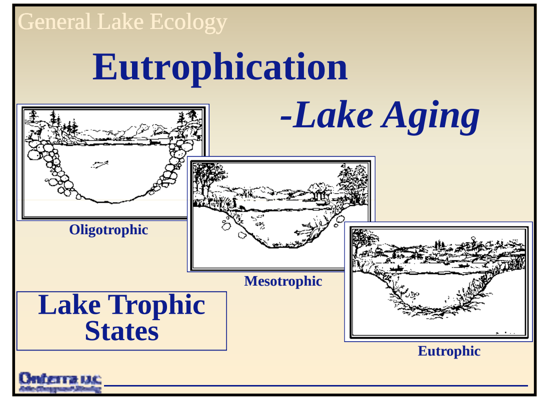

WS:LA
12:1
1,675 Acres


Land Cover
Legend
Watershed Boundary
Land Cover Types
Pasture/Grass
Mixed Agriculture
Forest
Open Water
Wetland

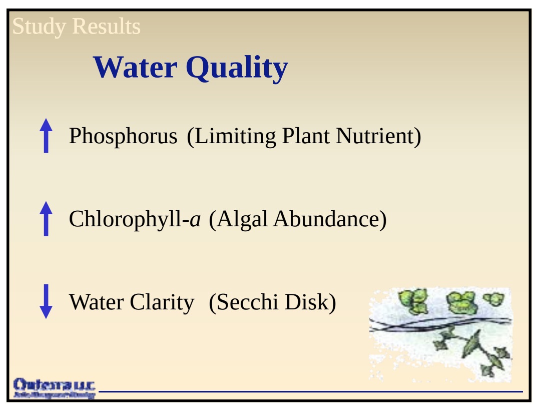

Study Results
Lake Ellwood Watershed
Land Cover (acres)
Forest 1350 81%
Mixed Agriculture 70 4%
Open Water 132 8%
Pasture/Grass 52 3%
Wetland 71 4%
Onterra LLC

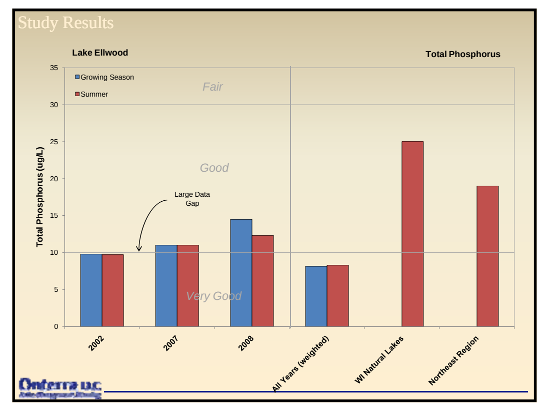

Study Results
Lake Ellwood Watershed
Phosphorus Loading (lbs/year)
Total Load: 214 lbs
Open Water
35
16%
Pasture/Grass
13
6%
Wetland
7
3%
Mixed Agriculture
51
24%
Forest
108
51%

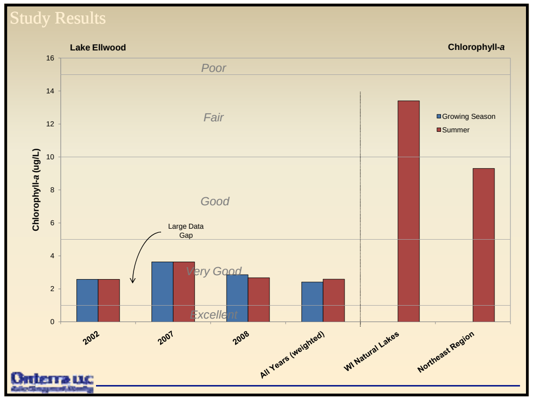

Study Results
Water Quality
Northwest
Northeast
Southwest
Central
Southeast
Lillie & Mason
Regions

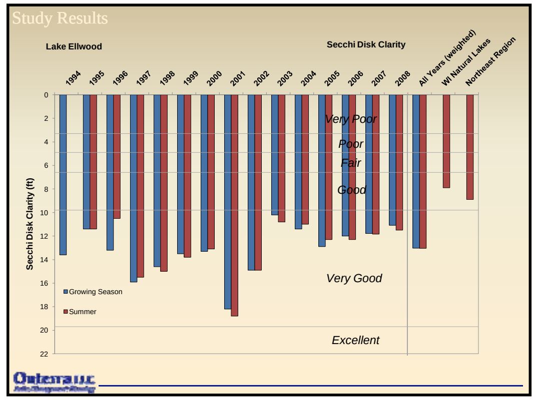

General Lake Ecology
Eutrophication
-Lake Aging
Oligotrophic
Mesotrophic
Eutrophic
Lake Trophic
States

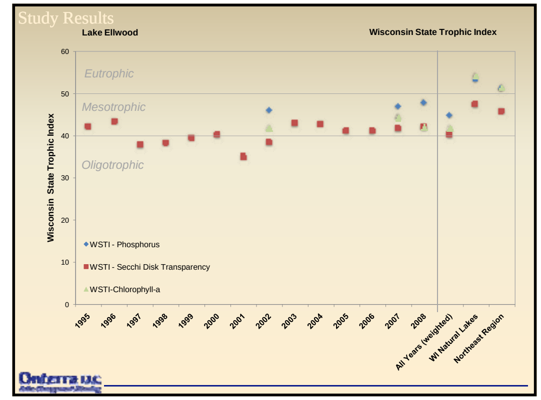

General Lake Ecology
Cultural Eutrophication
Accelerated eutrophication
caused by human activity.

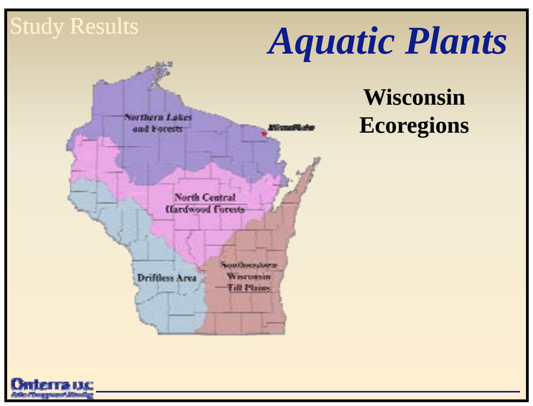

Study Results
Water Quality
↑ Phosphorus (Limiting Plant Nutrient)
↑ Chlorophyll-a (Algal Abundance)
↓ Water Clarity (Secchi Disk)


Study Results
Lake Ellwood
Total Phosphorus
Growing Season
Summer
Fair
Good
Very Good
Large Data
Gap
Total Phosphorus (ug/L)
0
5
10
15
20
25
30
35
2002
2007
2008
All Years (weighted)
WI Natural Lakes
Northeast Region

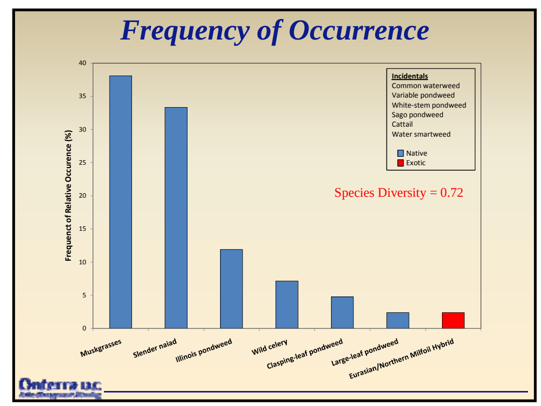

Study Results
Lake Ellwood
Chlorophyll-a
Poor
Fair
Good
Very Good
Excellent
Large Data Gap
Growing Season
Summer
Chlorophyll-a (ug/L)
2002
2007
2008
All Years (weighted)
WI Natural Lakes
Northeast Region


Study Results
Lake Ellwood
Secchi Disk Clarity
Very Poor
Poor
Fair
Good
Very Good
Excellent
Growing Season
Summer
Secchi Disk Clarity (ft)
All Years (weighted)
WI Natural Lakes
Northeast Region

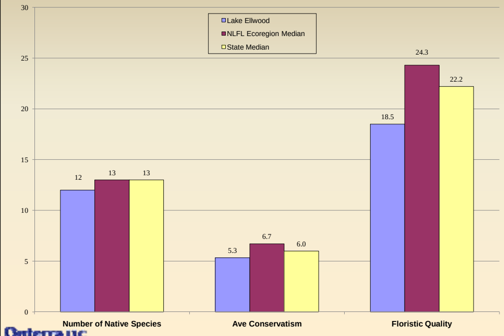

Study Results
Lake Ellwood
Wisconsin State Trophic Index
Eutrophic
Mesotrophic
Oligotrophic
Wisconsin State Trophic Index
WSTI - Phosphorus
WSTI - Secchi Disk Transparency
WSTI-Chlorophyll-a
All Years (weighted)
WI Natural Lakes
Northeast Region


Study Results
Aquatic Plants
Wisconsin Ecoregions
Northern Lakes and Forests
North Central Hardwood Forests
Driftless Area
Southeastern Wisconsin Till Plains


Study Results
Lake Ellwood Species List
• 12 native species
• 1 non-native species
• Eurasian x Northern Milfoil Hybrid


Frequency of Occurrence
Incidentals
Common waterweed
Variable pondweed
White-stem pondweed
Sago pondweed
Cattail
Water smartweed
Native
Exotic
Species Diversity = 0.72
Muskgrasses
Slender naiad
Illinois pondweed
Wild celery
Clasping-leaf pondweed
Large-leaf pondweed
Eurasian/Northern Milfoil Hybrid

Floristic Quality Assessment

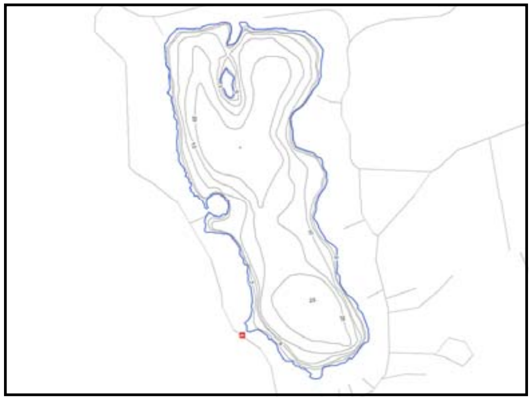


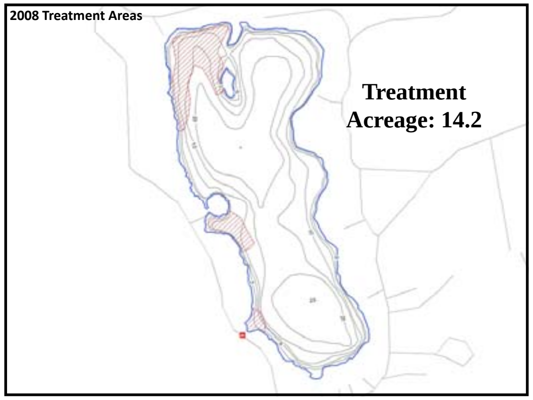
Community Mapping Survey

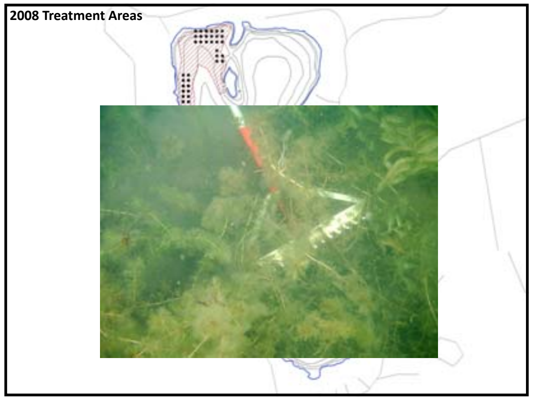
Treatment Monitoring

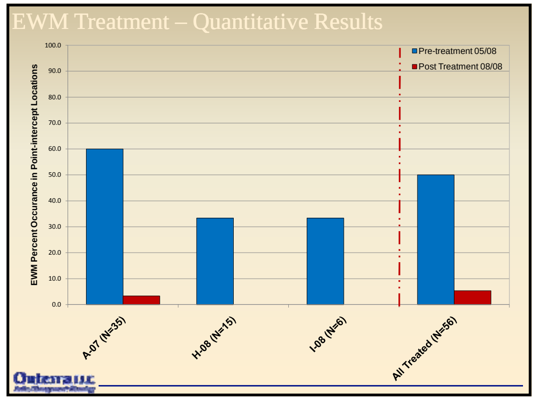
Objectives

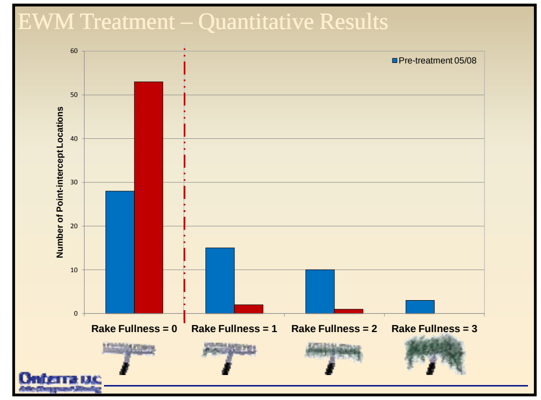
- Monitor EWM Treatments
  - Pre-treatment
  - Post treatment
- Use Information in Plan Development
- Provide Information

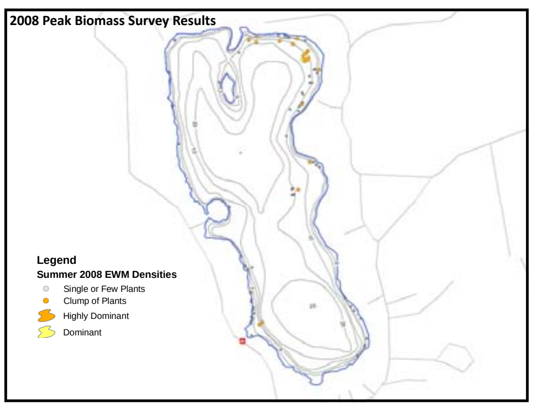


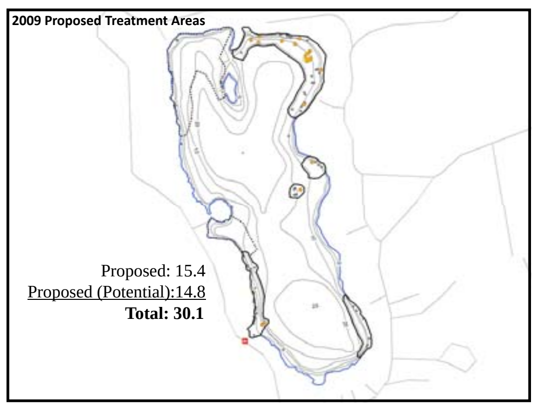












Conclusions

- Watershed
  - Land cover within watershed is excellent
    - Minimal loading – best to be expected
  - Makes immediate (shorelands) watershed very important
- Water quality
  - Good because of current watershed condition
  - Lack of historic chemical data makes long-term trend analysis difficult

Onterra LLC

Conclusions

- Aquatic plant community is moderate
  - Low productivity lakes sometimes have little plant growth
  - Lack of native vegetation raises concerns regarding EWM's ability to spread throughout the lake
- EWM Presence is of concern
    - Low abundance in P-I survey
    - Present throughout much of lake
  - No impacts on navigation, but possibly other forms of recreation
  - Impact to native habitat is a concern (Largest)
  - Higher dosage of herbicide is required for success
    - Due to depth of water that EWM is found in and density of these plants

Thank You

Many of the graphics used in this presentation were supplied by:

Wisconsin Lakes Partnership

B

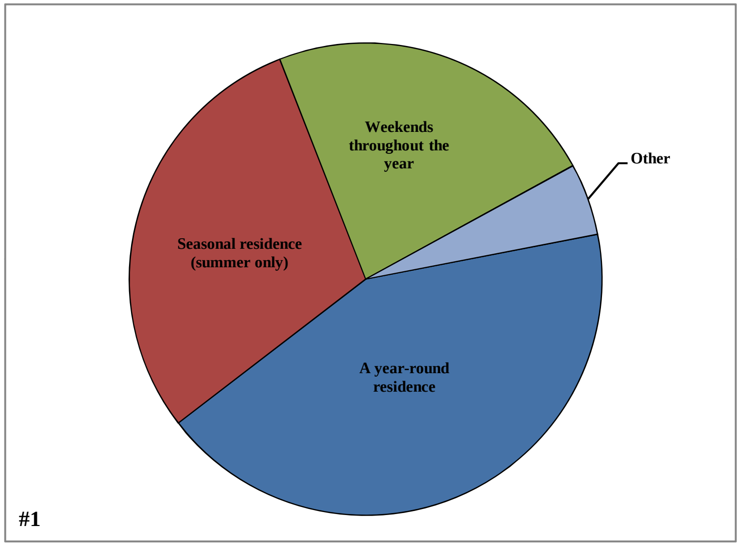
APPENDIX B

Stakeholder Survey Response Charts and Comments

Returned Surveys	58
Sent Surveys	90
Response Rate (%)	64.4

#1 What type of property do you own on Ellwood Lake?

	Total	%
A year-round residence	26	*42.6*
Seasonal residence (summer only)	18	*29.5*
Weekends throughout the year	14	*23.0*
Resort	0	*0.0*
Rental Property	0	*0.0*
Undeveloped	0	*0.0*
Other	3	*4.9*
	61	

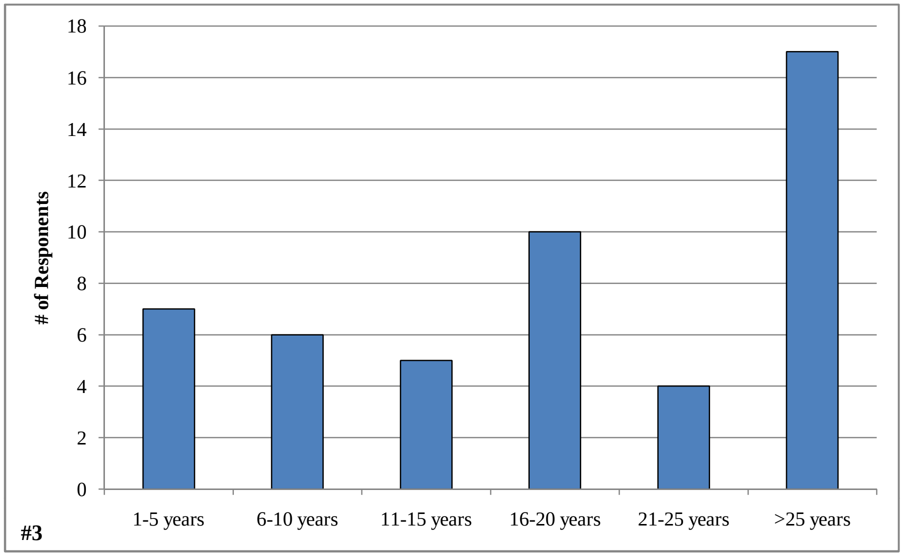


#2 If you are not a year-round resident, how many days each year is your property used by you or others?

Answered Question	28
Average	90.4
Standard deviation	51.1

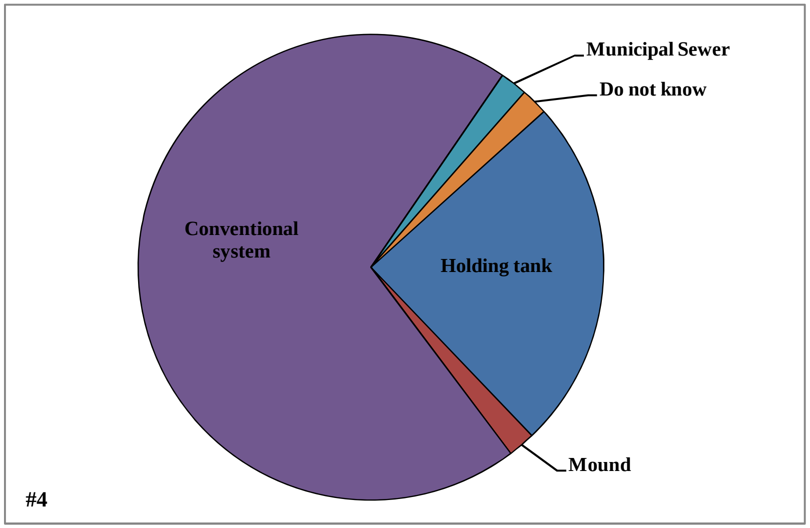
#3 How many years have you owned property on Ellwood Lake?

	Total	%
1-5 years	7	*14.3*
6-10 years	6	*12.2*
11-15 years	5	*10.2*
16-20 years	10	*20.4*
21-25 years	4	*8.2*
>25 years	17	*34.7*
	49	



#4 What type of septic system does your property utilize?

	Total	%
Holding tank	13	*24.5*
Mound	1	*1.9*
Advanced treatment system	0	*0.0*
Conventional system	37	*69.8*
Municipal Sewer	1	*1.9*
Do not know	1	*1.9*
	53	

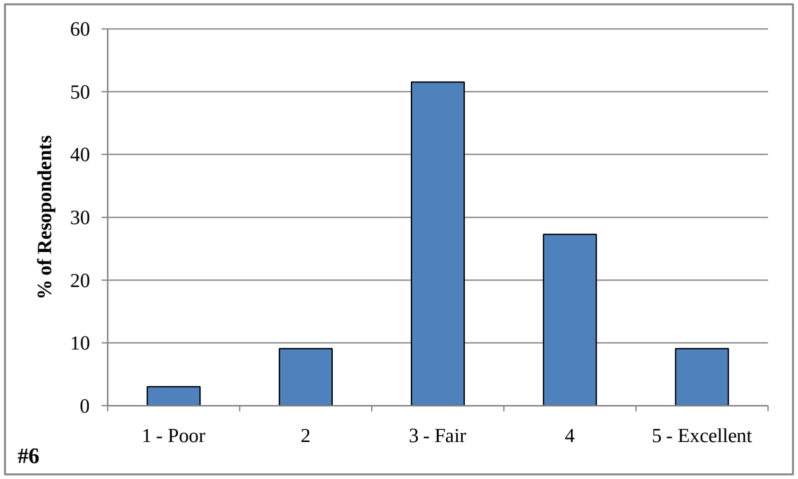


#5 Have you fished on Ellwood Lake in the past 3 years?

	Total	%
Yes	23	*40.4*
No	34	*59.6*
	57	

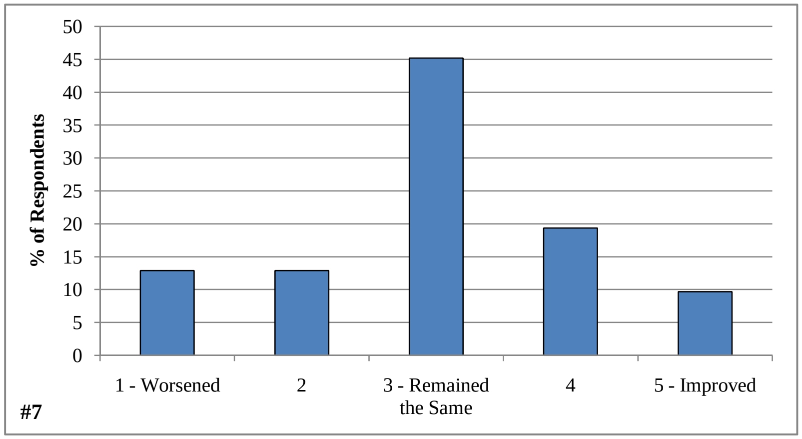
#6 How would you describe the current quality of fishing on Ellwood Lake?

	Total	%
1 - Poor	1	*3.0*
2	3	*9.1*
3 - Fair	17	*51.5*
4	9	*27.3*
5 - Excellent	3	*9.1*
	33	



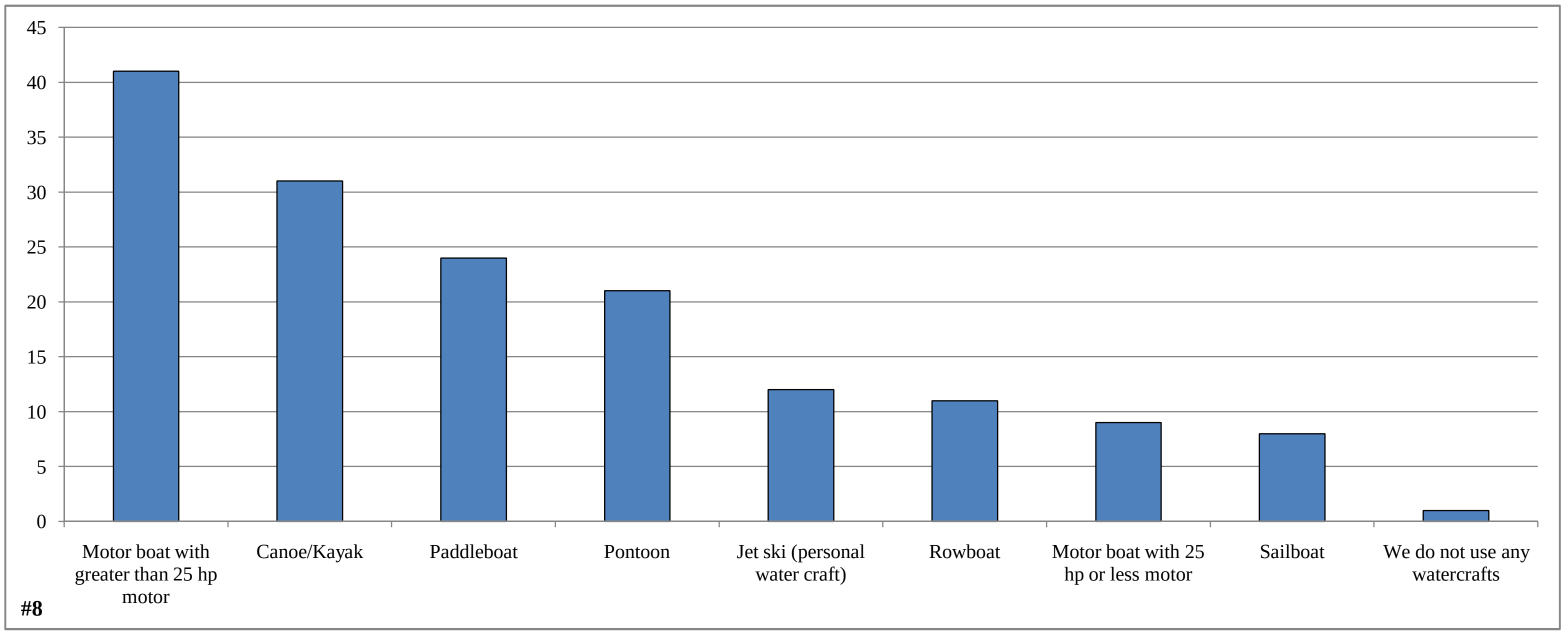
#7 How has the quality of fishing changed on Ellwood Lake since you obtained your property?

	Total	%
1 - Worsened	4	*12.9*
2	4	*12.9*
3 - Remained the Same	14	*45.2*
4	6	*19.4*
5 - Improved	3	*9.7*
	31	



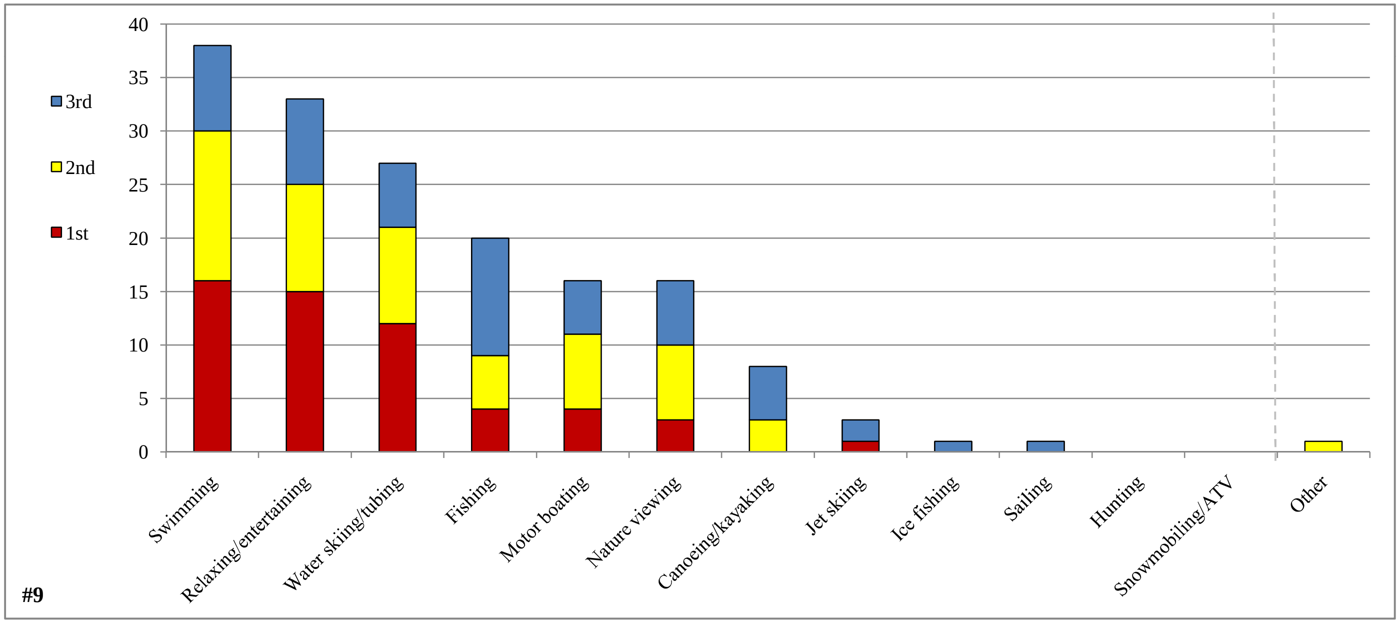
#8 What types of watercraft do you or others that use your property, currently use on the lake?

	Total
Motor boat with greater than 25 hp motor	41
Canoe/Kayak	31
Paddleboat	24
Pontoon	21
Jet ski (personal water craft)	12
Rowboat	11
Motor boat with 25 hp or less motor	9
Sailboat	8
We do not use any watercrafts	1
	157



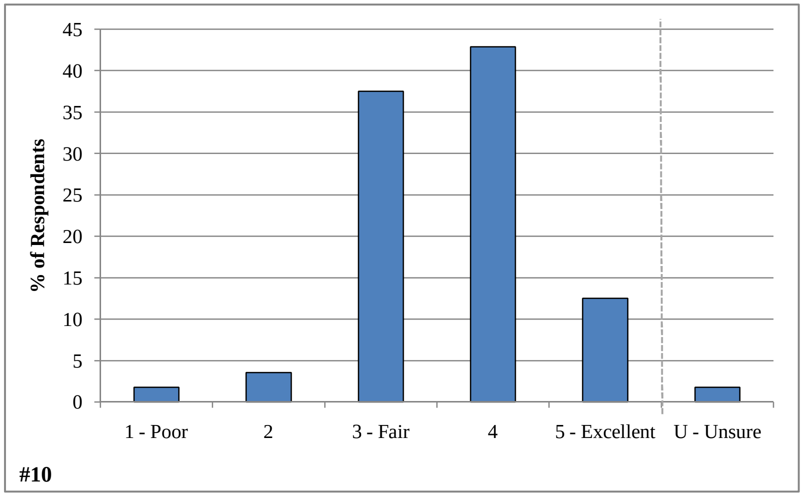
#9 Please rank the activities below that are the most important or enjoyable to you on Ellwood Lake?

	1st	2nd	3rd	*% ranked*
Swimming	16	14	8	*23.0*
Relaxing/entertaining	15	10	8	*20.0*
Water skiing/tubing	12	9	6	*16.4*
Fishing	4	5	11	*12.1*
Motor boating	4	7	5	*9.7*
Nature viewing	3	7	6	*9.7*
Canoeing/kayaking	0	3	5	*4.8*
Jet skiing	1	0	2	*1.8*
Ice fishing	0	0	1	*0.6*
Sailing	0	0	1	*0.6*
Hunting	0	0	0	*0.0*
Snowmobiling/ATV	0	0	0	*0.0*
Other	0	1	0	*0.6*
	55	56	53	



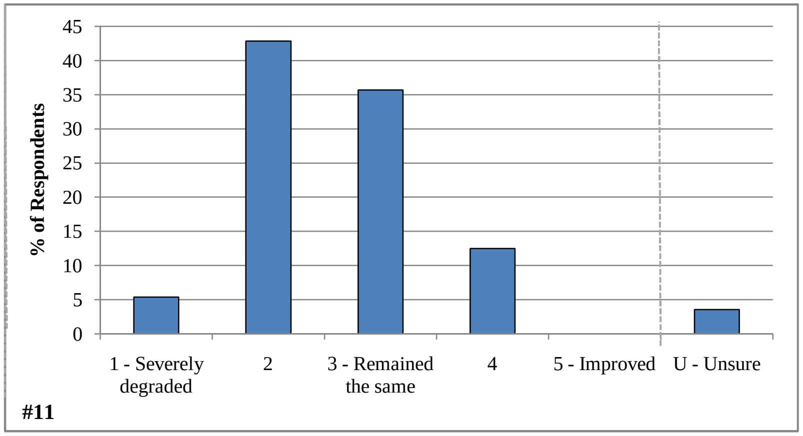
#10 How would you describe the current water quality of Ellwood Lake?

	Total	%
1 - Poor	1	*1.8*
2	2	*3.6*
3 - Fair	21	*37.5*
4	24	*42.9*
5 - Excellent	7	*12.5*
U - Unsure	1	*1.8*
	56	*100.0*



#11 How has the water quality changed in Ellwood Lake since you obtained your property?

	Total	%
1 - Severely degraded	3	*5.4*
2	24	*42.9*
3 - Remained the same	20	*35.7*
4	7	*12.5*
5 - Improved	0	*0.0*
U - Unsure	2	*3.6*
	56	



#12 Have you ever heard of aquatic invasive species?

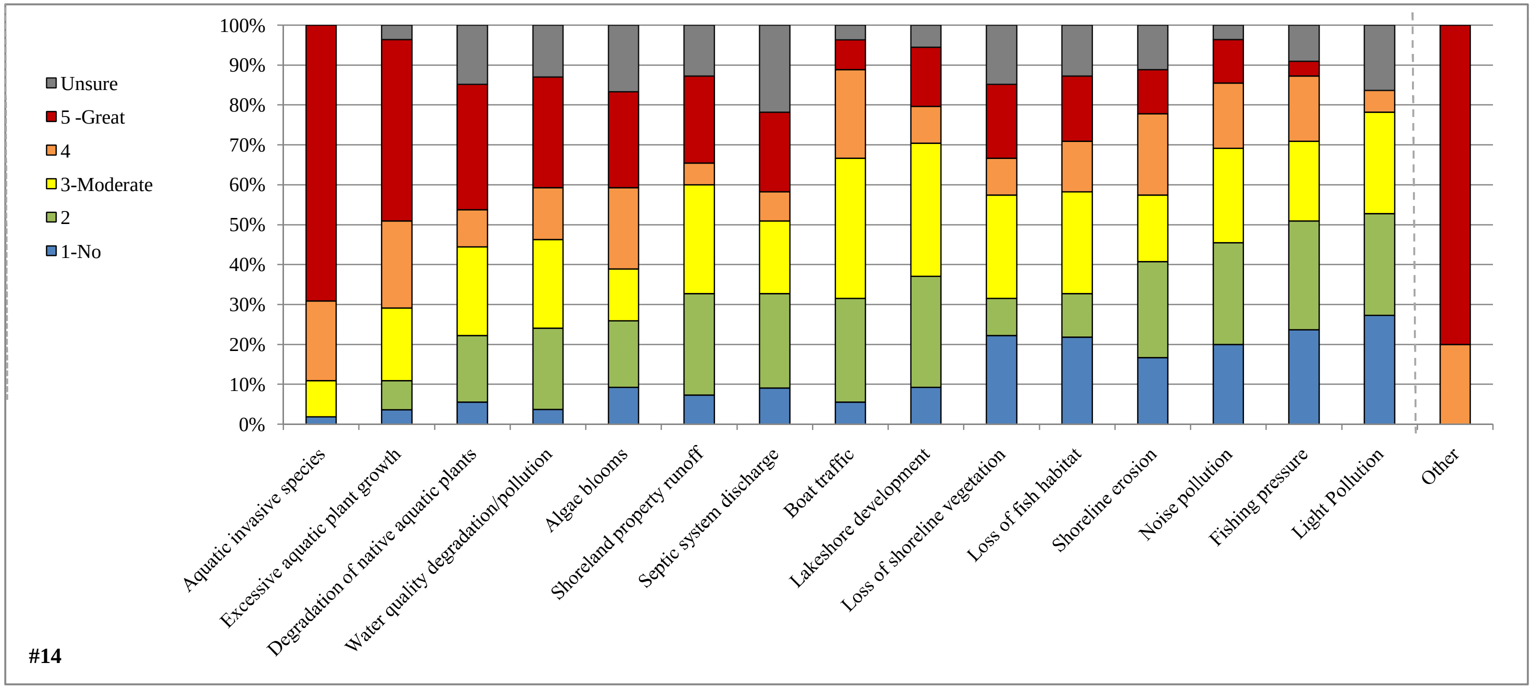
	Total	%
Yes	55	*98.2*
No	1	*1.8*
	56	

#13 Are you aware of aquatic invasive species in Ellwood Lake?

	Total	%
Yes	56	*100.0*
No	0	*0.0*
	56	

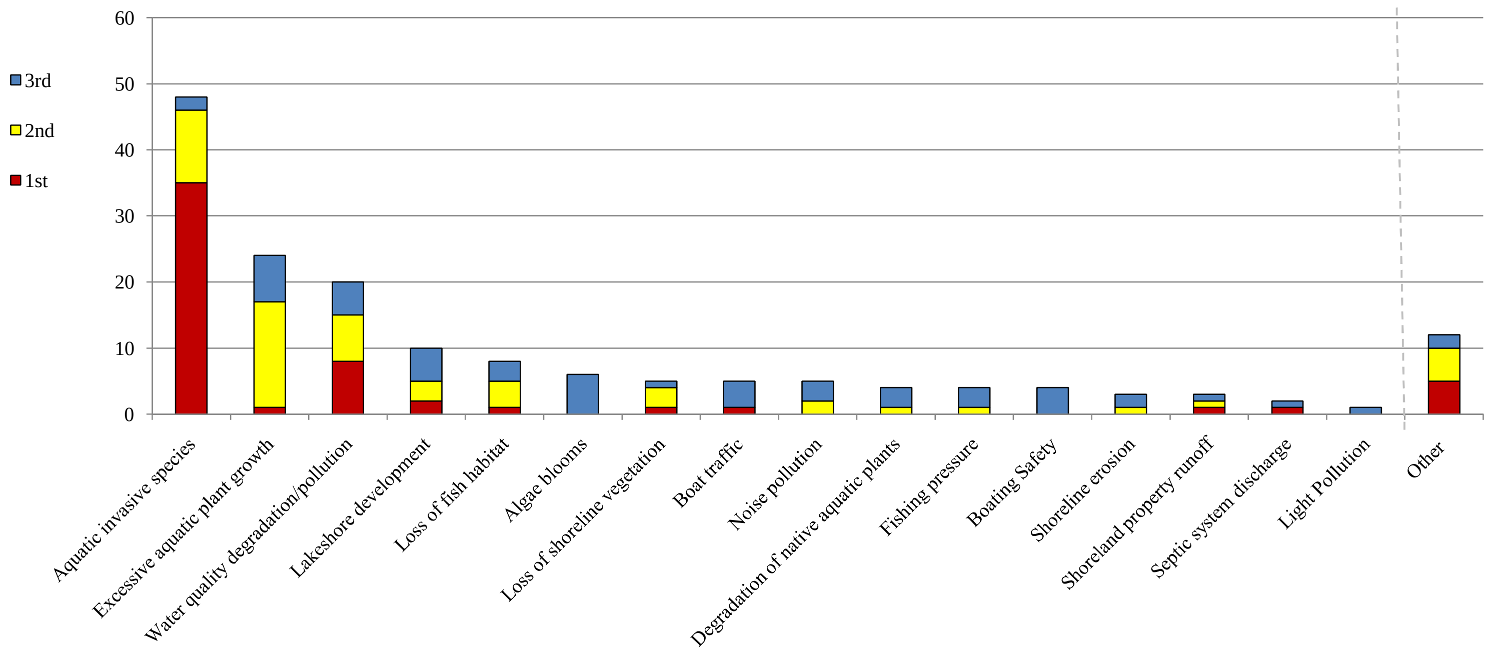
#14 To what level do you believe each the following factors are negatively impacting Ellwood Lake?

	1-No	2	3-Moderate	4	5 -Great	Unsure	*Total*	*Average*
Aquatic invasive species	1	0	5	11	38	0	*55*	*4.5*
Excessive aquatic plant growth	2	4	10	12	25	2	*55*	*4.0*
Degradation of native aquatic plants	3	9	12	5	17	8	*54*	*3.5*
Water quality degradation/pollution	2	11	12	7	15	7	*54*	*3.5*
Algae blooms	5	9	7	11	13	9	*54*	*3.4*
Shoreland property runoff	4	14	15	3	12	7	*55*	*3.1*
Septic system discharge	5	13	10	4	11	12	*55*	*3.1*
Boat traffic	3	14	19	12	4	2	*54*	*3.0*
Lakeshore development	5	15	18	5	8	3	*54*	*2.9*
Loss of shoreline vegetation	12	5	14	5	10	8	*54*	*2.9*
Loss of fish habitat	12	6	14	7	9	7	*55*	*2.9*
Shoreline erosion	9	13	9	11	6	6	*54*	*2.8*
Noise pollution	11	14	13	9	6	2	*55*	*2.7*
Fishing pressure	13	15	11	9	2	5	*55*	*2.4*
Light Pollution	15	14	14	3	0	9	*55*	*2.1*
Other	0	0	0	2	8	0	*10*	*4.8*



#15 From the list below, please rank your top three concerns regarding Ellwood Lake?

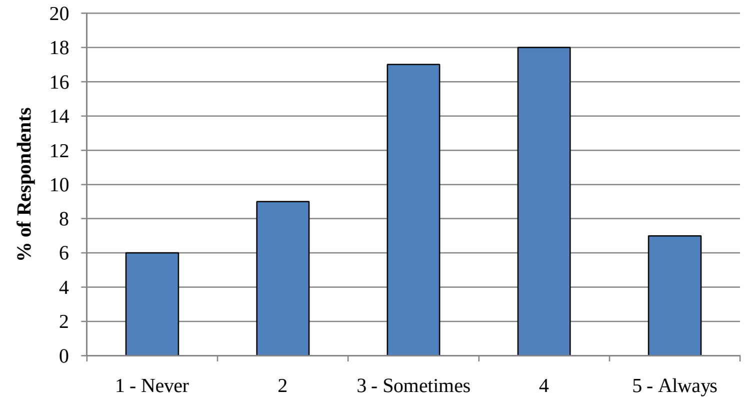
	1st	2nd	3rd	*% Ranked*
Aquatic invasive species	35	11	2	*87.3*
Excessive aquatic plant growth	1	16	7	*43.6*
Water quality degradation/pollution	8	7	5	*36.4*
Lakeshore development	2	3	5	*18.2*
Loss of fish habitat	1	4	3	*14.5*
Algae blooms	0	0	6	*10.9*
Loss of shoreline vegetation	1	3	1	*9.1*
Boat traffic	1	0	4	*9.1*
Noise pollution	0	2	3	*9.1*
Degradation of native aquatic plants	0	1	3	*7.3*
Fishing pressure	0	1	3	*7.3*
Boating Safety	0	0	4	*7.3*
Shoreline erosion	0	1	2	*5.5*
Shoreland property runoff	1	1	1	*5.5*
Septic system discharge	1	0	1	*3.6*
Light Pollution	0	0	1	*1.8*
Other	5	5	2	*21.8*
	56	55	53	



#15

#16 How often does aquatic plant growth impact your enjoyment of Ellwood Lake?

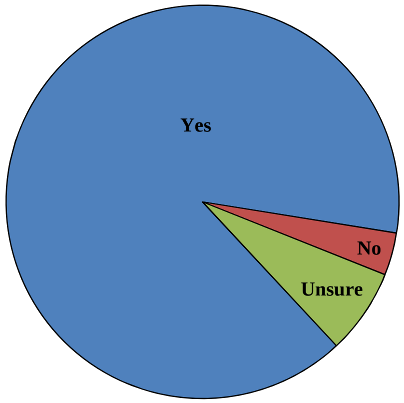
	Total	%
1 - Never	6	*10.5*
2	9	*15.8*
3 - Sometimes	17	*29.8*
4	18	*31.6*
5 - Always	7	*12.3*
	57	



#16

#17 Considering your answer to the question above, do you believe aquatic plant control is needed on Ellwood Lake?

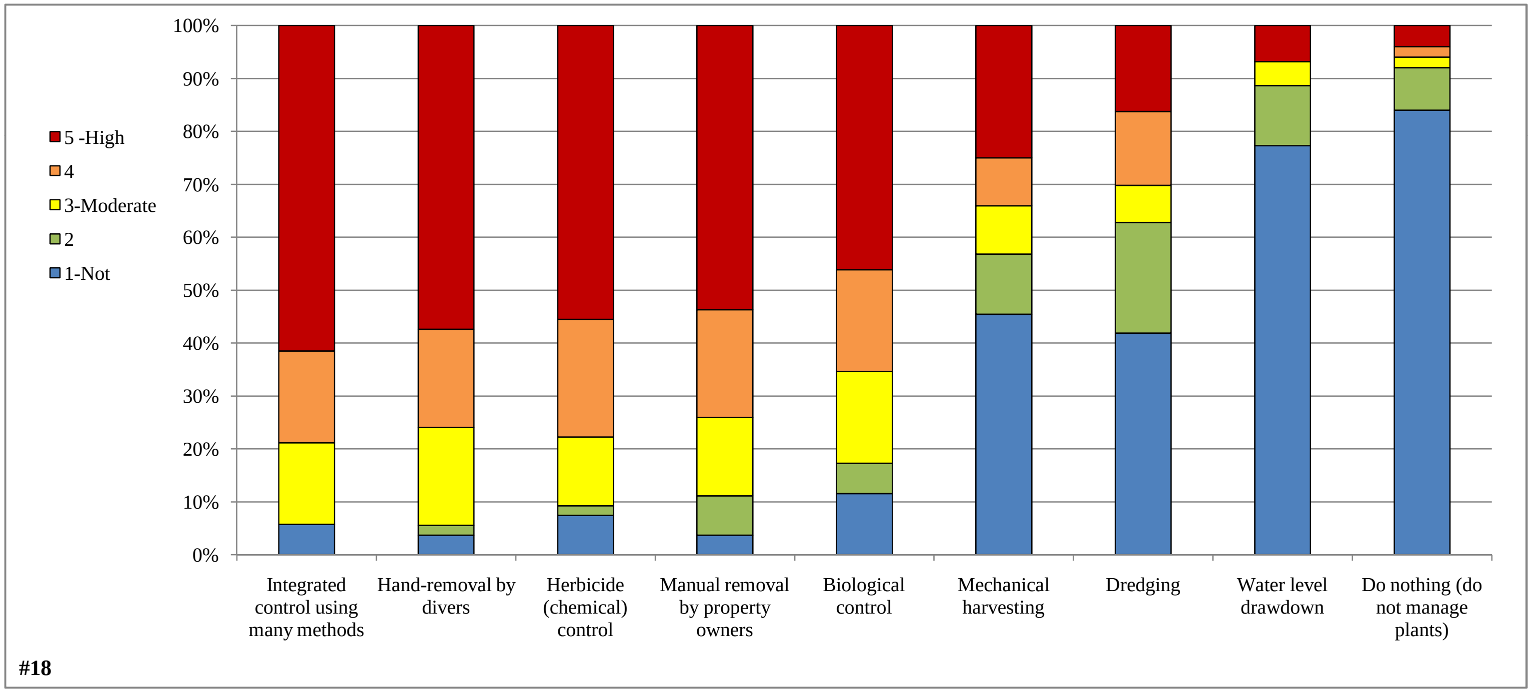
	Total	%
Yes	51	*89.5*
No	2	*3.5*
Unsure	4	*7.0*
	57	



#17

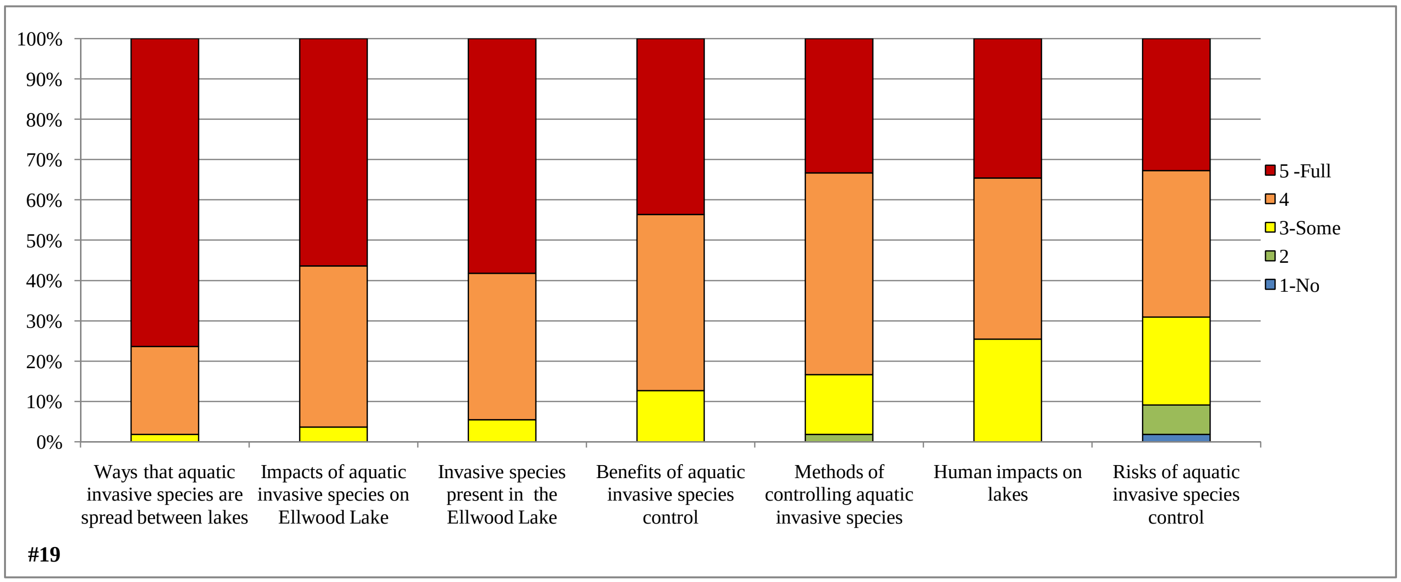
#18 What is your level of support for the responsible use of the following techniques on Ellwood Lake?

	1-Not	2	3-Moderate	4	5 -High	Unsure	*Total*	*Average*
Integrated control using many methods	3	0	8	9	32	0	*52*	*4.4*
Hand-removal by divers	2	1	10	10	31	1	*55*	*4.2*
Herbicide (chemical) control	4	1	7	12	30	1	*55*	*4.2*
Manual removal by property owners	2	4	8	11	29	1	*55*	*4.1*
Biological control	6	3	9	10	24	1	*53*	*3.9*
Mechanical harvesting	20	5	4	4	11	1	*45*	*3.2*
Dredging	18	9	3	6	7	1	*44*	*3.0*
Water level drawdown	34	5	2	0	3	1	*45*	*2.3*
Do nothing (do not manage plants)	42	4	1	1	2	0	*50*	*1.4*



#19 Please describe your level of understanding of each of the following lake management issues.

	1-No	**2**	**3-Some**	**4**	**5 -Full**	*Total*	*Average*
Ways that aquatic invasive species are spread between lakes	0	0	1	12	42	*55*	*4.7*
Impacts of aquatic invasive species on Ellwood Lake	0	0	2	22	31	*55*	*4.5*
Invasive species present in the Ellwood Lake	0	0	3	20	32	*55*	*4.5*
Benefits of aquatic invasive species control	0	0	7	24	24	*55*	*4.3*
species	0	1	8	27	18	*54*	*4.1*
Human impacts on lakes	0	0	14	22	19	*55*	*4.1*
Risks of aquatic invasive species control	1	4	12	20	18	*55*	*3.9*



#20 Before receiving this mailing, have you ever heard of the Ellwood Lake Association?

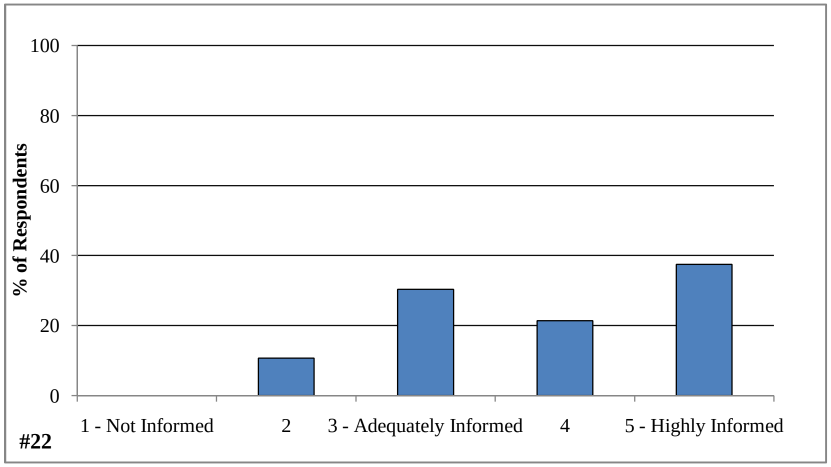
	Total	%
Yes	56	*100.0*
No	0	*0.0*
	56	

#21 Are you currently a member of Ellwood Lake Association?

	Total	%
Yes	46	*82.1*
No	5	*8.9*
	51	

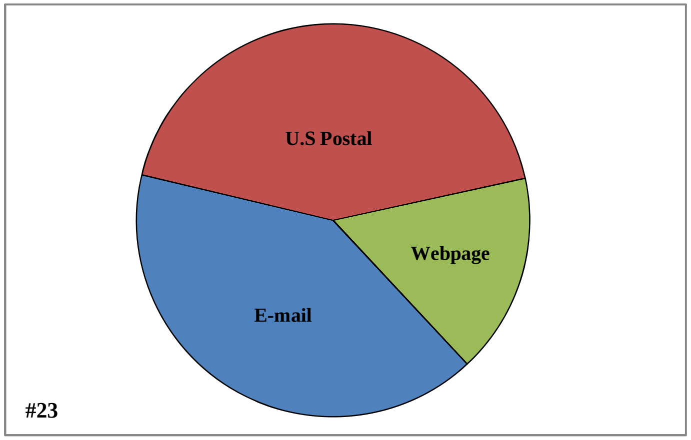
#22 Do you believe the Ellwood Lake Association has kept you adequately informed regarding issues with Ellwood Lake and its management?

	Total	%
1 - Not Informed	0	*0.0*
2	6	*10.7*
3 - Adequately Informed	17	*30.4*
4	12	*21.4*
5 - Highly Informed	21	*37.5*
	56	



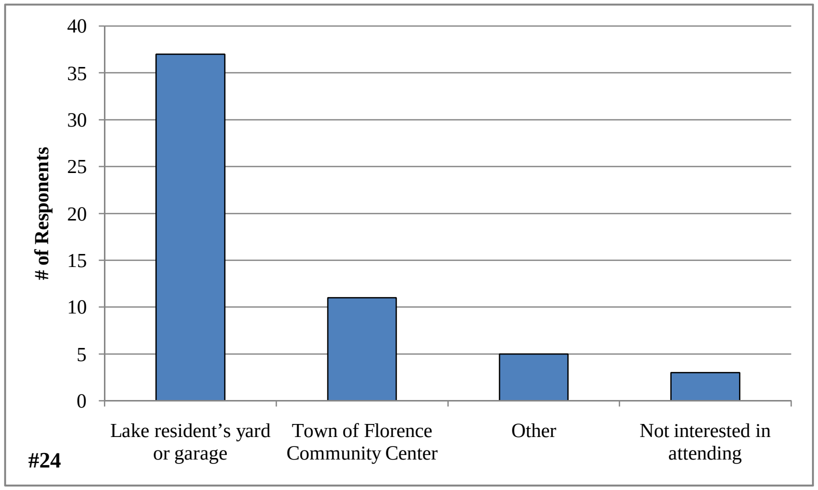
#23 How would you like to receive Lake Ellwood Association communications?

	Total	%
E-mail	37	40.7
U.S. Postal	39	42.9
Webpage	15	16.5
Not interested in receiving communications	0	0.0
	91	



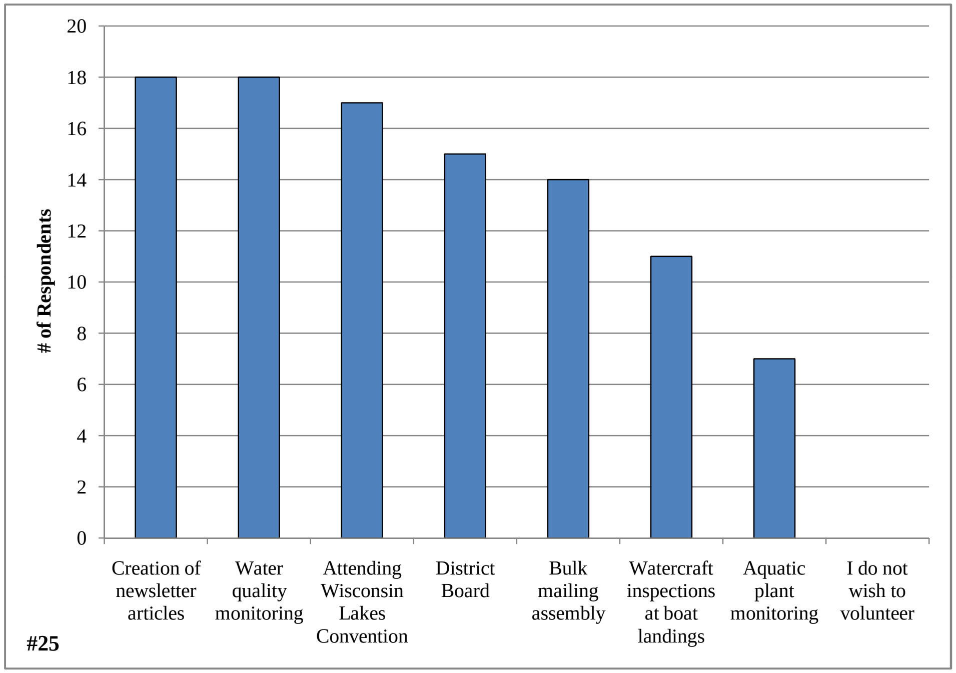
#24 Where would you prefer to meet for the annual Lake Ellwood Association meeting?

	Total
Lake resident's yard or garage	37
Town of Florence Community Center	11
Other	5
Not interested in attending	3
	56



#25 Please circle the activities you would be willing to participate in if called upon.

	Total
Creation of newsletter articles	18
Water quality monitoring	18
Attending Wisconsin Lakes Convention	17
District Board	15
Bulk mailing assembly	14
Watercraft inspections at boat landings	11
Aquatic plant monitoring	7
I do not wish to volunteer	0
	100



Survey Number	1g Comment	9m Comment	14p Comment	15q Comment	24c Comment	Other Comments
2	Recreation year round.					
9			Jet skis should be limited.			22: Better this last year 23b: For important issues--votes, etc.
10	Possible future year round residence.					
12					Boat landing. Accessible and public.	7: Don't know 21: If paying money makes me a member, than yes. Nothing else; no application process 22: Meetings of the Board are not "noticed up" publicly, nor even to all "members" (i.e. withdrawal of petition for statuatory lake association.
13		Skating.				
14						21: Unsure
16			Public access.			25i: At this time.
17	Voting resident of Niagara.					
19						25h: Fund raising
20			Public boat launch access has been the #1 cause of lake degredation caused by invasive species introduction (re, milfoil,etc.). Lake level continual droppage 2nd biggest problem--results in elevated temps, more light infiltration, leading to unprecedented plant growth (re, milfoil). Cause: unknown? Perhaps fact that most homes are year-round creates excess well demand.			11: Milfoil, lowered lake level, much fewer fish 18a: Has not worked 17: Not control, eradication
21						2: Varies
23				Loss of water.		
24				Low water level.		25i: unsure
25			Low water level.			3: Built by our family in 1966 4d: Septic/dry well 14n: Jet Skiis 15p: Loss of CCW traffic pattern
26					Boat landing.	11: It changes 2-4
28			Chemicals placed in lake by association.	Chemicals placed in lake by association.	Boat landing.	
30			Water level.	Water level.		
31						11: 2.5 clarity has gone down
32			Cyclical water level changes.			

Survey Number	1g Comment	9m Comment	14p Comment	15q Comment	24c Comment	Other Comments
33				Make no wake after 6:00 pm - 10:00 am.		
35			Drop in water level.	Drop in water level.		4d: With lift station 21: We pay contributions
37				Water level.	Boat landing.	22: Not honest
38						3: 3-months
40						4a: I have a good system and it's pumped regularly. 5: Grandchildren only
41				water depth		
42				also algae blooms		25i: I am unable to volunteer
43		cross-country skiing				
46	Does not live on the lake but completed survey. Stated familiarity with lake at 58 years. Use lake home year round, but don't live there.			Water table.	Doesn't matter.	
47						9(1st): a, b, c,e, f,g, h,I, j, k
51						25i: I live out of town and don't spend enough time on the lake to help
53			brother-in-law			
58				Indicates all are concerned		

Stakeholder Survey Comments for Question 26

Survey #	Comments
1	We need the Town of Florence, as a land owner, to be an active and interested member of the Lake Ellwood Association. We need the County of Florence Soil Conservation District Representative to be an active and interested member of the Lake Ellwood Association. As an active and interested member, both government organizations should participate at some level in providing support, monetarily, in the LEA annual fund drive.
4	Would like to comment that the recent presentation by Onterra at the Florence Town Hall on Lake Ellwood was very informative and helpful. Please continue your great efforts; you'll have our support.
5	The water clarity of Lake Ellwood has not changed in the past dozen years I have been checking it. Aquatic plants have increased dramatically on the west short of our lake the last dozen years. The lake bottom in the area of our dock has changed from no plant growth 17 years ago to complete coverage of the lake bottom, in the same area, this year. The Lake Ellwood Association has changed a great deal over the past 15 years I have been a member. Fifteen years ago it was a social gathering where all of the land owners could meet each other, talk about the lake and enjoy the potluck lunch. When the potluck lunch was dropped many of the ladies quit attending and attendance at the yearly meeting was minimal. Recently, since milfoil was discovered, interest in the association has risen but attendance at the yearly meeting is still sparse. There are probably only a dozen homeowners that have continued to be involved in the association since I joined some fifteen years ago.
6	Concerned about significant decrease in water level.
8	Where has our water gone? Are the aquifers low right now? Can we charge non-residents a launch fee?
9	I think the committee has done a great job in 2007. More organized and better communication.
12	I have personally heard comments from Nick Simone, John Bishop and Mr. Priehm (sp.?) that disparaged "outsiders," i.e., non-shore land property owners and which indicated, directly or indirectly, that the lake should be closed to non-shore land owners. Though I believe that would never occur, the attitude of these people is appalling to me. This type of attitude dissuades other landowners, like me, from volunteering for people like them who are, apparently, elitist. The degradation of the lake is, in my opinion, from the people who use it the most—the property owners. A job well done, however, to you who are volunteering.
16	Are we able to temporarily close public access until milfoil is eliminated? Lake level is a concern. Exit pipe at south end should be raised so that when lake level does rise water will not be prematurely lost.
17	I feel we are doing a much better job of informing people. The first poison application was poorly done. We were not notified and therefore the restrictions were (not?) given to us. Three owners, no one else, knew what was being done. Since that time a better job is done. We have to continue to keep all owners notified—seasonal and permanent owners. Seasonal owners are often overlooked. They are important even though the county doesn't think so. Thanks for the work. I have been here for a long time. Keep up the good work. (Ray O., 9/30/08)
19	Remain interested in community garage sale to raise funds. Appreciate motivated board members and coordination and interest in health of Lake Ellwood.

20	Differences from 40 years ago to today. Then: - only one year-round home in lake – Swanson's (end of lake), - fishing (family) was exceptional, lake was teeming with bluegill, crappie, perch, bass and even brook trout (at that time Swanson's creek had water in it that ran down to the Pine River and I personally caught hundreds of NATIVE 9 – 13" brook trout). In the 1970's I scuba dove and snorkeled the entire perimeter of the lake many times and fish presence was incredible—kids/teens would catch bluegill, rock bass and perch ever single cast day or night. The DNR in their infinite wisdom sterilized the entire lake, killing all fish one summer—I believe approx. in 1968-9, so they could "manage" installing the type game fish they thought was needed—the lake was NEVER the same. In the late 1970's-early 1990's masses of people made their weekend cottages their full-time homes, consequently wanting lush green lawns which requires land disruption, fertilizers/chemicals (which run of their "Cliffside" homes by gravity to the lowest point, the lake) and huge water demand to water lawns, wash cars and for laundry and showers. Water level continues dramatic decline, less water means elevated water temps and increased aquatic life such as milfoil, and even "swimmers' itch" type bacteria. Cause? Ellwood is (or at least used to be spring fed) – perhaps either the 120+ year round home demands for water have decreased pressure of the springs, meaning less spring water injected into the lake, or perhaps the springs are fed by other main geological aquifers running from the UP to Chicago? The DNR's failure to shut down public access to lakes throughout our region before they were infected with milfoil is unconscionable.
21	Keep up the good work.
22	I worry about the quality of the water for my grandchildren. Also, I think we should all pay the same for the treatments. If you collect $150 – 200 from each family we would have $15 – 18K every year. I believe this affects each(?) and every (?) property the same, a percentage. (Pick a number.)
23	Committee members should be congratulated for all their time and commitment. It is too bad that some people refuse to acknowledge that AIS is a problem nationwide. Keep up the good work.
24	I was very concerned at the level of negative reaction to the attempt to establish a lake district. It seemed to be considered a battle between the wealthy and those of lesser means. I suggest that future endeavors emphasize the cost-benefit ratio of any plan so that as large a percentage of property owners as possible will feel they are in agreement. By the way, I really dislike the word "stakeholder." Perhaps a substitute could be utilized.
25	Lake living is a luxury and a responsibility. Those that cannot "afford" to support the management of the lake should move off the lake. The majority vote should be followed and supported by all owners. Future projects (potential) - Boat wash station at landing - Highway sign with names and fire # - Walking trail around the lake (w easements) - Ice fishing/hockey/SC ski winter festival - Lake Ellwood Triathlon bike/swim/run/walk - Lake Ellwood Town Hall/Boat storage (money maker?) - Deep high GPM well at landing to maintain water level - Dredge channel north of island.

28	I believe the association has grown without reason. I believe it should be a social organization. The issues the association is engaging in should be handled on a county level.
29	1) I don't think the district idea is over. From what we have learned, we did not present it well. If we were to present a district charter (written within the state guidelines, i.e., limit amount of taxation to 1%. etc.) and answer all the questions that were presented, and show that most of these concerns with an association as well. I also think a letter with a copy of the report given at our last meeting about the history of milfoil on that lake in Michigan (Sawyer Lake), their size, money spent, the fact that milfoil took over their lake, the success of the plan (weevils) and the fact that they found a combined effort—chemicals and weevils—was the best approach. 2) We should tell everybody of our success as well as the problems that still exist. The problem will not go away. 3) Maybe we should work on a plan based on *weevils*?(Sorry, I can't be sure this is the right word.) 4) I don't think we use the web page enough. It could be my problem as well; I don't check it very often.
30	I'm surprised there is no mention of the water level. Regardless of whether or not anything can be done about it, that is, by far, my greatest concern. Several residents have even had trouble with their boat lifts or dock locations because the water has gotten too shallow.
33	I think you have done a great job over the years. Keep up the good work! It was unfortunate the Lake District did not go through. I will gladly support the Lake Association financially to help fight the invasive weeds.
35	This Stakeholder Survey tells us lots about what we, the homeowners on Lake Ellwood, are fearful about. You outline a history of the "Association," describing it as partially a social gathering, then you describe incorporation and move on from there. Some of us simply do not want a "homeowner's Association" with all the rules and regulations that someday may rain down upon us. The formation of a more aggressive Association that today wants to watch out for Eurasian Milfoil, tomorrow may want to control our use of the lake, runoff waters, septic pollution, and whatever else! The mere inclusion of questions about such matters is bothersome to us. The Association as described to us in 2008, would have three Lake Ellwood property owners,, and two quasi-government members. That's 40% of any vote cast by non-property owners. If even *one* property owner were to vote on any issue alongside the two non-property owners, they would have a 60% or better majority. No, no, no! But our point in writing these comments, is to suggest that the Lake Ellwood Association appears to be moving on to other matters. . .but is missing the one item now of greatest concern: a diminishing water level. That's what we talk about now! We perceive you've got a handle on the Eurasian Milfoil matter. We perceive you'll let us know how much you need from each of us, and you would like us to pay it. Now let's move on. Let's talk WATER LEVEL. What can be done about the uselessness of our docks and piers? What can be done if our water well systems give out? Are some systems failing right now? How many and how frequently? And what's with the question in this survey, giving us a possibility to "draw down the water level"??? If the landowners on Lake Ellwood really want a "homeowners Association," all we ask is that the water level rises again, and then give us an opportunity to sell to someone who doesn't mind being a member of an Association. We'd like to relocate to a lake without restrictions.

38	My wife and I just moved to the lake and we enjoy being on the lake and would like to continue to see the lake healthy and safe for me and my family.
40	Over the years, our water table has decreased about 2-3 feet. I would think that one main concern is "Where is our water going?" Years ago you could see bubbles from our water springs and feel the water. Are our springs blocked? Is our water table being tapped from the city of Kingsford? How would we find out? Lake Ellwood is a beautiful lake but with the FAST boat traffic on our lake I don't think that has helped our water and weed growth.
41	We appreciate all that those on the board have done and would like to be kept informed and updated on issues concerning Lake Ellwood. Thank you Lake Ellwood Association Board!
43	I am happy to see that grant money was secured and a management plan will be developed. I disagreed with the past emphasis on using chemical treatment and hope that the future plan will use a variety of methods to control the invasive plant species. I assume that part of the plan will be to monitor for appearance of other invasive species, such as zebra mussels. Also, I would not be opposed to a moratorium on size of boat/motors. Also, thank you to those that are volunteering.
44	I'm not in support of any chemical use in the lake. I would support the use of the weevil and the manual removal of AIS in the lake.
45	One note: I would suggest the association use a flat per property owner fee on the next voluntary assessment. I for one am not happy with past participation (or lack thereof) and would be much more prone to pay when it is same for all.

46 (Says he doesn't live on the lake, but uses it all year round.)	For starters, Lake Elwood, the word Elwood from old documents, is not spelled with two ls. I am very surprised that nobody hasn't pointed this out. Elwood is spelled Elwood, not Ellwood. Do your research! Next, instead of worrying about milfoil, I would be worried about the water level. If all the milfoil is gone and you have no water, what good is the lake? If/or Costa's place is sold and subdivided, you will have more houses drawing off the water table. Remember Lake Elwood is spring fed but all the springs are gone. Through my 58 years on the lake I could have showed you where every spring was. Now they're gone. Something to check into as most people years ago had point wells (we still do but had to drive point down further this August) to see how many people now have drilled wells versus points which will impact the lake a lot. Also we never had any problems with milfoil in lake until the County redid the boat landing. Now a Cadillac can put a boat in or out where before you needed a 4 x 4 truck which everyone on the lake never had any trouble before obtaining. This new launch I **know** brought more imports in with dirty boats. Also these fishermen catch lots of small pan fish (that are hooked good) and let them go. I see lots of small dead fish here and there. Also there is one guy in a bass boat that fishes by the sand bar between Henry's and island who thinks he owns the lake. He parks right in the way so boats circling the whole lake have to go around him. Is this RIGHT? (He doesn't pay taxes because I know for a fact he is an import.) Also something to look into which down the road could help Elwood, Frog and Spring Lakes with water levels. I monitor a dam on the river as part of my job. In the spring we spill at all the dams from Peavy Falls to Lake Michigan a lot of excess water which we call wasting because our water wheels can only generate so much power and take so much water so we spill excess (that) in turn runs into Lake Michigan. Years ago when the lake was at normal, water used to flow down a creek (located south end of lake where Underwood's place was) out to the Pine River. Hamilton Lake and the Spread Eagle Chain have small dams so you will know where I am going with this. If Elwood dries up so you cannot use your boat our property values will drop, in turn the state of Wisconsin and Florence City will lose money which brings me to my point. I don't know who you would talk to about permits or grant money to save a recreational lake. If we were to run a culvert pipe underground from the Pine River by way of the old creek we would be able to control water level. You would need a small dam with a screen on inlet side to catch weeds or milfoil, etc., etc., to flow into a small catch basin. This catch basin would have a lift pump which would pump the water, then the culvert pipe to Elwood. (Could eventual T pipe to go to Frog and Spring Lakes.) The only time we could use it is in the spring when the rivers have excess water. A few people, along with myself, could be trained on how to operate it. Thus during the spring, you could bring lake up to desired water level and leave alone then. That way comes September, instead of lake being down 5 feet, it will be 2 feet. You would have to keep records to allow for summer evaporation or if you had lots of rain so lake doesn't go too high. We never get enough rain anymore. So this for sure will not be a problem. The amount of water we would take would not even put a dent in Lake Michigan. Remember the lake only gets its water from rain, run-off snow, or the springs. The springs are gone so if you don't come up with a plan there will be no water. People are still building all around the lake and drilling wells. If everyone (including Kingsford wells by airport and Spread Eagle golf courses irrigation system) are all tapped into the same aquifers the water will be gone. Trust me, I've been on the lake all my life and it's never been this bad. Thank you.
47	I do not believe a district is the answer.
49	I/we do not have time to volunteer currently. We will continue to support the Lake Ellwood Association financially. Thanks for your past efforts and seeking our input.

51	I don't feel the lake is polluted or has a pollution problem. Some erosion due to boating (mainly jet skis). The milfoil is a concern. Chemicals are a temporary solution but we need a more natural solution.
53	We would like to do more to help, but we live in Illinois. We appreciate what efforts that the volunteers do, and we thank them. What can we do to raise the lake level—maybe a rain dance?
55	Very concerned about the low water level.
56	Living in Madison, we have watched how invasive species like milfoil has taken over many local lakes. In Madison, as you can imagine, they seem to be willing to do nothing to control the problem. They have chosen to primarily control by manually harvesting periodically. This is a *(__illegible word)* problem and leaves the lakes in a state only enjoyed by people looking to fish. You will find very few swimmers or water skiers on these lakes. We are in favor of aggressive treatment and willing to share in the financial commitment necessary to keep our lake great. Thanks for all of the hard work by the committee.

C

APPENDIX C

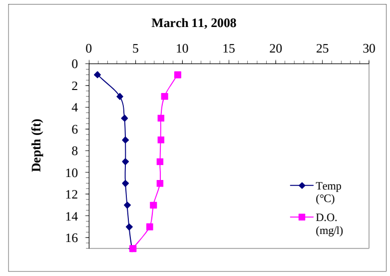
Water Quality Data

Ellwood

Date: 03-11-08
Time: 11:00
Weather: Full sun, 30 F
Ent: BTB **Verf:**

Max Depth (ft): 20.0
ELS Depth (ft): 3.0
ELB Depth (ft): NA
Secchi Depth (ft): 16.0

Depth (ft)	Temp (°C)	D.O. (mg/l)	pH	Sp. Cond (µS/cm)
1.0	0.9	9.5	7.4	226
3.0	3.3	8.1	7.3	229
5.0	3.8	7.7	7.2	229
7.0	3.9	7.7	7.1	229
9.0	3.9	7.6	7.2	230
11.0	3.9	7.6	7.1	230
13.0	4.1	6.9	7.1	232
15.0	4.3	6.5	7.0	235
17.0	4.6	4.7	6.9	238



Parameter	ELS	ELB
Total P (µg/L)	10.000	NA
Dissolved P (µg/L)	2.000	NA
Chl a (µg/L)	NA	NA
TKN (µg/L	700.00	NA
NO3+NO2-N (µg/L)	ND	NA
NH3-N (µg/L)	333.000	NA
Total N (µg/L)	700.00	NA
Lab Cond. (µS/cm)	229	NA
Lab pH	7.30	NA
Alkal (mg/l CaCO3)	NA	NA
Total Susp Sol (mg/l)	ND	NA
Calcium (mg/l)	NA	NA

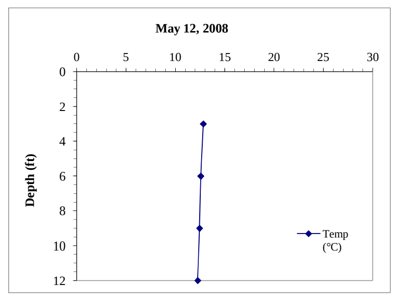
Data collected by TAH and EJH (Onterra)

Ellwood

Date: 05-12-08
Time: NA
Weather: NA
Ent: BTB **Verf:**

Max Depth (ft): NA
ELS Depth (ft): 3.0
ELB Depth (ft): 12.0
Secchi Depth (ft): 10.3

Depth (ft)	Temp (°C)	Temp (°F)
3.0	12.8	52.5
6.0	12.6	52.1
9.0	12.4	51.9
12.0	12.3	51.6



Parameter	ELS	ELB
Total P (µg/L)	21.000	NA
Dissolved P (µg/L)	4.000	NA
Chl a (µg/L)	3.44	NA
TKN (µg/L	930.00	NA
NO3+NO2-N (µg/L)	24.000	NA
NH3-N (µg/L)	188.000	NA
Total N (µg/L)	954.00	NA
Lab Cond. (µS/cm)	211	NA
Lab pH	8.32	NA
Alkal (mg/l CaCO3)	99	NA
Total Susp Sol (mg/l)	ND	NA
Calcium (mg/l)	22.2	NA

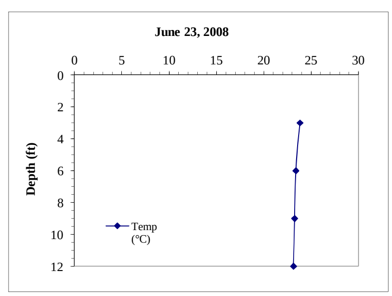
Data collected by William Collard (Ellwood Lake CLMN)

Ellwood

Date: 06-23-08
Time: NA
Weather: NA
Ent: BTB **Verf:**

Max Depth (ft): NA
ELS Depth (ft): 3.0
ELB Depth (ft): 12.0
Secchi Depth (ft): 12.0

Depth (ft)	Temp (°C)	Temp (°F)
3.0	23.8	70.1
6.0	23.4	69.4
9.0	23.3	69.2
12.0	23.1	69.0



Parameter	ELS	ELB
Total P (µg/L)	14.000	NA
Dissolved P (µg/L)	NA	NA
Chl a (µg/L)	4.10	NA
TKN (µg/L	630.00	NA
NO3+NO2-N (µg/L)	ND	NA
NH3-N (µg/L)	ND	NA
Total N (µg/L)	630.00	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkal (mg/l CaCO3)	NA	NA
Total Susp Sol (mg/l)	2	NA
Calcium (mg/l)	NA	NA

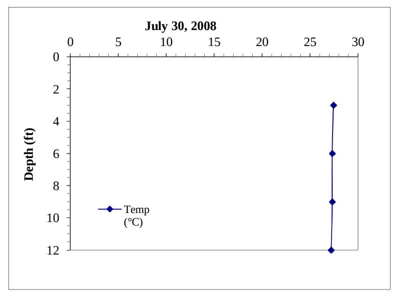
Data collected by William Collard (Ellwood Lake CLMN)

Ellwood

Date: 07-30-08
Time: NA
Weather: NA
Ent: BTB **Verf:**

Max Depth (ft): NA
ELS Depth (ft): 3.0
ELB Depth (ft): 12.0
Secchi Depth (ft): 11.0

Depth (ft)	Temp (°C)	Temp (°F)
3.0	27.4	75.9
6.0	27.3	75.7
9.0	27.3	75.7
12.0	27.2	75.5



Parameter	ELS	ELB
Total P (µg/L)	12.00	NA
Dissolved P (µg/L)	4.000	NA
Chl a (µg/L)	0.90	NA
TKN (µg/L	550.00	NA
NO3+NO2-N (µg/L)	ND	NA
NH3-N (µg/L)	ND	NA
Total N (µg/L)	550.00	NA
Lab Cond. (µS/cm)	208	NA
Lab pH	8.26	NA
Alkal (mg/l CaCO3)	NA	NA
Total Susp Sol (mg/l)	ND	NA
Calcium (mg/l)	NA	NA

Data collected by William Collard (Ellwood Lake CLMN)

Ellwood

Date: 08-25-08
Time: NA
Weather: NA
Ent: BTB **Verf:**

Max Depth (ft): NA
ELS Depth (ft): 3.0
ELB Depth (ft): NA
Secchi Depth (ft): 10.0

Parameter	MLS	MLB
Total P (µg/L)	11.000	NA
Dissolved P (µg/L)	NA	NA
Chl a (µg/L)	3.01	NA
TKN (µg/L	530.00	NA
NO3+NO2-N (µg/L)	ND	NA
NH3-N (µg/L)	37.000	NA
Total N (µg/L)	530.00	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkal (mg/l CaCO3)	NA	NA
Total Susp Sol (mg/l)	ND	NA
Calcium (mg/l)	NA	NA

No Profile Data

Data collected by William Collard (Ellwood Lake CLMN)

Water Quality Data

2008 Parameter	Surface Count	Surface Mean	Bottom Count	Bottom Mean
Secchi Depth (feet)	5	11.9	NA	NA
Total P (µg/L)	5	13.600	NA	NA
Dissolved P (µg/L)	3	3.333	NA	NA
Chl a (µg/L)	4	2.863	NA	NA
TKN (µg/L	5	668.000	NA	NA
NO3+NO2-N (µg/L)	5	24.000	NA	NA
NH3-N (µg/L)	5	186.000	NA	NA
Total N (µg/L)	5	672.800	NA	NA
Lab Cond. (µS/cm)	3	216.000	NA	NA
Lab pH	3	7.960	NA	NA
Alkal (mg/l CaCO3)	1	98.500	NA	NA
Total Susp Sol (mg/l)	1	2.000	NA	NA
Calcium (µg/L)	1	22.200	NA	NA

Wisconsin Trophic State Index (WTSI)

Year	TN	TP	Chla	SD
1994				
1995				42.04
1996				43.23
1997				37.61
1998				38.08
1999				39.29
2000				40.04
2001				34.83
2002		45.82	41.86	38.18
2003				42.82
2004				42.56
2005				40.95
2006				40.95
2007		46.80	44.44	41.50
2008		47.69	42.13	42.56
All Years (weighted)		44.61	41.89	40.37
WI Natural Lakes		53.19	54.23	47.33
Northeast Region		51.05	51.49	45.61

Morphological / Geographical Data

Parameter	Value
Acreage	131.96
Volume (acre-feet)	1908.2
Perimeter (miles)	2.86
Maximum Depth (feet)	25
County	Florence County
WBIC	650500
Lillie Mason Region(1983)	Northeast Region
Nichols Ecoregion(1999)	NLFL

	Secchi (feet)				Chlorophyll a (µg/L)				Phosphorus (µg/L)			
	Growing Season		Summer		Growing Season		Summer		Growing Season		Summer	
Year	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean
1994	2	13.6										
1995	6	11.4	4	11.4								
1996	4	13.2	1	10.5								
1997	4	15.9	1	15.5								
1998	5	14.6	4	15								
1999	5	13.5	4	13.8								
2000	6	13.3	4	13.1								
2001	6	18.2	4	18.8								
2002	7	14.9	7	14.9	2	2.58	2	2.58	5	9.8	3	9.7
2003	5	10.2	4	10.8								
2004	5	11.4	4	11								
2005	4	12.9	3	12.3								
2006	4	12	3	12.3								
2007	6	11.78	5	11.84	2	3.64	2	3.64	2	11	2	11
2008	4	10.81	3	11.00	4	2.86	3	2.67	4	14.5	3	12.33
All Years (weighted)		12.9		12.8		2.4		2.6		8.1		8.3
WI Natural Lakes				7.9				13.4				25
Northeast Region				8.9				9.3				19

D

APPENDIX D

Watershed Analysis WiLMS Results

Date: 11/13/2008 Scenario: Ellwood Current

Lake Id: Ellwood_Florence
Watershed Id: Ellwood

Hydrologic and Morphometric Data

Tributary Drainage Area: 1543.0 acre
Total Unit Runoff: 13.7 in.
Annual Runoff Volume: 1761.6 acre-ft
Lake Surface Area <As>: 132 acre
Lake Volume <V>: 1908 acre-ft
Lake Mean Depth <z>: 14.5 ft
Precipitation - Evaporation: 5.6 in.
Hydraulic Loading: 1823.2 acre-ft/year
Areal Water Load <qs>: 13.8 ft/year
Lake Flushing Rate <p>: 0.96 1/year
Water Residence Time: 1.05 year
Observed spring overturn total phosphorus (SPO): 7.0 mg/m^3
Observed growing season mean phosphorus (GSM): 10.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	0.0	0.50	1.00	3.00	0.0	0	0	0
Mixed AG	70	0.30	0.80	1.40	23.4	8	23	40
Pasture/Grass	52	0.10	0.30	0.50	6.5	2	6	11
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	0.0	0.05	0.10	0.25	0.0	0	0	0
Wetlands	71	0.10	0.10	0.10	3.0	3	3	3
Forest	1350	0.05	0.09	0.18	50.7	27	49	98
Lake Surface	132.0	0.10	0.30	1.00	16.5	5	16	53

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.3	0.5	0.8	
# capita-years	0.0				
% Phosphorus Retained by Soil		98	90	80	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	101.7	213.9	451.5	100.0
Total Loading (kg)	46.1	97.0	204.8	100.0
Areal Loading (lb/ac-year)	0.77	1.62	3.42	0.0
Areal Loading (mg/m^2-year)	86.37	181.67	383.42	0.0
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	89.9	178.6	333.8	100.0
Total NPS Loading (kg)	40.8	81.0	151.4	100.0

Phosphorus Prediction and Uncertainty Analysis Module

Date: 11/13/2008 Scenario: **Ellwood Current**
Observed spring overturn total phosphorus (SPO): 7.0 mg/m^3
Observed growing season mean phosphorus (GSM): 10.1 mg/m^3
Back calculation for SPO total phosphorus: 0.0 mg/m^3
Back calculation GSM phosphorus: 0.0 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 0 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	11	22	47	12	119
Canfield-Bachmann, 1981 Natural Lake	12	22	39	12	119
Canfield-Bachmann, 1981 Artificial Lake	12	21	34	11	109
Rechow, 1979 General	5	11	23	1	10
Rechow, 1977 Anoxic	16	33	70	23	228
Rechow, 1977 water load<50m/year	9	18	38	8	79
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	11	23	49	16	229
Vollenweider, 1982 Combined OECD	10	19	35	10	117
Dillon-Rigler-Kirchner	6	12	26	5	71
Vollenweider, 1982 Shallow Lake/Res.	8	15	29	6	70
Larsen-Mercier, 1976	10	21	45	14	200
Nurnberg, 1984 Oxic	7	14	30	4	40

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	13	39	FIT	0	GSM
Canfield-Bachmann, 1981 Natural Lake	7	63	FIT	1	GSM
Canfield-Bachmann, 1981 Artificial Lake	7	60	FIT	1	GSM
Rechow, 1979 General	6	20	FIT	0	GSM
Rechow, 1977 Anoxic	20	58	FIT	0	GSM
Rechow, 1977 water load<50m/year	10	32	FIT	0	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	11	44	FIT	0	SPO
Vollenweider, 1982 Combined OECD	9	35	FIT	0	ANN
Dillon-Rigler-Kirchner	7	21	FIT	0	SPO
Vollenweider, 1982 Shallow Lake/Res.	7	28	FIT	0	ANN
Larsen-Mercier, 1976	13	37	P Pin	0	SPO
Nurnberg, 1984 Oxic	7	26	FIT	0	ANN