Shakey Lakes Integrated Management Plan

[Lake Township, Menominee County, Michigan]

Prepared by:
Lindsay Peterson, Conservation Projects Manager
Wild Rivers Invasive Species Coalition
420 N Hooper St.
Kingsford, MI 49802

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(Lake Township, Menominee County, Michigan)

This plan is the product of MDNR Michigan Invasive Species Grant IS 14-1010 awarded to:

Wild Rivers Invasive Species Coalition
420 N. Hooper St.
Kingsford, MI 49802
(906) 774-1550 ext 102
wildriverscwma@gmail.com
www.wrisc.org

Plan Submitted to:

Shakey Lakes Association
N8650 Whispering Pine Rd #21.75
Stephenson, MI 49887

Plan Prepared by:

Lindsay Peterson
Conservation Projects Manager
Wild Rivers Invasive Species Coalition
420 N. Hooper St.
Kingsford, MI 49802
wriscproject@gmail.com
(906) 774-1550 ext 104

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Preface

Project Background

In early 2015, the Wild Rivers Invasive Species Coalition was awarded a Michigan Invasive Species Grant as funded by the Michigan Departments of Natural Resources, Environmental Quality, and Agriculture and Rural Development. The grant project, entitled "Wild Rivers Invasive Species Coalition Michigan Expansion Project," provided $126,000 in funding towards the aim of expanding invasive species strategic management efforts including education and outreach, citizen involvement, early detection, rapid response, mapping, monitoring, and control across Dickinson and Menominee Counties in the Upper Peninsula of Michigan. Included in these expanded efforts was the monitoring of water quality on 10 lakes within the counties and the development of lake management plans following two years of water quality and habitat analysis.

Management Planning Efforts

The purpose of this management plan is to encourage stakeholders involved in managing aquatic invasive species to engage in long-term monitoring of their lake as a tool for making informed decisions about management. This plan was developed using the management planning concepts presented in Michigan State University (MSU) Extension's "Citizen's Guide for the Identification, Mapping, and Management of the Common Rooted Aquatic Plants of Michigan Lakes" (MSU Extension, 2007).

This plan emphasizes aquatic plant and invasive species management but also provides summary analysis of lake characteristics, which facilitates a more comprehensive and informed knowledge base on which to determine appropriate management. This plan's scope is for 10 years, however periodic review and adaptation of the plan is recommended to maintain the relevancy of the plan.

Methods and Procedures

Of the various water quality and lake health parameters measured throughout the study period, a majority of these followed the MiCorps Cooperative Lake Monitoring Program (CLMP) protocols, which can be found on the MiCorps website, at https://micorps.net/. These CLMP monitoring parameters included chlorophyll-a, total phosphorus, transparency (secchi depth), aquatic vegetation surveys, and shoreline habitat assessments. Other parameters including dissolved oxygen, temperature, pH, conductivity, calcium, milfoil genetic testing, and eDNA testing with follow-up plankton tow sampling were also conducted but are not included as MiCorps CLMP metrics and therefore followed other standard protocols.

Lake Inventory

Shakey Lakes and the Surrounding Area

Located in Menominee County, Shakey Lakes is approximately 12 miles west of Stephenson, Michigan. The Shakey Lakes chain is composed of 7 lakes including Bass and Baker, which are located on the south side of the park, Becker, Spring, Long, East, and the central basin known as Resort. They are the result of a man-made impoundment created from a dam located on the west end of Long Lake and is fed by the Shakey River, which enters the chain on the east end of Becker Lake. Once passing the dam, the Shakey River continues west and quickly connects with the Menominee River (Figures 1 and 2).

Shakey Lakes Park is a 215 acre, 148-site campground (120 sites with electrical hook-up) that features a shower building, flush toilets, sewage dump station, baseball field, horseshoe pits, basketball hoops, shelters, playground, and concession stand. With 11,000 feet of water frontage, a beautiful swimming beach, and two quality boat launches (Resort and Baker), Shakey Lakes Park is a recreationist destination. The park also annually hosts the Menominee County Fair.

The Shakey Lakes area is included in the Escanaba River State Forest and contains the largest area of pine and oak barrens in northern Michigan. Five distinctly different savanna ecosystems are found at the site along with five state threatened or special concern species. Historians believe that native peoples purposely set fires on a regular basis to improve game habitat and blueberry crops. These fires, along with lightning strikes, apparently maintained a savanna-type landscape (MDNR, 2016).

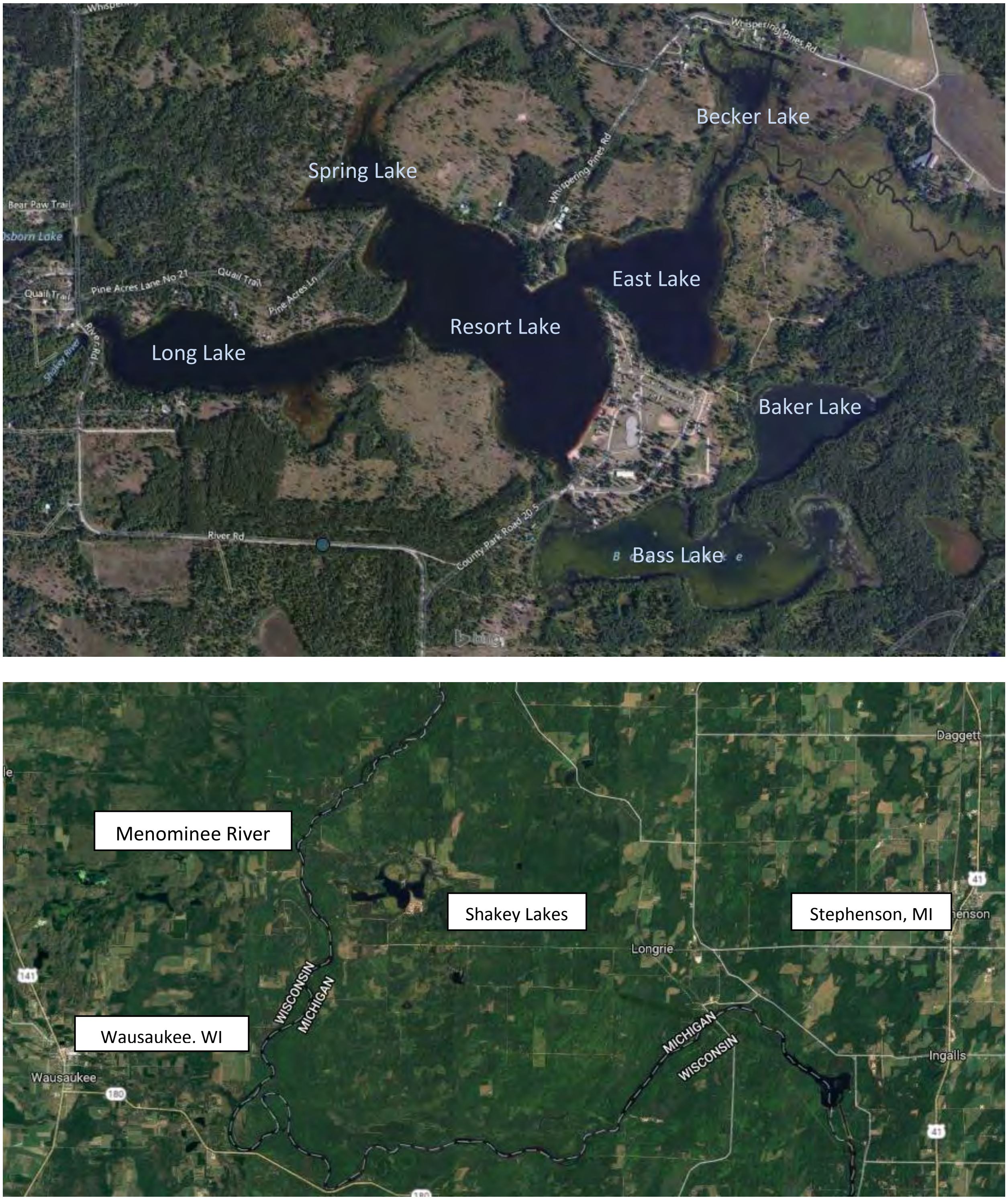


Figure 1. Satellite imagery of the various Shakey Lakes basins, and the lake's position in the surrounding area

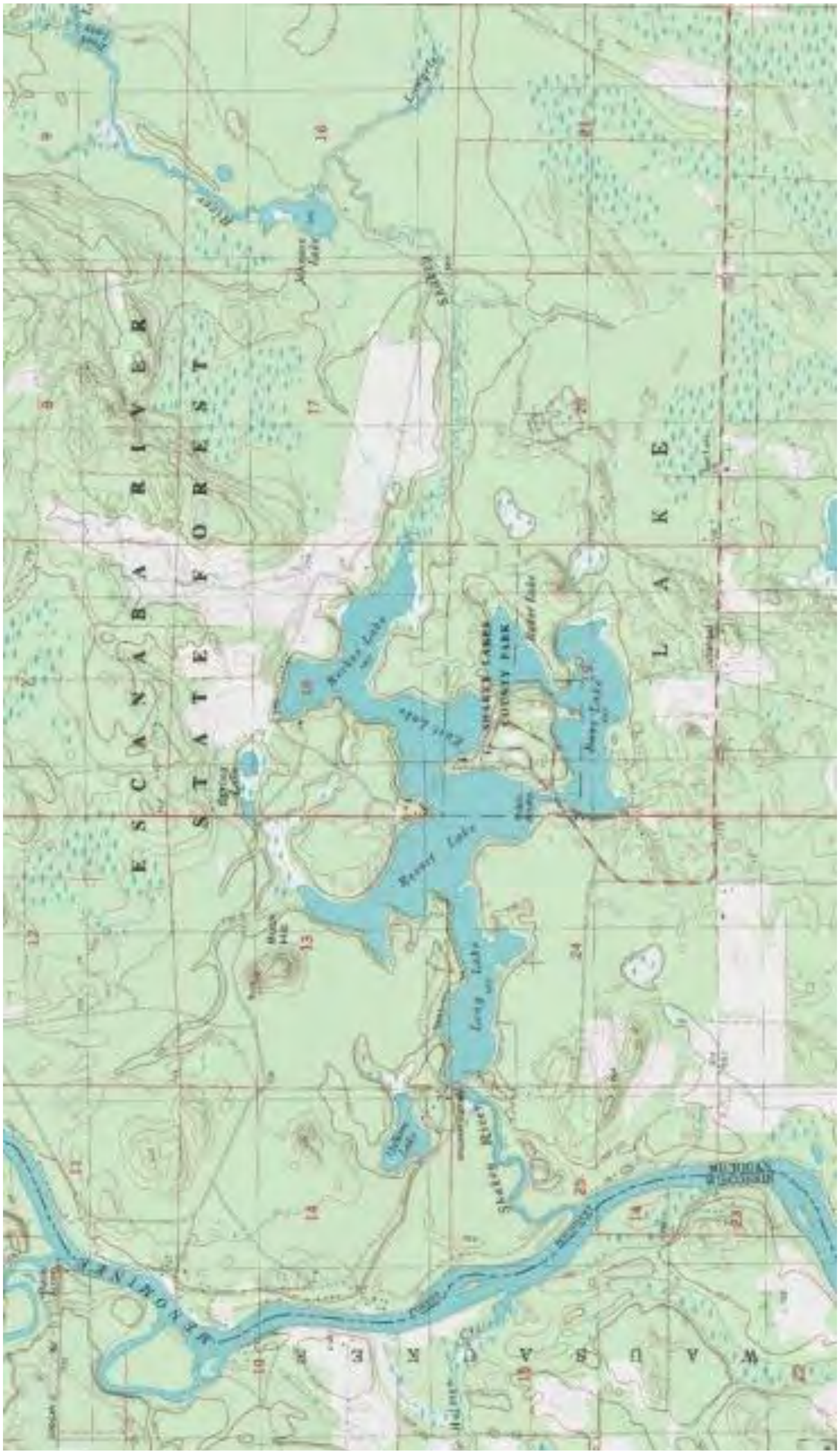


Figure 2. Topographic map of Shakey Lakes and the surrounding area

Lake Morphology

Shakey Lakes has approximately 15 miles of shoreline and 394 surface acres (MDEQ, 2016) with a maximum depth of about 40 feet. Much of the riparian shoreline remains relatively natural and development is typically found in clusters throughout the basins. The irregularity of the lake creates several shallow water areas that are heavily vegetated and maintain natural shorelines.

Lakes tend to reflect their geological origins in their morphology. For instance, many lakes in this region were formed during glaciation. One way to assess a lake's morphology is by calculating the shoreline development factor. Shoreline development is the degree of shoreline irregularity expressed as ratio. A larger ratio means the shoreline is more contoured and hence the potential for littoral community development is greater. The closer this ratio is to 1, the more circular the lake. The shoreline development factor of Shakey Lakes is calculated to be 5.39.

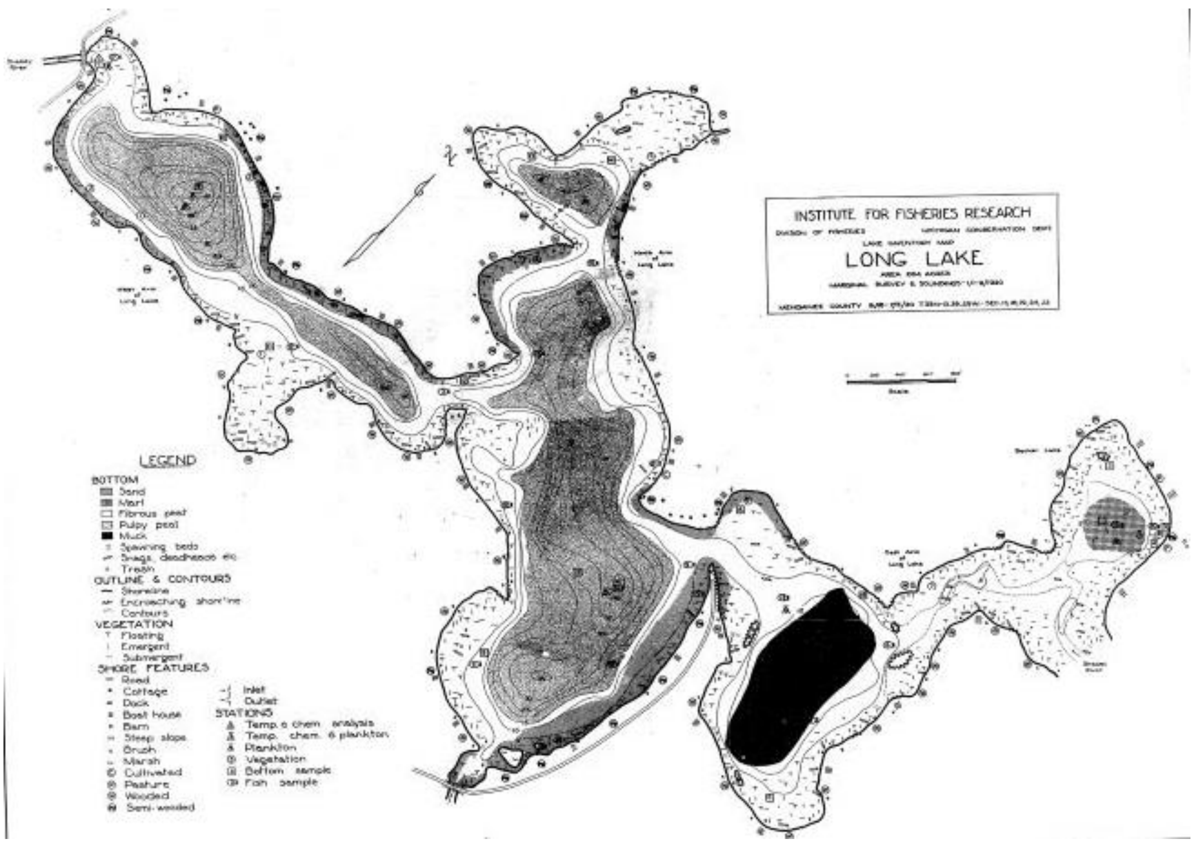


Figure 3. Bathymetric map of "Long Lake," currently known as Shakey Lakes, consisting of Long Lake to the west, Spring Lake to the north, Resort Lake is centralized in the basin, with East Lake and Becker Lake being positioned to the east where the Shakey River flows into the basin.

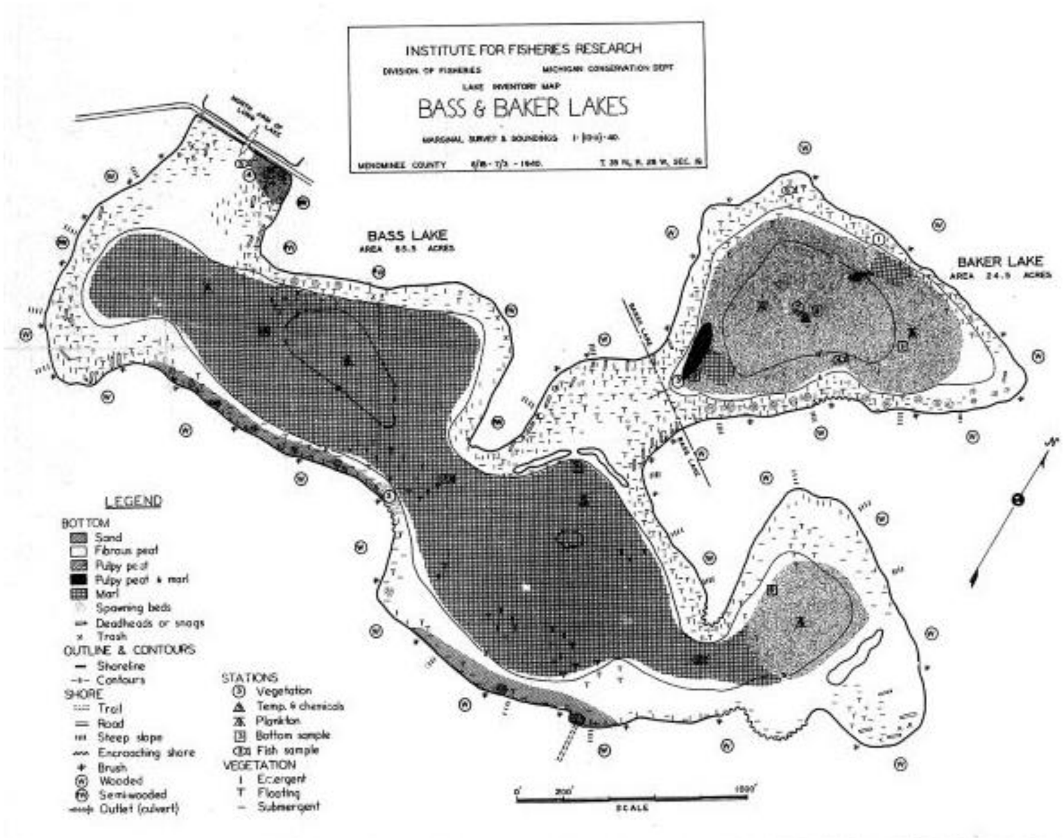


Figure 4. Bathymetric map of Bass and Baker Lakes, which lie to the south of the other five lakes in the Shakey Chain. The park lies along the northern shores of these lakes and they are generally much more shallow than the main basin.

Watershed

Shakey Lakes lies within the Menominee River Watershed (HUC 0403010809) and is part of the larger Menominee Watershed (HUC 04030108), which is approximately 4,070 square miles in size, with 2,618 square miles located in Michigan and 1,452 square miles located in Wisconsin. The Menominee Watershed extends from (Figures 5 and 6). Land use percent coverage for the two watershed areas was determined using Long Term Hydrological Impact Analysis (L-THIA) (Purdue University, 2015). From this analysis, it is clear that Wetlands and various Forest types make up much of the landscape of these watersheds, however notice that Pasture Land becomes quite prevalent in the Menominee River Sub-Watershed (Figures 7 and 8).

The importance of watershed management can be assessed by considering a lake's trophic status and size in comparison to watershed area. Lakes that have moderate fertility, like Shakey Lakes, can be somewhat susceptible to impacts from nutrient inputs. The larger the watershed, the more potential there is for sources of nutrient pollution and therefore these systems require greater attention to watershed management, with consideration for economic and practical feasibility. The watershed/lake area ratio for Shakey Lakes is 11, which puts watershed management for the Shakey Lakes area in the

"Important" category, and on the low end of the scale leaning towards "Critical" (MSU Extension, 2007). Therefore, watershed management is an important factor to consider in maintaining and managing Shakey Lakes' water quality.

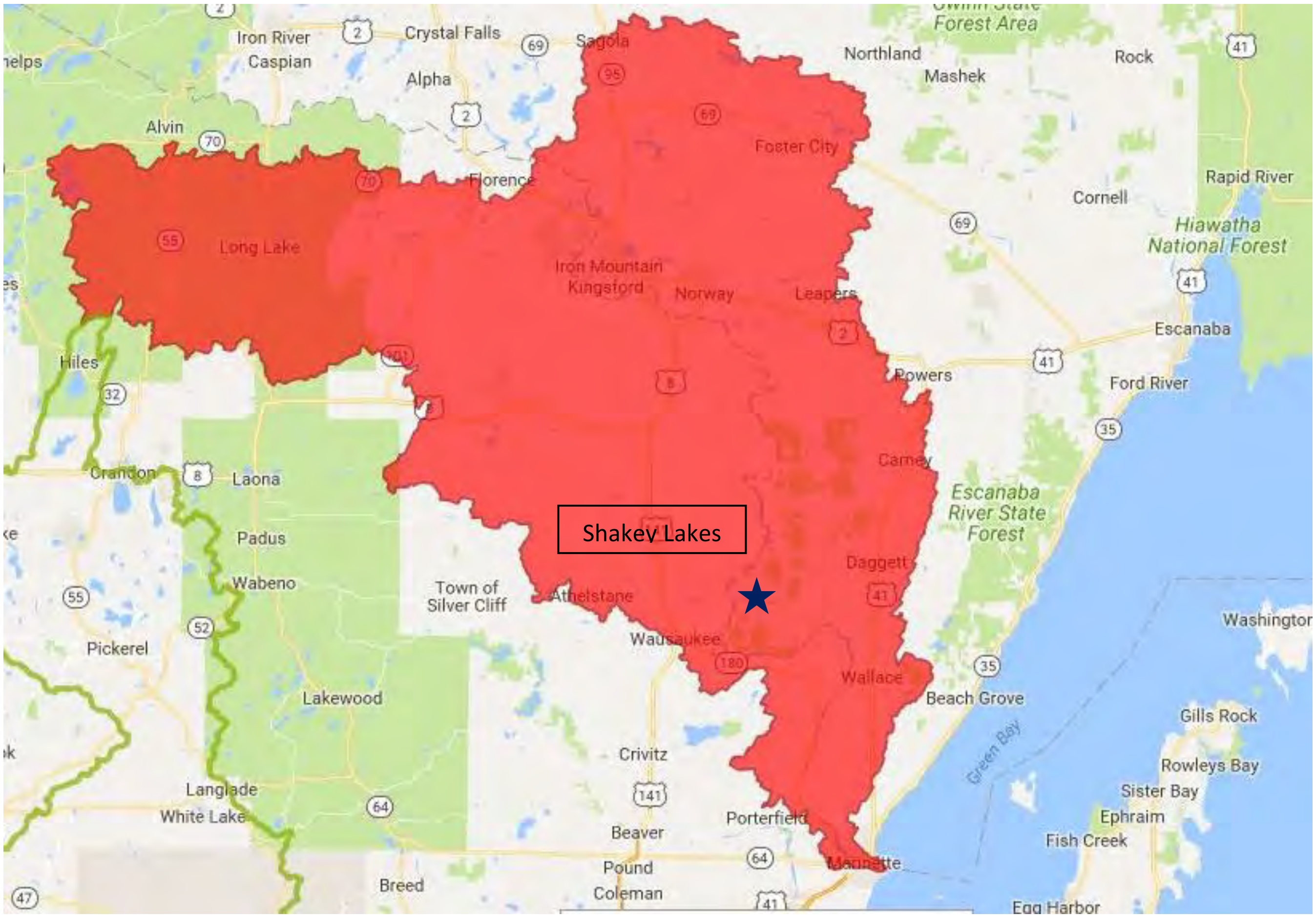


Figure 5. Delineation of Menominee Watershed (HUC 04030108).
Blue star indicates location of Shakey Lakes within the watershed.

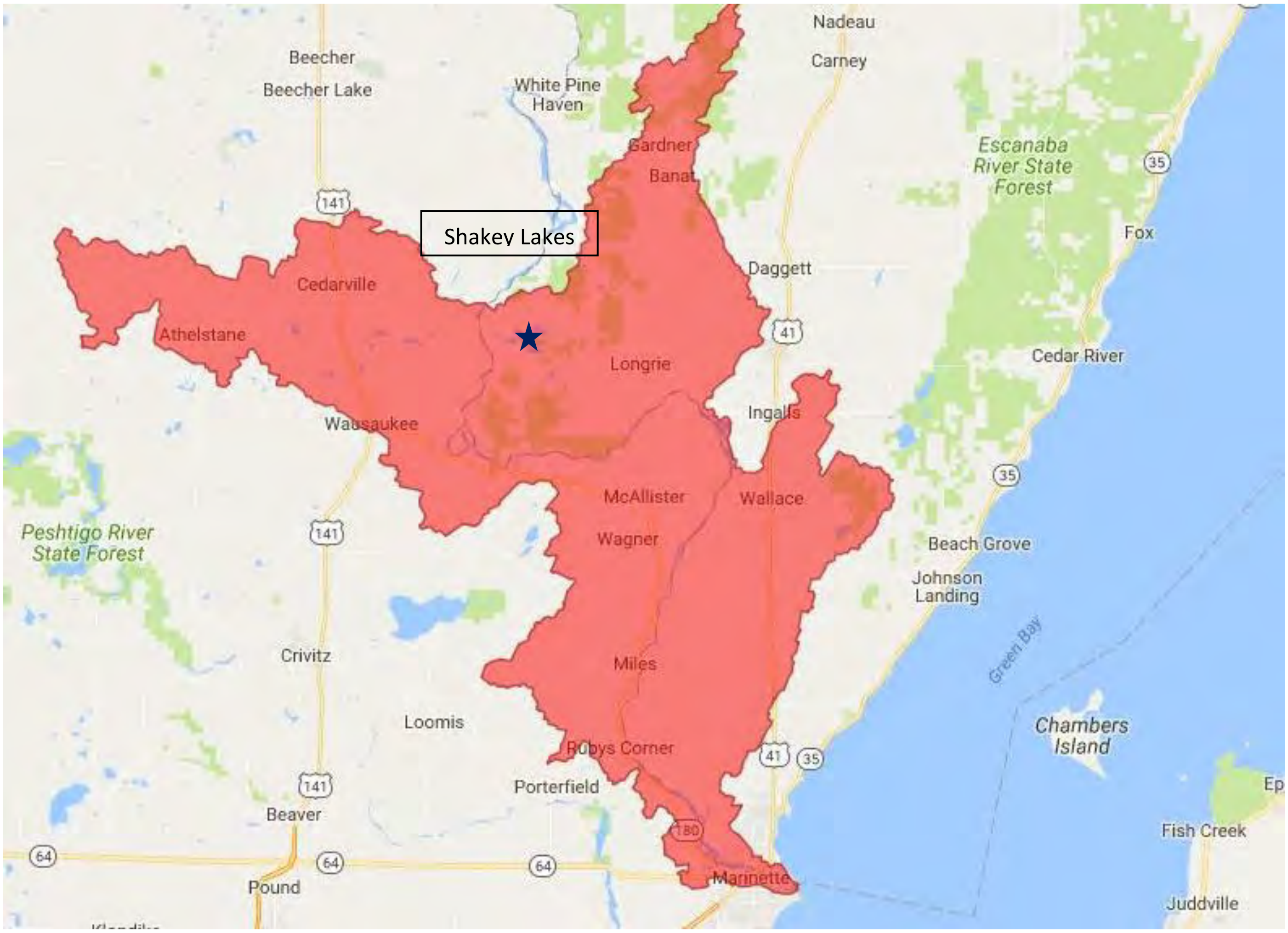


Figure 6. Delineation of Menominee River Watershed (HUC 0403010809).
Blue star indicates location of Shakey Lakes within the watershed sub-basin.

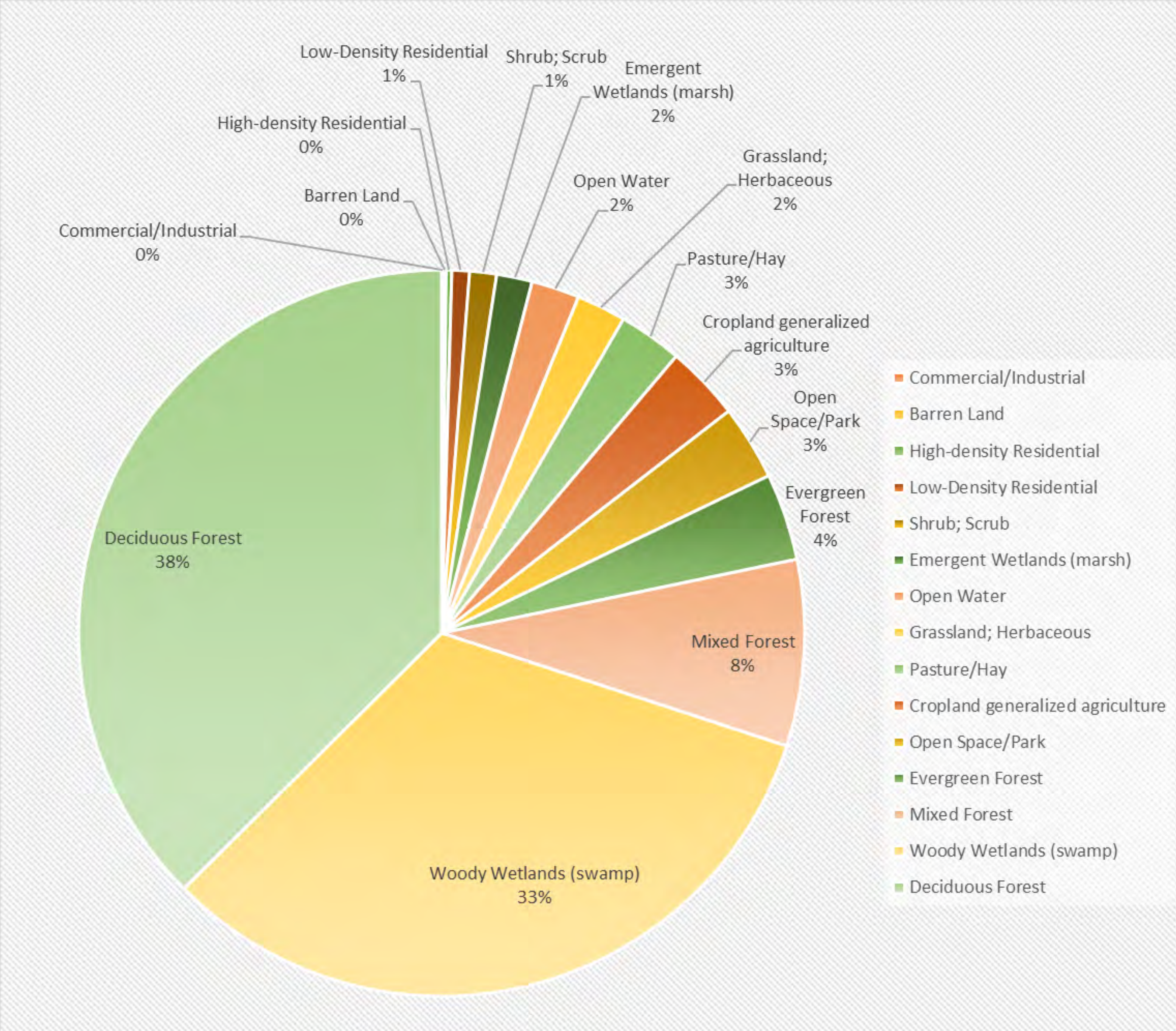


Figure 7. Land Use Percentages for HUC 04030108 Menominee Watershed

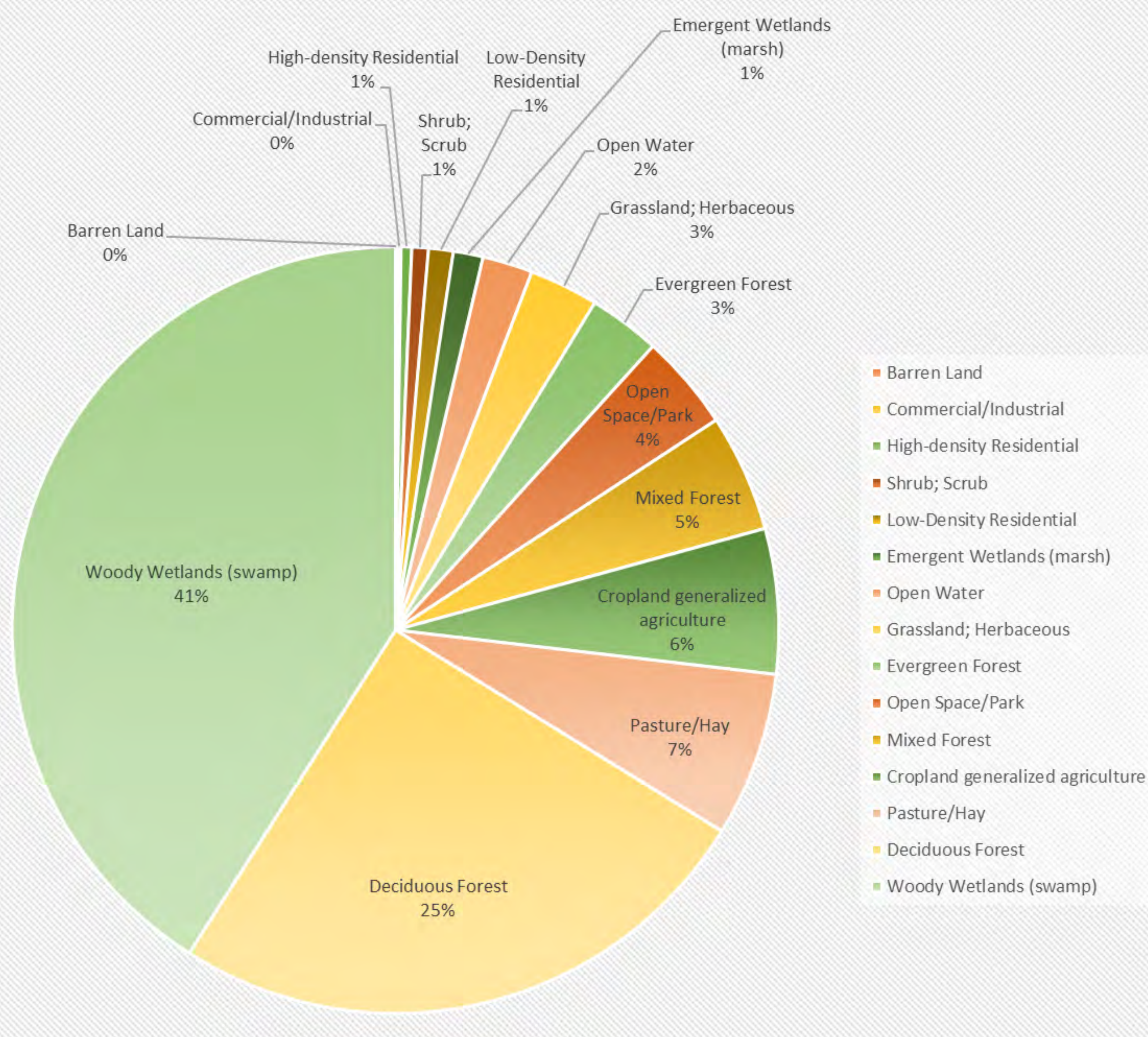


Figure 8. Land Use Percentages for HUC 0403010809 Menominee River Watershed

Water Quality

Water quality, being a measure of the condition of the physical, chemical, and biological characteristics of a waterbody, is essential to understand in order for proper and effective management to occur. There are numerous parameters (or characteristics) that can be analyzed in the assessment of water quality, several of which were addressed during this project. The testing of a single parameter is not enough to ascertain an understanding of a lake's character and several tests over the course of many years are needed. Continued monitoring of several parameters allows for the establishment of baseline data, which explains the lake's normal state. This makes it easier as monitoring continues to notice abnormalities in various parameters or deviations from established trends that may indicate and help target an issue affecting the lake.

Throughout the following sections of this document, various lake zones will be alluded to as several parameters and subsequent analyses are discussed. For reference, Figure 9 below illustrates these zones and their relative location within each waterbody. The littoral zone is the area of the lake near the shoreline and includes all depths where rooted plants are present. The extent of this region varies greatly among lakes and is largely dictated by the geomorphology of the lake basin. Beyond this is the limnetic zone, or the open water area of a lake. Here it is too deep for rooted plants to grow and there isn't much aquatic life present other than planktonic organisms. The photic zone is the depth to which light penetration through the water reaches 1% that of the surface. Photosynthesis cannot occur beyond this point and the remaining depth is known as the aphotic zone. Temperature differences also creates zonation in lakes, typically resulting in an epilimnion, thermocline, and hypolimnion. The epilimnion is the warmer surface waters that are actively mixed. The thermocline is the thin transition layer where the temperature changes drastically from the upper to lower layers of the water column. Finally, the hypolimnion is the deeper, cold waters that are relatively stagnant. Note that these temperature gradients are typical of deep, stratified lakes but are not present in shallow, mixed lakes.

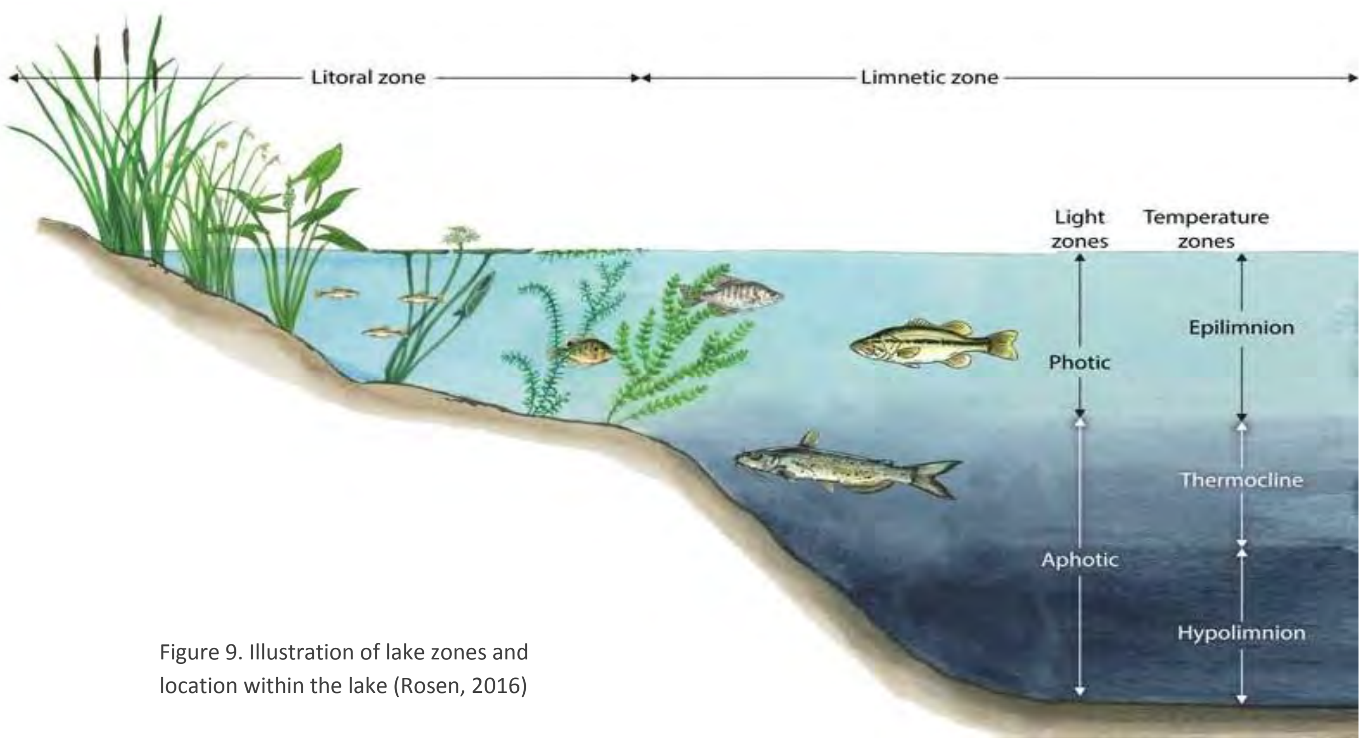


Figure 9. Illustration of lake zones and location within the lake (Rosen, 2016)

Trophic Status

Several water quality parameters are interconnected and changes to one often leads to or is caused by changes in another. Sub-sets of parameters can also be used to generally assess specific characteristics of a lake, one of those being trophic status, or the measure and classification of a lake in regard to productivity and fertility. Parameters such as transparency, total phosphorus, and chlorophyll-a concentrations are often used to determine this classification, all of which were included in this study.

Figure 10. Secchi disk in stained water. (Peterson, 2015)

Transparency, or water clarity, is often considered a basic water quality test, mostly because it is a simple test, but is one of the most important water quality measures and an easy, cost effective way to gain insight into the character of a waterbody. An 8 inch disk, painted black and white and attached to a long rope or tape measure, is used to measure transparency. This device is called a secchi disk. The secchi disk is lowered into the water just until it disappears from sight. A measurement of depth is taken at this point, then the disk is raised until it is visible again and another depth measurement is taken. The average of these depth measurements is what is recorded. This depth of transparency is influenced by a number of factors including the amount of sediment or other particles suspended in the water column or the presence and abundance of algae, both of which can cloud the water and decrease its clarity.

Phosphorus is a limiting nutrient in lentic ecosystems (still, fresh water) and is mainly responsible for the abundance of algae, the productivity of aquatic plant communities, and increases the rate of eutrophication. While phosphorus is naturally occurring, there are several human activities that can introduce phosphorus to a lake or to the watershed, such as fertilizers, manure, or organic wastes from industrial effluents. Phosphorus is a threat to lakes regardless of where it is introduced within the watershed. Since phosphorus tends to attach to soil particles and therefore can be introduce to surface water in runoff, both urban and agricultural. Studies conducted by the USGS have also shown that phosphorus can migrate through groundwater flows which poses a threat to surface water impairment as groundwater often discharges to surface waters (Perlman, 2016). Phosphorus was collected twice each year during this project: at ice-out and during late summer. This sampling schedule allows us to see the amounts of phosphorus available right at the beginning of the growing season (as soon as ice leaves the lake) and at the end of the growing (late August) when most plants and algae have started to senesce.

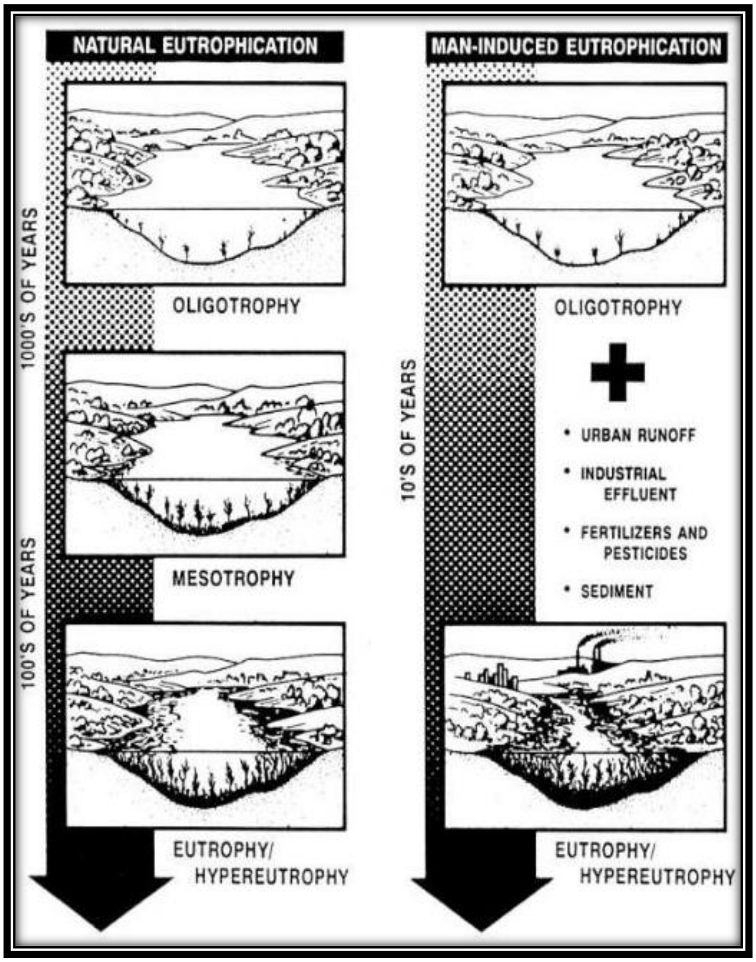
Chlorophyll-α is another parameter that, along with transparency and phosphorus, can be used to determine a lake's tropic status. Chlorophylla-α measures the concentration of green pigment, or chlorophyll which is what facilitates photosynthesis, and provides a measurement of algal biomass. Samples for chlorophyll-α are collected throughout the growing season since the amount of algae changes over the course of the summer.

With the assessment of these three parameters, a lake's trophic status can be determined. Lakes are divided into three categories: oligotrophic, mesotrophic, and eutrophic (Figure 11).

Figure 11. Lake Trophic Status Classification (Taken from A Citizen's Guide for the Identification, Mapping, and Management of the Common Rooted Aquatic Plants of Michigan Lakes, MSU Extension, 2007)

Oligotrophic	The lake is typically deep with a sandy bottom. The water is clear because of low algal populations. Aquatic plants are few and limited to protected bays and inlet areas where incoming nutrients and sediments allow some growth. The deep water maintains dissolved oxygen during the summer months. Trout and other cold-water fish species are present. **Measures :** 1. Summer Secchi disk average is greater than 15 feet. 2. Summer surface total phosphorus values are less than 10 ug/l. 3. Summer chlorophyll a values are less than 2.2 ug/l.
Mesotrophic	The lake is usually of good quality, but bays tend to have mucky bottoms. Aquatic plants are common on protected shores but less prevalent on wave-washed shores. The water is less clear and an occasional algal bloom will occur. The water below 30 feet loses oxygen during the summer, and cold-water fish species are rare. **Measures:** 1. Summer Secchi disk average is between 7.5 and 15 feet. 2. Summer surface total phosphorus values are between 10 and 20 ug/l. 3. Summer chlorophyll a values are between 2.2 and 6 ug/l.
Eutrophic	The lake is generally shallow, and the water is usually turbid and colored. Aquatic plants are usually abundant in shallow water. Water below 30 feet is often devoid of oxygen, and the lake supports warm-water fish such as bass, bluegill and pike. **Measures:** 1. Summer Secchi disk average is below 7.5 feet. Water clarity may be higher if rooted plants are very abundant. 2. Summer surface total phosphorus values are over 20 ug/l. 3. Summer chlorophyll a values are over 6 ug/l. (Chlorophyll a values may be less than 6 ug/l if rooted plants are very abundant.)

As they age, lakes tend to naturally become more productive. Over thousands of years, organic matter and nutrients can accumulate in oligotrophic lakes and increase the productivity of these water bodies until eventually they become eutrophic. Development along the shoreline and within the watershed can accelerate this process (Figures 12 and 13). Due to this, it is important to maintain water quality monitoring and trophic status assessment over the long term. This dataset allows changes to be detected but also allows management to be framed in a practical manner to create realistic goals.



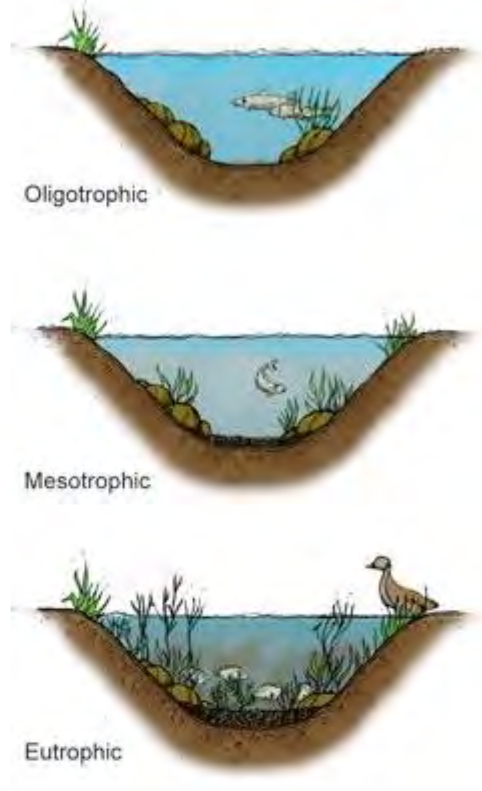


Figure 12 (left). Natural eutrophication vs. Man-induced eutrophication. Note the time scale change. (*Coastal Environmental/PBS&J, Inc., 1998)*

Figure 13 (right). Visual of the three trophic classifications. (Houghton Lake Improvement Board, 2016)

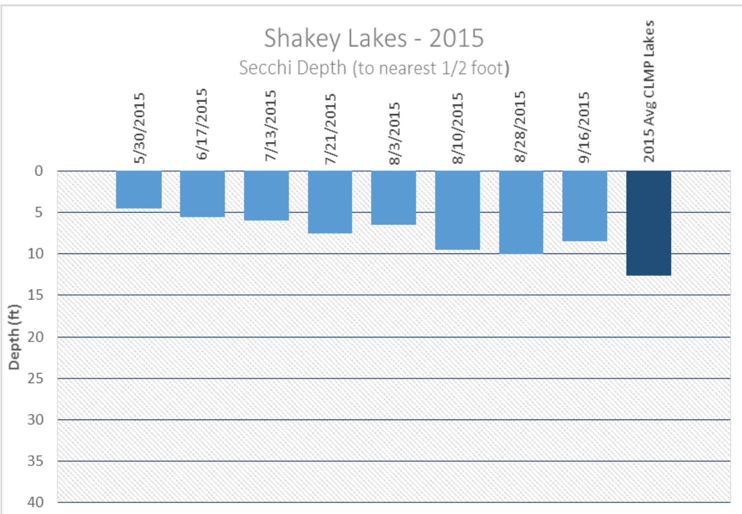
Based on the recent water quality sampling, Shakey Lakes is considered a mesotrophic lake, with a TSI (trophic status index) score of 41 in 2015. This result is based on a very limited data set; therefore, this classification can only be so accurate. Many monitoring programs require several years of data or a certain number of samples per year. For instance CLMP recommends at least eight secchi depth readings each year and recommend eight years of monitoring to develop accurate trends, and the longer a system is monitored, the stronger and more accurate the data will become, especially when used in analyses such as this. Also, note that at the time of this plan's development, the 2016 water quality data was not yet available. However, this should be updated once the results are posted. This is an example of the adaptive and integrated format of this management plan.

Table 1. Trophic status data, including transparency (secchi depth), cholorophyll-α, and total phosphorus, for Shakey Lakes.

	Secchi Depth (ft)			**Chlorophyll-α (µ/L)**			**Spring Total Phosphorus (µ/L)**	**Summer Total Phosphorus (µ/L)**
Sample Year	*Min.*	*Max.*	*Avg.*	*Min.*	*Max.*	*Median*	*Avg.*	*Avg.*
1977-1982	7.0	16.0	12.4					
2015	4.5	10.0	7.3	<1.0	2.5	1.3	*	14.0
2016	7.5	10.5	9.0	**	**	**	**	**

*Spring Phosphorus was not sampled in 2015

**CLMP results for 2016 testing are not yet available



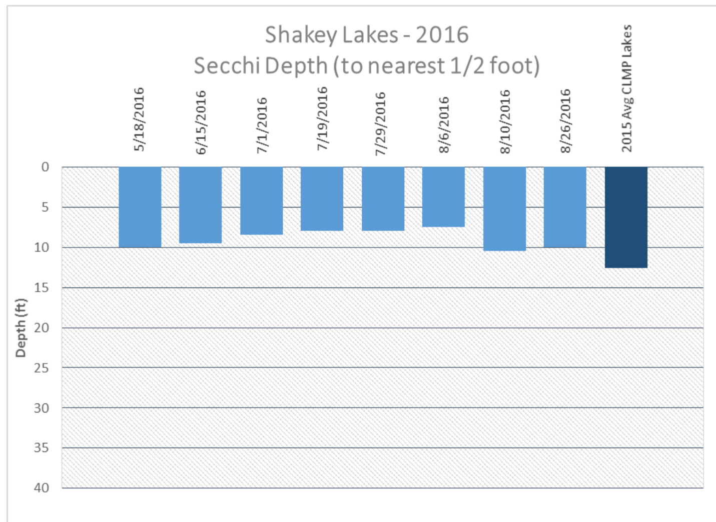


Figure 14. Secchi depth measurements from Shakey Lakes, 2015 and 2016, as compared to average secchi depth for all CLMP lakes in 2015 (2016 average not available at the time of this report's development).

Temperature and Dissolved Oxygen

Oxygen is of fundamental importance in a lake for aerobic aquatic life to exist. Dissolved oxygen is supplied to the waterbody through interactions with the atmosphere and as aquatic plants produce it, which is consumptively balanced by the respiration of biota and non-biotic chemical reactions. The solubility of oxygen in water is affected by temperature so essentially, as water temperature decreases, the solubility of oxygen increases and allows for more oxygen to be dissolved in the water. This relationship and its effects are important factors both in water quality and creating suitable habitat for aquatic organisms, especially fish and invertebrates. Many of these species are adapted to specific ranges of temperature and oxygen, growing stressed or even dying out if these ranges shift too drastically (Figure 15). In many cases, the presence of more sensitive species can be a helpful tool in assessing the quality of a waterbody (Wetzel, 2001).

Based on the Lathrop/Lillie Equation (1980), used to predict lake stratification types, Shakey Lakes is determined to be a deep, stratified lake. Lake stratification is the thermal separation of warmer surface waters from deeper cooler waters and typically occurs in deeper lakes. Shallower lakes are more easily warmed by the sun or can be mixed by wind energy, creating similar levels of oxygen and temperature throughout the water column. Stratified lakes also have the potential for anoxic conditions (without oxygen) at the bottom of the water column, which can lead to nutrient release or chemical reactions within the substrate. The dissolved oxygen and temperature profiles recorded in 2015 and 2016 support the Lathrop/Lillie prediction and are presented in the graphs below (Figures 16-22). There is a distinct depth point where both temperature and oxygen begin to decrease rapidly. This is known as the thermocline and is only present in stratified lakes. Stratified lakes tend to do so in the summer and reverse stratify in the winter (warmer in deeper waters), with mixing of the temperature layers, or turnover, occurring in the spring and fall (Figure 23).

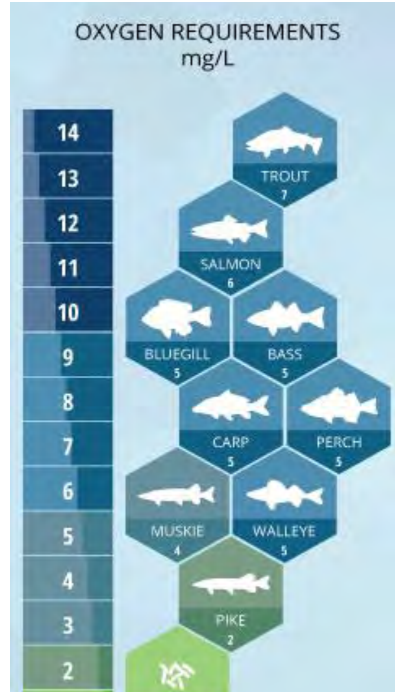
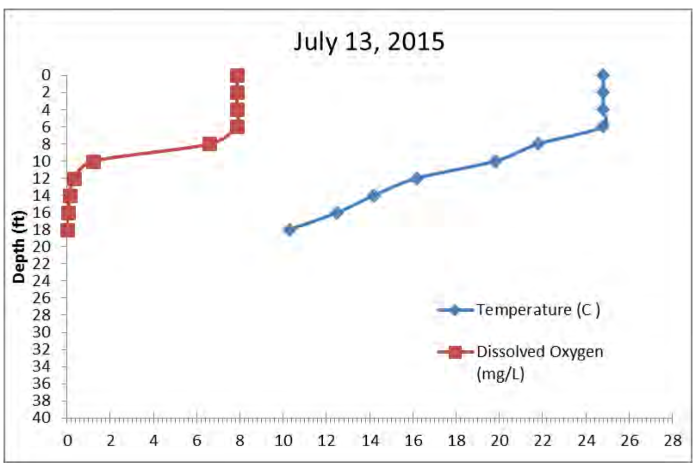
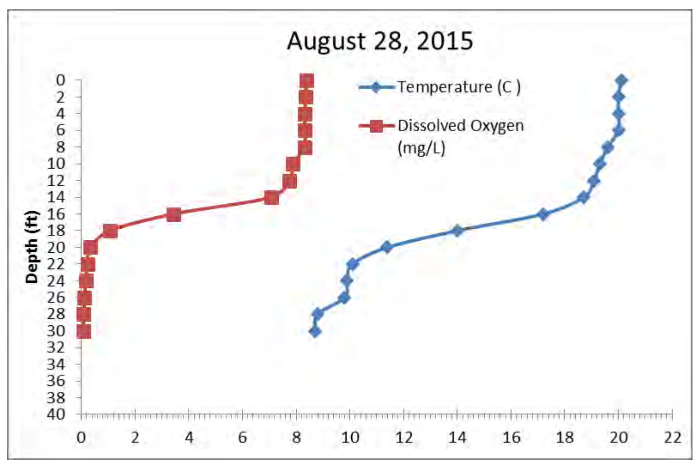
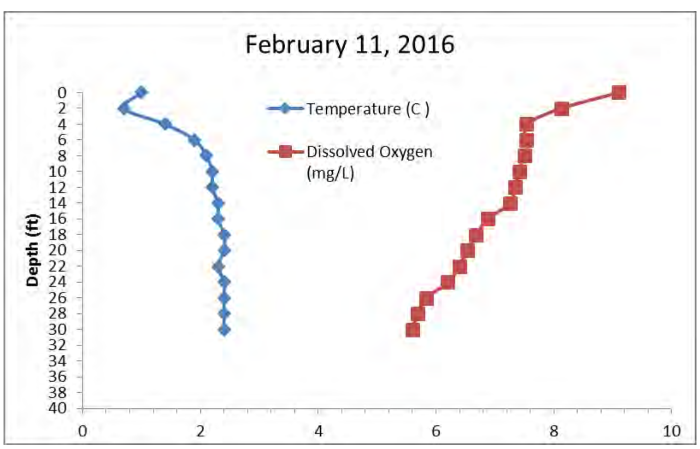
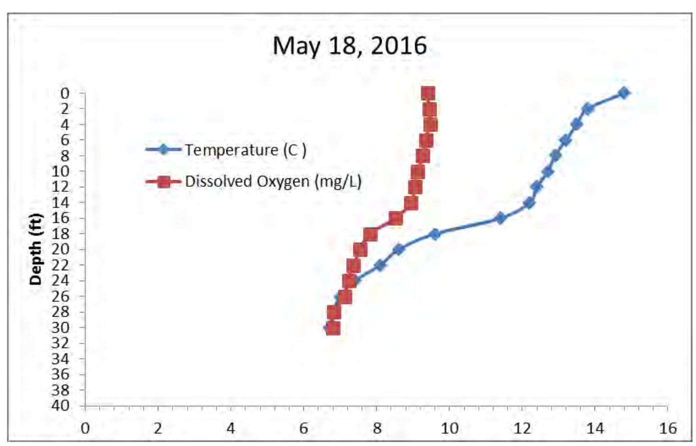


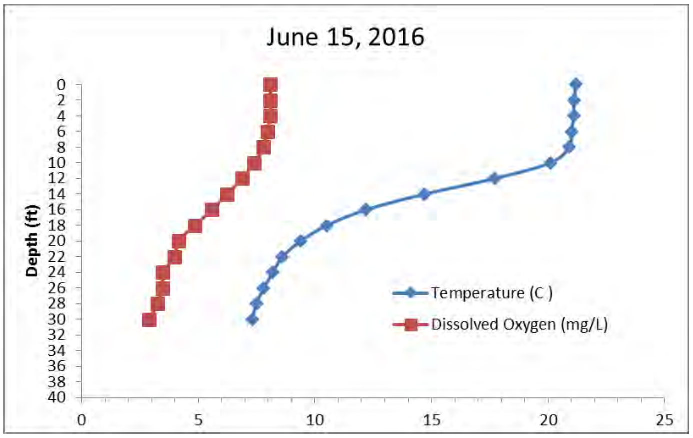
Figure 15. Freshwater fish oxygen requirements (Fondriest Environmental, Inc., 2013)

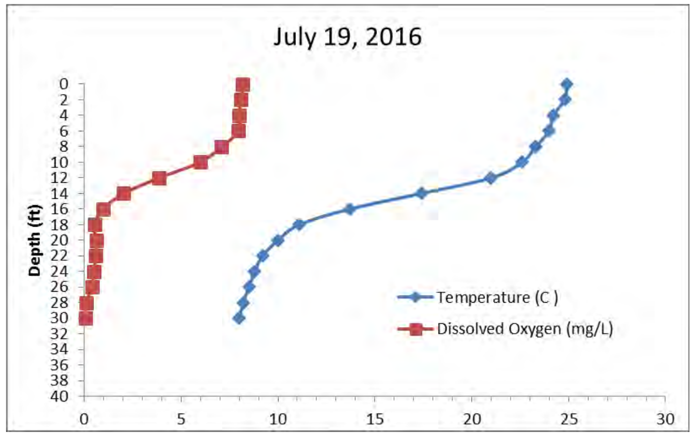


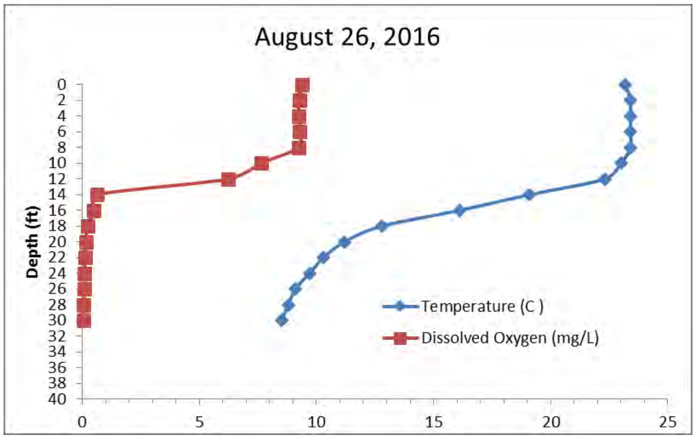












Figures 16-22. Dissolved oxygen and temperature profiles recorded for Shakey Lakes during 2015 and 2016 by WRISC staff.

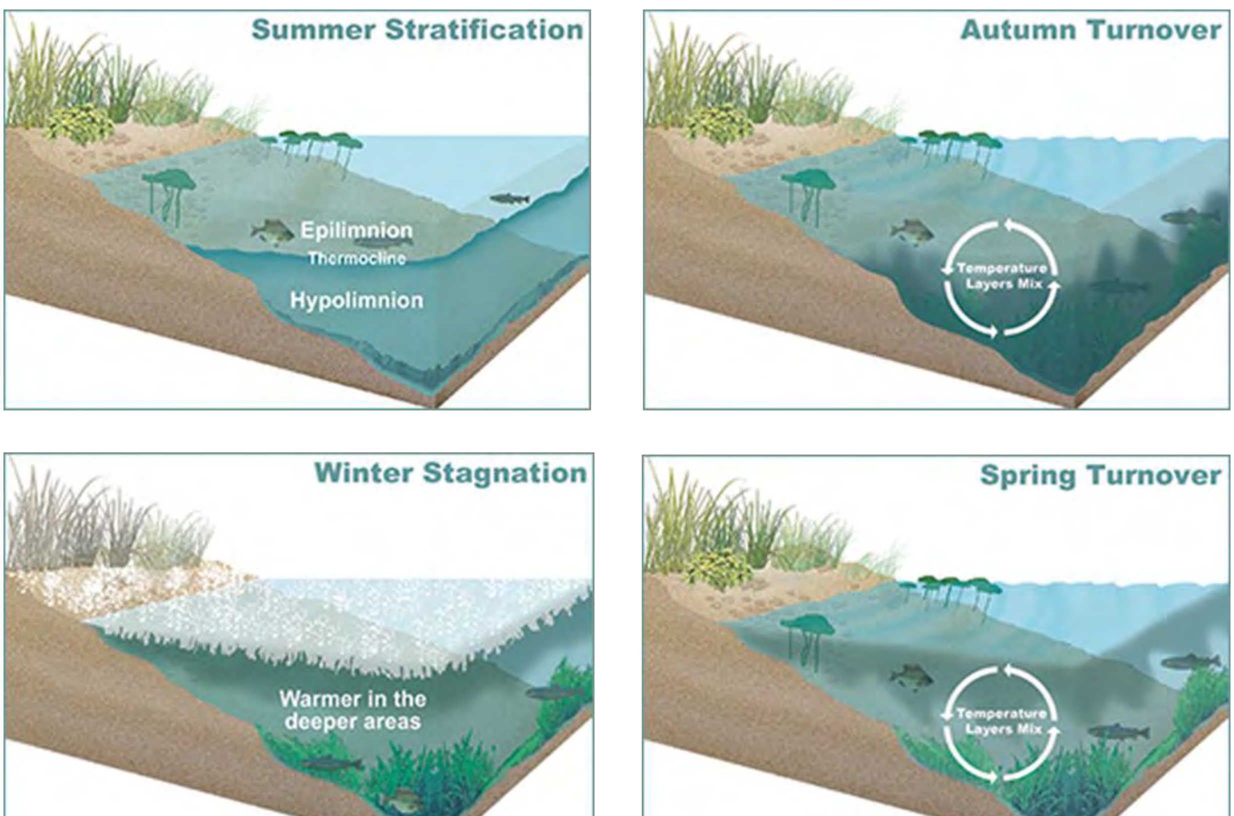


Figure 23. Seasonal changes in lake temperature: stratification and turnover (Vertex Water Features, 2016).

Lake Acidity - pH

Lake acidity is assessed by measuring pH, or the concentration of hydrogen (H+) ions. pH is measured on a scale of 0 to 14, with 7 being neutral. Values above 7 are considered alkaline, or basic, while those below 7 are acidic. In this region, lakes can range in pH from 4.5 in acid bog lakes to 8.4 in hard water, marl lakes (Shaw et al, 2004). pH is an important factor of a lake's carbonate cycle and affects many of the basic biological processes. A lake's ability to buffer acid rain or to regulate the solubility of many toxic compounds is driven by natural variation in chemical reactions involved in a lake's carbonate system. While somewhat lower pH levels do not usually harm fish, the metals such as aluminum, zinc, or mercury that can become soluble under these conditions can be problematic. For instance, mercury levels can be elevated in fish in acidic lakes. While this is not typically harmful to the fish, it can pose health impacts to loons, eagles or osprey, and humans that consume these fish.

Water pH	Effects
6.5	Walleye spawning inhibited
5.8	Lake trout spawning inhibited
5.5	Smallmouth bass disappear
5.2	Walleye, burbot, lake trout disappear
5.0	Spawning inhibited in many fish
4.7	Northern pike, white sucker, brown bullhead, pumpkinseed, sunfish and rock bass disappear
4.5	Perch spawning inhibited
3.5	Perch disappear
3.0	Toxic to all fish

Figure 24. Effects of acidity on fish (Shaw et al, 2004)

Shakey Lakes had an average pH value of 8.4 over the course of the project. While this is above neutral, it is within the range of lake pH for natural lakes in this region and the alkaline environment is good for fish and plant life. (Holdren, 2001).

Conductivity

Conductivity is the measure of water's capability to pass, or conduct, an electrical current. This ability is directly related to the concentration of dissolved inorganic chemicals in the water. Regular conductivity monitoring can be a useful water quality parameter, being utilized as an early indicator of change in a system. Geology plays are large role in a lake's natural conductivity, which can be a wide range, seeing as clay soils will contribute to conductivity, while granite bedrock will not. However, most water bodies tend to maintain a constant natural conductivity baseline. Due to this, a sudden increase or decrease in conductivity can be indicative of pollution. For instance, agricultural runoff or a sewage leak will increase conductivity due to the additional chloride, phosphate and nitrate ions. An oil spill or addition of other organic compounds would decrease conductivity as these elements do not break down into ions (Fondriest Environmental, Inc., 2013). Both cases can be quite detrimental to water quality. The conductivity of Shakey Lakes is 325 µS/cm on average and remained quite consistent for the duration of project monitoring efforts.

Aquatic Plant Community

Aquatic plants are typically the subject of scrutiny when it comes to lake management, as many lake users consider aquatic plants a nuisance. However, aquatic plants play an extensive and important role in lake ecosystems. Aquatic plant communities benefit lakes by providing habitat and food sources for fish, mammals, birds, insects, and amphibians. These plants also stabilize sediments, prevent erosion of the shoreline, filter water, and provide oxygen for the entire lake community. While aquatic plants benefit the entire lake, they are limited to the littoral zone, or the area of the lake where sunlight reaches the bottom (refer to Figure 9). Most aquatic life exists in this productive zone. However, light is not the only factor that influences the distribution of plant communities. Wave action, water temperature, sediment type, and availability of nutrients also affect the distribution and abundance of these populations, as well as the types of plant species that may be present.

Aquatic Plant Groups

Submersed Plants

Submersed plants are those that grow beneath the surface of the water. This is a diverse group of plants and can be found in every depth of the littoral zone. These plants vary greatly in appearance but such variation creates much of the structure in the littoral zone. Many submersed plants have thin, finely divided leaves which increases the surface area of the plant, allowing them to survive in areas with lower light levels. Examples of these plants are Milfoils (*Myriophyllum spp*.) and Bladderworts (*Utricularia spp*.). Others have oval or lanceolate shaped leaves that can vary in size from ½ inch to 8 inches long. Some plants have long ribbon-like leaves that flow with currents, such as Wild Celery (*Vallisneria americana*). Many of these species create important habitat for aquatic invertebrates and juvenile fish, as well as spawning areas, and are vital food sources for waterfowl, like *Potamogeton* species. However, some species can reach nuisance levels under certain conditions.

Emergent Plants

Emergent plants, such as reeds, rushes, and cattails, are those plants that extend out of the water. They are typically found along the shallow edges of the lake and are tolerable of water level fluctuations. This group of plants is important in limiting erosion of shorelines as their roots stabilize sediments and they reduce the impact of wave action. While these species are quite beneficial to lake ecosystems, they can be considered a nuisance in swimming and beach areas or if recreational access is impeded.

Figure 25. Emergent and floating-leaf plants, such as cattails and water lilies. Hanbury Lake, Norway, MI (Peterson, 2015)

Floating Leaf Plants

As their name suggests, the leaves of these plants float on the surface of the water, however they are still rooted in the substrate. This group of plants tends to occupy deeper water, replacing emergent plants that have reached their depth limits. These plants are good at diminishing wave action but can be a recreational nuisance if extensive, present in shallow water areas, or near waterbody access. If populations are dense, floating leaf plants can also shade out submersed plants growing beneath them. Examples include Yellow or White Water Lilies (*Nuphar spp., Nymphaea odorata*) and Watershield (*Brasenia schreberi*).

Free-floating Plants

Free-floating plants are just that. They are unrooted and simply exist in the lake. These species, known as Duckweeds, are typically quite small (less than ½ inch), but this allows them to reproduce quickly. The duckweed Watermeal (*Wolffia spp*.) is the world's smallest flowering plant! Species in this group are typically found growing in quiet waters, such as protected bays, and are transported easily by currents. Duckweeds are an important food source for waterfowl and don't typically reach nuisance levels. They may shade out other plants or be an annoyance in dense populations, however control is difficult and results are highly variable.

Invasive Plants

An invasive species is a non-native species that is introduced to a new habitat where it does not belong and causes harm, both ecologically and economically. Invasive aquatic plants can fall under any of the plant groups discussed above and ultimately disrupt the ecosystem balance through excessive growth that out-competes native species, reduces diversity, and limits recreational and navigational use of the infested waterbody. Invasive aquatic plants are typically the focus of management and control efforts due to their detrimental impacts.

Figure 26 (left): Invasive milfoil flowers break the surface mid- to late summer.
Figure 27 (right): Purple loosestrife is a common wetland or shoreline invasive.

Aquatic Plant Management

Aquatic plant management can vary in its goals but typically revolves around nuisance plants or those that interfere with the use of a waterbody, which is especially true of invasive plants. Most often aquatic plant management aims to reduce the density or abundance of a plant to improve swimming beaches or boat access. However, management could also be aimed at increasing the presence of some plants to improve habitat and benefit the fishery. This section describes some of the various management options available and commonly utilized for aquatic plant management in lakes. These options all have benefits and drawbacks and may work better in certain situations and not others. It is important to note that not all of these options may be suitable for Shakey Lakes. Appendix A provides a table highlighting the advantages and disadvantages of each management strategy.

It is also important to implement an integrated management approach, which utilizes several options or strategies to maximize resources and treatment or management effectiveness. The Michigan Lakes and Streams Association (Davidson, 2015) details an integrated pest management to include the following components:

- Correctly identifying the invasive or nuisance plant(s)
- Identifying vegetation preferred to achieve fish and wildlife habitat goals
- Establishing tolerable levels of any single plant species, including target nuisance plant(s)
- Making decisions based on site-specific information
- Using ecosystem, watershed, and cost-benefit perspectives to determine long-term management strategies
- Developing an on-going system of integrated control methods that include mechanical, cultural, biological, and chemical treatments as needed
- Educating local managers and the public about the importance of protecting water resources from invasive weeds to maintain healthy water quality and fish and wildlife habitat
- Assessing results of invasives weed control programs (including quantitative documentation of results of all control strategies) and re-evaluating management options

Keep in mind that there is no one solution for treating invasive plants or managing a lake. These options continue to improve and develop and management efforts must follow suit. When planning for and conducting management for invasive species, it is important to remember that eradication is seldom achievable and is typically an unrealistic management goal.

Shoreline Protection and Restoration

A natural defense can be the best offense. Protecting native vegetation along shorelines by minimizing disturbance or development, increases the ecosystem's resilience and stability and can actually help prevent infestation by invasive species. Invasive species see disturbance as opportunity, both on land and in the water. When a shoreline is developed or the naturally occurring vegetation is removed the entire lake ecosystem becomes disturbed. As discussed earlier, shoreline vegetation stabilizes sediments and combats erosion. Without this effect, erosion could increase leading to excessive sediments and nutrients entering the lake. This impacts water clarity as sediments cloud the water and nutrients fuel excessive plant and algae growth. Removing shoreline vegetation could diminish the diversity of the ecosystem as well. Many animals such as birds and amphibians live in natural shoreline habitats and without this habitat these species would systematically be removed from the ecosystem.

These negative ecological impacts are typically caused by several practices, including:

- mowing lawns to the water's edge
- excessive fertilization of lawns
- removing woody debris (habitat for insects and fish)
- raking out rooted aquatic vegetation
- installing rip-rap or seawalls

Shoreline protection can be as simple as not fertilizing the lawn or not mowing right to the water, leaving what's called a "buffer" of vegetation, preventing erosion and filtering run-off. Restoration of an impaired shoreline could include the installation of native vegetation buffers or other erosion control structures that still provide habitat for animals and other aquatic organisms.

Figure 28. Left, traditional lake front landscape. Middle, residential lake front landscape with natural or restored buffer zones. Right, residential lake front landscape with manicured landscape with buffer zones. (Bricault, 2011)

Figure 29. Example of shoreline buffer created with native vegetation, compared to a shoreline that lacks a buffer zone. (Bricault, 2011)

Physical Control

Physical control includes a variety of options. Practices such as dredging, installation of benthic barriers, or even water level drawdowns fall under this management category.

Benthic barriers are designed to lay on the bottom of a lake in a localized area and suppress plant growth by blocking sunlight. These barriers can be made of different materials, such as burlap, plastics, perforated Mylar, or other synthetic materials. To be effective, a barrier must be durable, heavier than the water, reduce light penetration to prevent plants from growing, relatively easy to install and maintain. The mats should also be porous enough to limit the "ballooning" effect of gases from decomposition which will collect under the mat. Nearly any material placed as a benthic barrier will experience this "ballooning" effect, so anchors or weights are important to install to prevent hazards if the mat were to dislodge.

Dredging is the physically removal of sediment from the bottom of the lake. While this method would remove plants and seeds from the soils, it is costly and has high environmental impact, so is rarely used for aquatic plant control. Typically this is done to clear sedimentation or high levels of muck from certain lake areas.

Drawdowns involve substantially lowering the water level of a lake or pond in order to dewater vegetated areas and effectively expose target plants to desiccation. In the northern region, drawdowns are started in the fall and water levels remain low until the following spring. This exposes vegetation to both desiccation and freezing which more effectively kills the plants or damages the seed bank. However, a water level control structure such as a weir or dam is necessary to lower the water levels. This method is also non-selective of plant species and some species may even benefit from this process, exhibiting increased or excessive growth following this process. Drawdowns can also impact adjacent wetlands, drinking water, and other organisms in the lake.

Mechanical Control

Mechanical control methods involve the use of tools or equipment to remove nuisance plants and are quite varied. Several methods typically involve cutting up aquatic plants using the equipment. Some techniques involve the collection of plant material during this process, therefore it is sometimes referred to as mechanical harvesting. However, not all methods collect the plant material and sometimes leave it in the lake for disposal, usually after shredding or grinding. Methods such as rotovating do not focus on cutting plant material but rather on impacting substrates, in this case with a long-armed cultivator and preventing the establishment of rooted vegetation in these areas. Weed rolling is also used to compact sediments to prevent plant growth as well.

Figure 30. Example of mechanical weed harvester (www.inlandlakeharvester.com, 2016)

Many of these methods are non-selective and large scale. They can impact other aspects of the system as well, such as native vegetation when mowing is use or benthic (bottom of the lake) communities in methods that impact the substrate.

Also included in this category are hand cutting/pulling and diver assisted suction harvesting, or DASH. Hand pulling involves removing the entire plant, including roots, by hand. This method is low impact, selective of native species, and if done carefully can be useful to control small, localized infestations. Similarly, hand cutting is done on small populations of target plants but is more likely to cause fragmentation of plant parts as compared to skillful hand-pulling. For deeper waters or somewhat larger infestations of nuisance plants, DASH may be utilized. In this method a diver uses their hands to remove the plant and the root but instead of having to resurface to dispose of the plants, plant material is fed into a vacuum hose and transported to a boat on the surface. At the surface, plants are collected in bins or bags which allow water to filter out but retains all of the plant material, reducing fragmentation and risk of spread. However this method is still time consuming and demanding for the diver, so is best used with small or pioneering populations in moderate depths.

Figure 31. Diver uses suction harvesting to remove invasive milfoil in Marinette Co. (Hennelly, S., WI Land and Water, 2016)

Biological Control

Biological control is a method in which insects, pathogens, or animals are introduced to the system to suppress target pests. This method of control could also include enhancing native vegetation through plantings with the aim of out-competing target species or preventing introductions of invasives by improving the health of current, native populations.

Purple loosestrife, an invasive wetland plant, is often controlled using biological practices. The black-margined purple loosestrife beetles (*Galerucella calmariensis*), which eat and defoliate the plant effectively killing it, are commonly raised and released onto purple loosestrife infestations, where the beetle population will hopefully establish themselves for continued impact. Weevils, such as *Eurychiopsis lecontei*, have had mixed results as biological control for Eurasian Watermilfoil. The weevil is native to North America and can be found naturally in lakes, however, to effectively control milfoil infestations weevil populations need to be augmented which can require years of stocking for them to become established. This process can be particularly expensive as well.

Biological methods involving pathogens or native plant restoration are still subject to research efforts, such as ongoing research for the use of *Mycoleptodscus terrestris*, a fungal pathogen, for milfoil control, or research for more successful and less expensive native plant restoration techniques.

Chemical Control

The chemical control of aquatic plants is a common practice and is usually the first tool implemented in management of aquatic plants. This is mostly due to the fact that in many cases chemicals can be fast acting and cost effective. However, of the hundreds of chemicals approved and registered by the EPA in the United States, only a few are designated for use in aquatic environments, such as lakes, and may have restrictions related to water use (delay swimming or drinking water uses). It is also important to note that an herbicide that is legal for use in one state may not be in another, since states have their own specific registration requirements for herbicides. For instance, while Wisconsin utilizes both liquid and granular 2, 4-D, the State of Michigan does not allow the use of the liquid formulation of 2, 4-D.

Aquatic herbicides fall under two categories: contact or systemic herbicides. Contact herbicides kill only the parts of the plant that they make contact with, but kill quickly, while slower-acting systemic herbicides more thoroughly kill the entire plant by being absorbed into the plant system. Herbicides can also be categorized as selective or non-selective, based on the ability of the chemical to kill only targeted species or if it impacts all vegetation types.

The effectiveness of herbicide treatments depends on two main factors: the concentration of applied herbicide and the duration of exposure. Systemic herbicides require longer exposures as compared to contact herbicides, as they need time to be taken up by the plant. Concentrations and exposure times can be reduced below adequate levels by several factors including water depth, flow, treatment size, plant density, and even weather. While each treatment scenario is different, it is important to take all factors into consideration. Since there are so many complex considerations involved in herbicide treatments in lake ecosystems, only licensed professional applicators should apply aquatic herbicides. Appendix B contains more information pertaining to specific herbicides.

Permitting

The Michigan Department of Environmental Quality, Water Resource Division - Aquatic Nuisance Control (ANC) Program regulates the application of aquatic herbicides to ensure proper application and that impacts from chemical treatments are minimized. Permits required by the State of Michigan for the chemical treatment of aquatic plants are submitted to and issued through the MDEQ ANC Program.

The State of Michigan requires legal authority to treat aquatic plants but the requirements may vary depending on the applicant applying for the permit or the treatment scenario proposed. For whole lake treatments, approved lake management plans are required for by MDEQ in addition to a permit. Hand removal of plants that involves the use of power (such as Diver Assisted Suction Harvesting (DASH)) requires a joint permit from MDEQ and the United States Army Corps of Engineers (USACE) and this permit is different than an Aquatic Nuisance Plant Control permit. In several cases, a list of threatened and endangered species may be required before lake management can occur. This permit requirement can be obtained by contacting the Michigan Department of Natural Resources Wildlife Division.

Generally, the small-scale removal of plants, either by hand pulling/cutting or raking, or even mechanical harvesting, does not require a permit so long as the bottom of the lake is not disturbed and all plant fragments and material are disposed of properly. More information regarding DEQ's Aquatic Nuisance Control, including a list of Frequently Asked Questions, can be found at http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3710---,00.html.

History of Aquatic Plant Management

In 1986 and 1987, Michigan State University Extension and Michigan Sea Grant Extension conducted a study on Shakey Lakes which focused on water quality, fish, and aquatic vegetation (Burton et al, 1992). This survey was in response to concerns expressed by the recently formed Shakey Lakes Association (SLA) in regards to the aquatic plant problems in the lake. It was reported that the plants were hindering many lake recreation activities. The 1986-87 study was originally aimed at analyzing the effects of a drawdown on aquatic plant control in Shakey Lakes. However, the new Association did not pass the vote to conduct a drawdown due to its controversial nature.

In 1991, with plants still posing a problem, the SLA worked to form a committee to develop action item recommendations for management. Ultimately several management recommendations were developed and presented to the committee (Appendix C), including drawdown, mechanical harvesting, and aquatic herbicides. The Shakey Lakes Association moved forward with the drawdown management option and conducted three fall/winter drawdowns in 1996-97, 1998-99, and 2000-01. The consecutive drawdown events in the late 1990s seem to be the start of Shakey Lakes' current drawdown scheme, which involves a lake level drop every third year, which has continued to this day with the most recent drawdown happening over the course of the 2016-17 winter.

Inconsistent records make it difficult to determine every year in which a drawdown has occurred. It is recommended that an accurate history of all aquatic plant management events be developed for inclusion in this plan. SLA members should coordinate with WRISC to share anecdotal record and walk through Shakey Lakes' paper records to clarify what actions have been taken and when these events occurred. Once a timeline is developed it should be added to the plan; yet another display of this plans dynamic and adaptive nature.

Aquatic Plant Surveys

Survey Methods

While there is not an extensive history of aquatic monitoring for the Shakey Lakes chain, there is some data on record that provides insight into the dynamic vegetative communities of Shakey Lakes. In July of 1940, an aquatic vegetation analysis was conducted by the Michigan Department of Natural Resources. While no density or population area data was collected, several aquatic plant species were identified and can provide a valuable comparison to the current composition of the vegetation present in Shakey Lakes.

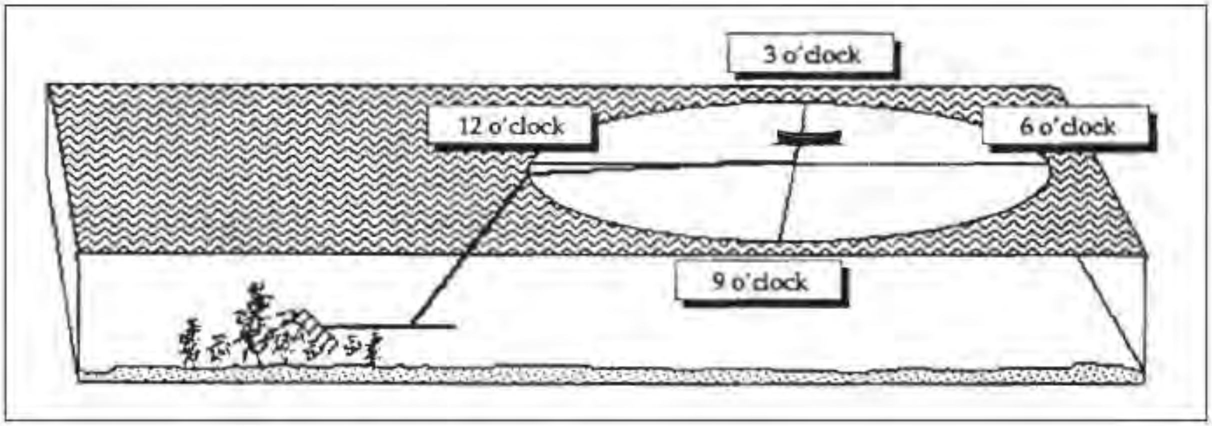


Figure 32. A rake is tossed at each direction and dragged along the bottom to collect vegetation. This vegetation is then collected at the boat, identified, and density ratings are assigned. (MSU Extension, 2007)

The Shakey Lakes Association requested that a follow-up survey be conducted following the first three consecutive drawdowns in the late 1990s. Therefore in 2001 Michigan State University conducted another survey of the aquatic vegetation of Shakey Lakes (Appendix D). Five transects in both Resort and Long Lakes were sampled, as well as the inlets for Becker and Resort.

A full aquatic plant survey was conducted on Shakey Lakes in the summer of 2015 following the CLMP transect survey method. The CLMP utilizes MSU Extension's Citizen's Guide for the Identification, Mapping, and Management of the Common Rooted Aquatic Plants of Michigan (2007) to guide survey and mapping practices. For this protocol, several transects are established around the lake based loosely on acreage, but are mostly subject to the samplers' judgement and should aim to encompass all habitats and cover types throughout the lake. Plant data, including species and density, are recorded along each transect at water depths of 1 foot, 4 feet, and 8 feet. At these depths, four rake tosses are made, one toward shore, one away from shore, and one on each side of the boat parallel to the shore (Figure 32). Density ratings for each plant species are assigned for each depth and only after all four rake tosses have been collected. The density assigned is based on a five-part scale that takes into account how many of the rake tosses that species was present in (Figure 33). Due to the extensive nature of this type of survey, only the main basin, or Resort Lake, was sampled but there is confidence that this still resulted in a representative sampling of the impoundment.

Dense (D)	Species fills the rake in all four casts (12, 3, 6 and 9 o'clock).
Heavy (H)	Species found mixed with other plants in all four cast of the rake.
Moderate (M)	Species found in three of the four rake casts.
Sparse (S)	Species found in two of the four rake casts.
Found (F)	Species found in one of the four rake casts.

Figure 33. Aquatic plant density ratings (MSU Extension, 2007)

Survey Results

Table 2 below lists the species identified during the 1940 survey. Many are still found in the lake today, including several pondweed species, milfoils, coontail, and chara, to name some of the more abundant species.

Common Name	*Scientific Name**
Common Waterweed	*Anacharis canadensis (Elodea canadensis)*
Watershield	*Brasenia schreberi*
Bottle-brush Sedge	*Carex comosa*
Lesser Tussock Sedge	*Carex diandra*
Coontail	*Ceratophyllum demersum*
Spikerush	*Eleocharis spp.*
Horsetail	*Equisetum spp.*
Blue-flag Iris	*Iris versicolor*
Flat-stem Pondweed	*Potamogeton zosteriformis*
Milfoil	*Myriophyllum spp*
Floating Pondweed	*Potamogeton natans*
Straight-leaved Pondweed	*Potamogeton rutiloides* (variation of *P.strictifolius)*
Common Bladderwort	*Utricularia vulgaris*
White Water Lily	*Nymphaea odorata*
Yellow Pond Lily	*Nuphar spp.*
Marsh cinquefoil	*Potentilla palustris (Comarum palustre)*
Long-leaved Pondweed	*Potamogeton x angustifolius (*hybrid of *P.gramineus* and *P.lucens)*
Various-leaved Pondweed	*Potamogeton gramineus*
Narrow-leaved Pondweed	*Potamogeton strictifolius*
Broadleaf Arrowhead, Duck-potato	*Sagittaria latifolia*
Chara, Muskgrass	*Chara spp.*
*Parentheses indicate current name of species or naming-related details, as several have been updated since the time of this survey	

Table 2. Species of Aquatic Plants identified during a 1940 DNR Vegetation Analysis

During the 2001 survey conducted by MSU, several species were found to exhibit "moderate" to "heavy" density ratings in the Resort Lake basin in June and August. These species included coontail, chara/muskgrass, wild celery, and pondweeds. It was also noted that these species, as well as water lilies, were recorded as dominant plants in the 1986-87 study as well. The 2001 study also mentions that the excellent growth of wild rice in Becker Lake and near the inlet could have been enhanced by the drawdowns in the years previous.

A full transect survey of Shakey Lakes (Resort Lake basin) was conducted on August 10th, 2015 by WRISC staff. During the survey, 31 native and no exotic plant species were identified along 25 transects established around the lake. This is known as the species richness, or the number of different species identified in the lake. Species richness is often confused with species diversity, which describes how evenly distributed species are throughout the lake. A lake with only a few species can be more diverse than a lake with several different species if they are evenly spread throughout the lake. Diversity is important to maintain in ecosystems since diverse systems tend to be more stable and resilient to outside or ecological changes. Per transect, species richness averaged about 12 species, with individual transects ranging from 5 to 16 species.

Table 3 describes each of the species found and their typical role in a lake ecosystem. The most commonly sampled plants in Shakey Lakes were wild celery and coontail, followed closely by aquatic moss and chara. Ten different pondweed species were identified as well.

Table 3. Aquatic vegetation descriptions and ecological significance.

Common Name	*Scientific Name*	Ecological Significance
Wild Celery	*Vallisneria americana*	All parts of this plant are a food source for waterfowl and other wildlife, some ducks will change their migration patterns to find beds of wild celery
Coontail	*Ceratophyllum demersum*	Good habitat for invertebrates and offering foraging opportunities for fish throughout the year as this species overwinters (evergreen plant)
Chara	*Chara spp.*	Is a favored waterfowl food, good bottom stabilizer, and can benefit water quality by slow the movement of suspended sediments
Flat-stem Pondweed	*Potamogeton zosteriformis*	Wildlife grazing, fish cover, plant has high anti-microbial properties
Common Bladderwort	*Utricularia vulgaris*	As free-floating species, can grow in soft, unconsolidated sediments, providing cover in uncolonized areas; bladders capture small prey for digestion (carnivorous plant)

Fern Pondweed	*Potamogeton robbinsii*	Good habitat for invertebrates and fish, particularly northern pike, typically grow at outer margin of mixed plant stands
Slender Naiad	*Najas flexilis*	Very important plant for waterfowl species, good producer of food and shelter for fish
Leafy Pondweed	*Potamogeton foliosus*	Fruit produced is important food source for waterfowl as it matures before other aquatic fruits, tolerant of eutrophic waters
Water Marigold	*Bidens beckii*	Flowers attract insects, leaves offer shade, shelter, and foraging for fish, sensitive to water quality changes (indicator species)
Various-leaved Watermilfoil	*Myriophyllum heterophyllum*	Waterfowl forage, foliage catches detritus providing food and habitat for invertebrates
Arum Arrowhead	*Sagittaria cuneata*	One of the highest value aquatic plants for wildlife, high-energy tubers for waterfowl migration, good plant for restoration
Slender Waterweed	*Elodea nuttallii*	Habitat, grazing opportunities for fish and wildlife, tolerant of low light levels and is disease resistant
Northern Watermoil	*Myriophyllum sibiricum*	Waterfowl forage, foliage catches detritus providing food and habitat for invertebrates, shade and shelter for fish
Nitella	*Nitella spp.*	Algae and invertebrates on plant are attractive food source for fish and waterfowl
Needle Spikerush	*Eleocharis acicularis*	Creates spawning habitat for fish and shelter for invertebrates, food for waterfowl
Large-leaf Pondweed	*Potamogeton amplifolius*	Provides shade, shelter, and foraging opportunities for fish, nutlet production is valuable for waterfowl, considered ecologically valuable habitat
Variable Pondweed	*Potamogeton gramineus*	Wildlife food source, network of leaves provide habitat for invertebrates and foraging opportunities for fish

Whorled Watermilfoil	*Myriophyllum verticillatum*	Waterfowl forage, foliage catches detritus providing food and habitat for invertebrates, shade and shelter for fish
Sago Pondweed	*Stuckenia pectinata*	Top food producer for waterfowl, both for fruit and tubers, also shelter for trout and other young fish
Yellow Pond Lily	*Nuphar spp.*	Anchors shallow water communities, disperses wave action, wildlife grazing, provides shaded habitat
Illinois Pondweed	*Potamogeton illinoensis*	Offers good shade and habitat structure for fish and invertebrates, fruit is food source for waterfowl and plant material may be grazed by muskrat or beaver
Small Bladderwort	*Utricularia minor*	As free-floating species, can grow in soft, unconsolidated sediments, providing cover in uncolonized areas; bladders capture small prey for digestion (carnivorous plant)
White Water Lily	*Nymphaea odorata*	Provides shaded shelter, wildlife grazing opportunities
Bur-reed	*Sparganium spp.*	Help anchor sediments, wildlife grazing, historically a medicinal plant
Water Stargrass	*Heteranthera dubia*	Good fish cover, waterfowl forage, grows in a variety of depths
Floating-leaf Pondweed	*Potamogeton natans*	Late-season food source, good fish habitat with combination of shade and forage opportunities
White-stem Pondweed	*Potamogeton praelongus*	Considered good food source for trout, waterfowl, valuable muskellunge habitat, can be an indicator of water quality, typically disappearing from disturbed systems due to low turbidity tolerance
Stiff Pondweed	*Potamogeton strictifolius*	Valuable fish habitat, waterfowl forage
Soft-stem Bulrush	*Schoenoplectus tabernaemontani*	Nesting material for waterfowl and muskrats, shelter for young fish and invertebrates, historically used as food source by native cultures

*Descriptions of ecological significance taken from Borman et al., 1997

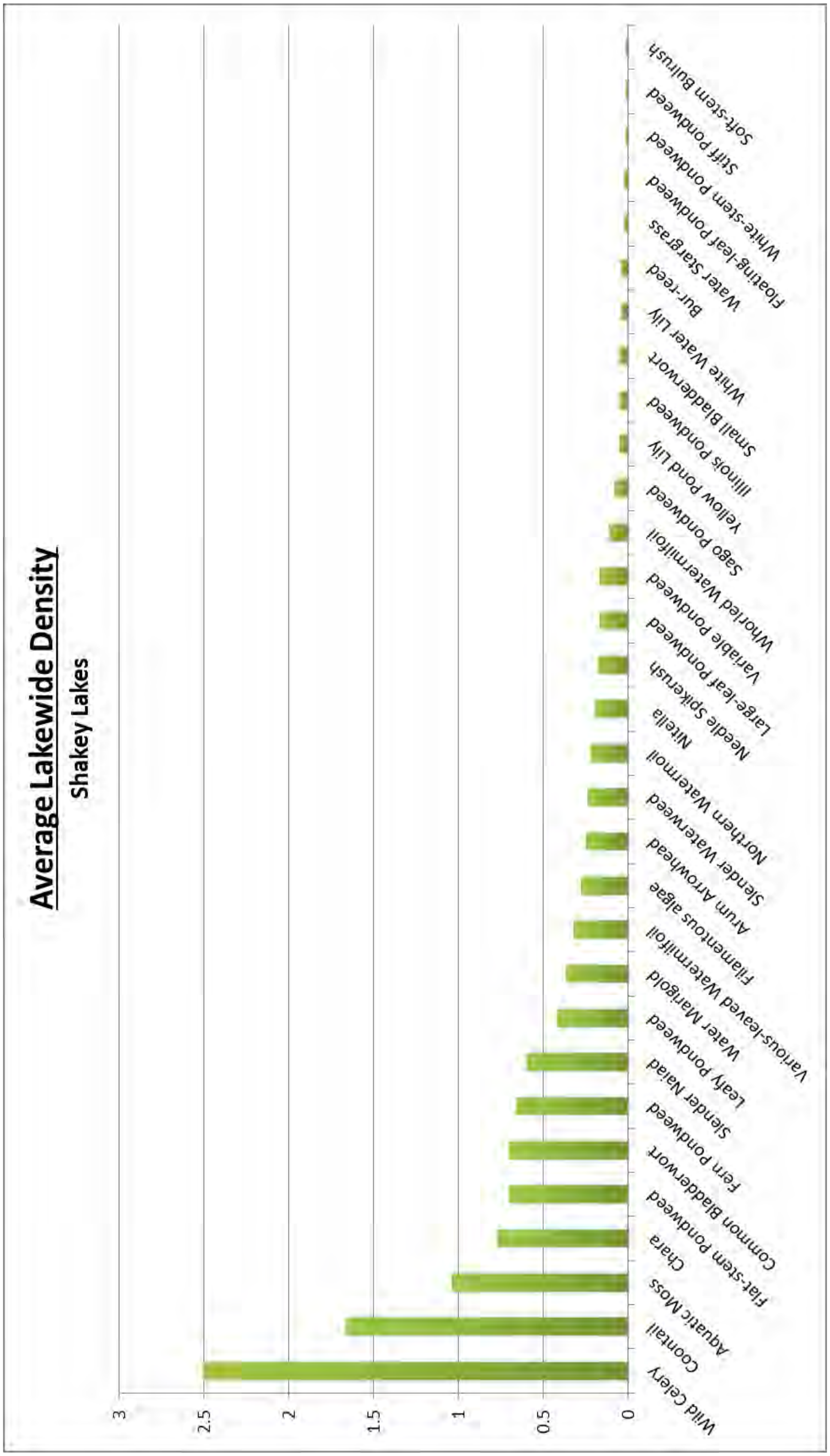


Figure 34. Average lakewide density for aquatic vegetation of Shakey Lakes, 2015

Note the range of average lake wide densities in Figure 34, which were calculated at 0.01 to 2.5. Since density is based on a five-part scale (Figure 33), this range indicates that the vegetation of Shakey Lakes is at a moderate to low density. This is consistent with observational data, however there were several 1' depths that could not be sampled due to the inability to navigate to that depth. This was mainly due to vegetation, which was too thick to easily move a boat through. Note that this absence of data could influence the overall density as well as species richness. For instance, Wild Rice is known to grow in areas of Shakey Lakes, however this species was not detected during this survey. Species richness and density is also skewed by the fact that only Resort Lake was surveyed, and not the entire chain. However, this is considered an accurate representation of plant community.

Table 4. Vegetation CLMP ID Codes and General Growth Patterns

Common Name	*Scientific Name*	ID Code	Growth Pattern	Plant Group
Wild Celery	*Vallisneria americana*	34	Low growing	Submergent
Coontail	*Ceratophyllum demersum*	41	Free-floating	Free-floating
Chara	*Chara spp.*	20	Low growing	Submergent
Flat-stem Pondweed	*Potamogeton zosteriformis*	33	Low growing	Submergent
Common Bladderwort	*Utricularia vulgaris*	48	Free-floating	Free-floating
Fern Pondweed	*Potamogeton robbinsii*	22	Low growing	Submergent
Slender Naiad	*Najas flexilis*	21	Low growing	Submergent
Leafy Pondweed	*Potamogeton foliosus*	37	Mid-water growing	Submergent
Water Marigold	*Bidens beckii*	47	Mid-water growing	Submergent
Various-leaved Watermilfoil	*Myriophyllum heterophyllum*	40B	Tall growing	Submergent
Arum Arrowhead	*Sagittaria cuneata*	8	Shoreline	Emergent
Slender Waterweed	*Elodea nuttallii*	36B	Mid-water growing	Submergent
Northern Watermoil	*Myriophyllum sibiricum*	40	Tall growing	Submergent
Nitella	*Nitella spp.*	39	Low growing	Submergent
Needle Spikerush	*Eleocharis acicularis*	24	Low growing	Emergent
Large-leaf Pondweed	*Potamogeton amplifolius*	30	Mid-water growing	Submergent
Variable Pondweed	*Potamogeton gramineus*	31	Mid-water growing	Submergent
Whorled Watermilfoil	*Myriophyllum verticillatum*	40C	Tall growing	Submergent
Sago Pondweed	*Stuckenia pectinata*	52	Mid-water growing	Submergent
Yellow Pond Lily	*Nuphar spp.*	13	Tall growing	Floating leaf
Illinois Pondweed	*Potamogeton illinoensis*	46	Mid-water growing	Submergent
Small Bladderwort	*Utricularia minor*	48B	Free-floating	Free-floating
White Water Lily	*Nymphaea odorata*	12	Tall growing	Floating leaf
Bur-reed	*Sparganium spp.*	29	Low growing	Emergent
Water Stargrass	*Heteranthera dubia*	35	Low growing	Submergent

Floating-leaf Pondweed	*Potamogeton natans*	43	Tall growing	Submergent/ Floating leaf
White-stem Pondweed	*Potamogeton praelongus*	44	Tall growing	Submergent
Stiff Pondweed	*Potamogeton strictifolius*	38	Mid-water growing	Submergent
Soft-stem Bulrush	*Schoenoplectus tabernaemontani*	7	Shoreline	Emergent

As detailed in Table 4, there is a good variety in the growth patterns of the plants found in Shakey Lakes. This is important for establishing a healthy plant community, as species will colonize a wider variety of habitats and conditions and fill more niches. This further prevents the establishment of invasive species that are generally opportunistic and tend to infest any somewhat suitable, uninhabited areas. This variety also provides excellent habitat structure to the benefit of the fishery. Having many types of habitats and refuges is valuable for young fish and their invertebrate food sources.

Aquatic vegetation communities do change over time for a myriad of factors that may not necessarily be related to management efforts. Therefore it is valuable to revisit large scale plant surveys every few years to track the community as it develops, changes, and stabilizes time and again. It also allows for a more intensive monitoring effort for invasive species, which can often go unnoticed for several years before becoming established. Figure 35 details which plant species were identified and at what densities for each survey transect.

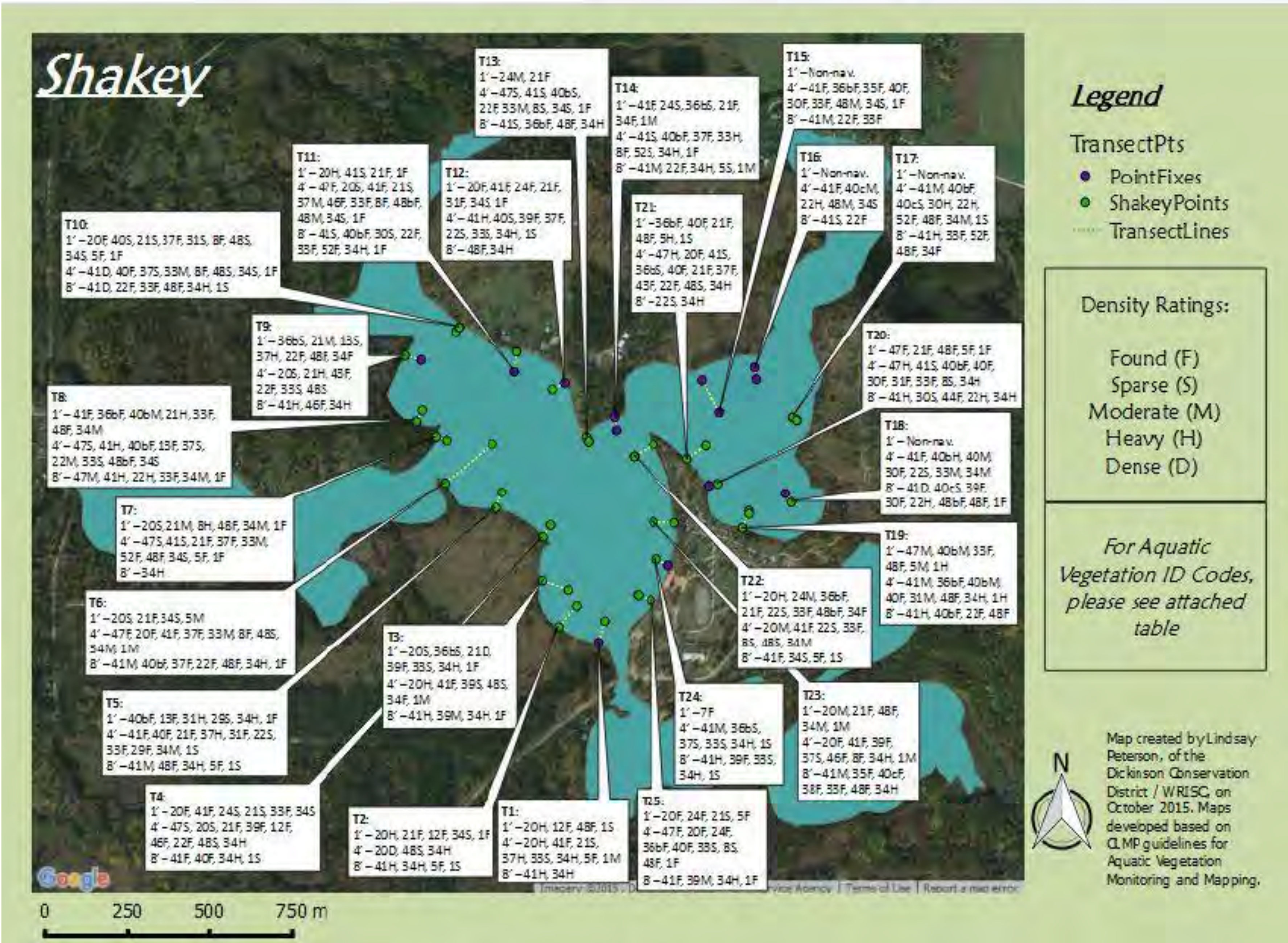


Figure 35. Aquatic vegetation survey map of Shakey Lakes, 2015, detailing transect locations and the vegetation data collected at each. Table 3 includes CLMP Vegetation ID Codes.

Aquatic Invasive Species

Aquatic invasive species (AIS) are a constant threat to Shakey Lakes and other waterbodies in the region. Presently, however, there are no known invasive species present in Shakey Lakes. Nonetheless, several AIS species that show potential for introduction to Shakey Lakes will be discussed in this section; however note that new AIS are continually being discovered and it is important to be informed of all potential invasive threats.

In this region, Eurasian watermilfoil (*Myriophyllum spicatum*) is a wide-spread invader, being established in countless lakes for more than a decade. The non-native milfoils in lakes are typically hybrid water milfoils (HWM), which are a cross between the Eurasian and native (typically Northern, but possibly Variable and Whorled milfoil) strains. In 2015, milfoil plants from Shakey Lakes were sampled and sent for genetic analysis at Grand Valley State University - Annis Water Research Institute. The samples taken proved to be identified as three different native milfoils, including: Northern Watermilfoil, Various-leaved Watermilfoil, and Whorled Watermilfoil (Figure 36). Shakey Lakes is one of a very few to not have a known Invasive Milfoil population. It is likely that because Shakey Lakes has such a diverse and robust native vegetation community, that invasive plants struggle to establish and compete for limited resources. It is crucial to continue monitoring for Invasive Milfoils, especially since there are several native strains, with which an invasive could hybridize. Hybrid milfoils, from a management stand point, tend to be more difficult to control and having various natives to hybridize with could lead to a vigorous infestation. Being somewhat resistant or able to develop resistance to herbicides, hybrids are essentially a "bigger, badder milfoil."

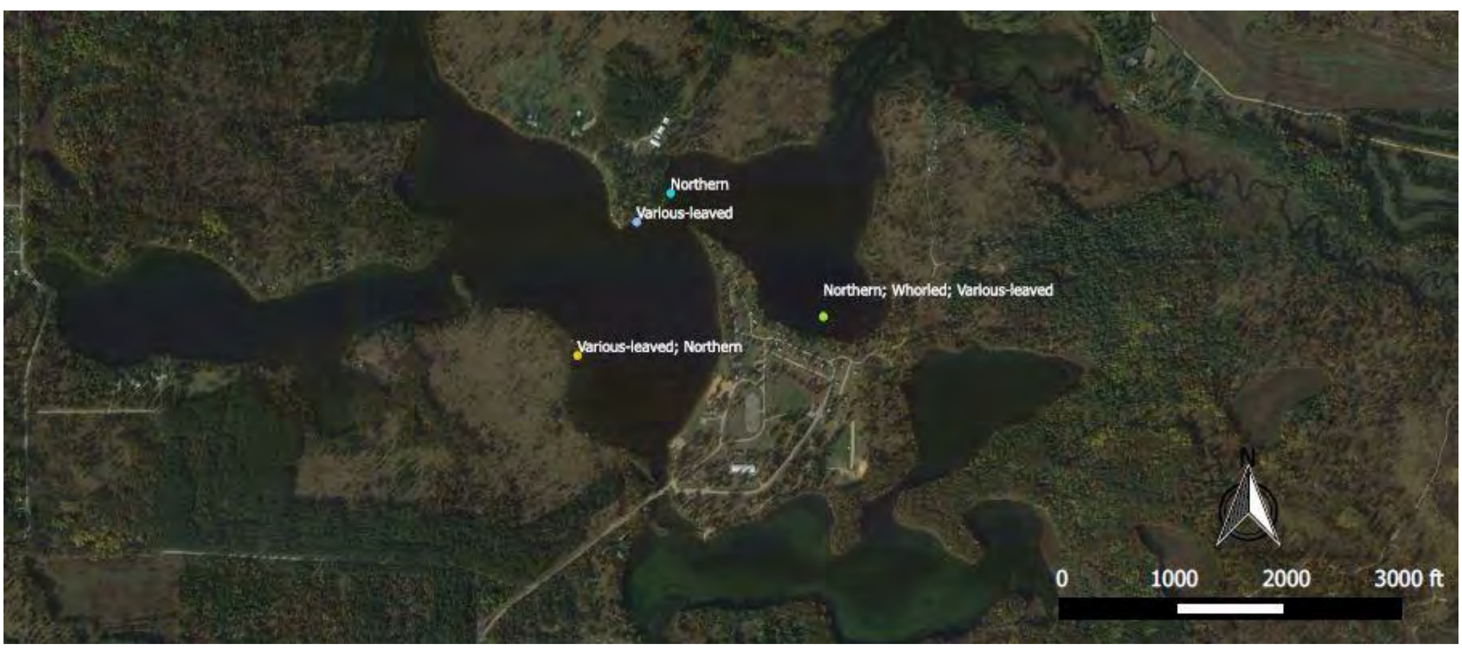


Figure 36. Location and identification of various Watermilfoil beds. Shakey Lakes, 2015.

Zebra mussels are another long-standing threat to lakes in this region. Zebra mussels (*Dreissena polymorpha*) are native to the Black and Caspian Seas and are believed to have been introduced to the Great Lakes through shipping and ballast water, eventually migrating inland to lakes and rivers, their spread often being augmented by human activity, especially recreation. Zebra mussels tend to be quite small (< 50mm) and are actually microscopic during their larval stages of development, where they're known as veligers, making it difficult to prevent spreading them. They mature much quicker than native mussels (within about 1 year) and reproduce rapidly since over 40,000 eggs can be laid in a reproductive cycle and up to one million in a spawning season. As the veligers settle to the bottom of the lake, they seek out and attach themselves to suitable substrates using their byssal threads. Zebra mussels tend to prefer hard surfaces, such as rocks, docks, or even native mussels, but are known to attach to vegetation as well (Benson et al., 2017).

Figure 37. Zebra mussels. (Benson et al, 2017)

Zebra mussels can have profound effects on the ecosystems they invade. They primarily consume phytoplankton, but other suspended material is filtered from the water column including bacteria, protozoans, other zooplankton, and silt. For example, increase water clarity caused by zebra mussel filtration can allow aquatic plant communities to grow more and even colonize new areas that were not suitable before. Zebra mussels also impact fisheries by consuming phyto- and zooplankton, which are food sources for juvenile fish. The selective feeding strategies of the zebra mussels can also result in toxic algae blooms as they consume most other algae but reject those that may be toxic, allowing that algae to thrive in the absence of competition.

In 2015, eDNA (environmental DNA) testing was implemented. This test used water samples (1L unfiltered lake water and a filter that had 20L lake water passed through it) to perform a broad-spectrum test for 17 different invasive species. eDNA analysis detects DNA from organisms in the water without evidence of the source. So, materials such as cells, tissues, excrement, or even dead animals, all contain DNA that can be introduced to a body of water and detected with this testing method. Result format is shown in Table 5. The analysis of these samples was done by Michigan State University.

Table 5. eDNA Test Result Interpretation	
eDNA Detected	A positive results in all of the test replicates
eDNA Below Detection Limit	eDNA was either not present or at a very low concentration and not detectable by the test
"*1 out of 6 reactions were positive*" or similar	eDNA was present, but at lower concentrations

For the samples collected from Shakey Lakes (Resort) in June 2015, a positive result for Zebra Mussels was returned as "eDNA Detected" (Appendix E). Since eDNA testing is still under research and the reliability of broad spectrum tests can be variable, a second batch of samples was collected in August 2015.

In the meantime, the calcium level of Shakey Lakes was analyzed to determine if the system could realistically support a zebra mussel population if one were to be introduced. The calcium level of Shakey Lakes was assessed at 48 mg/L, which is well within the adequate range to support a zebra mussel population. This supports the University of Wisconsin – Madison's Aquatic Invasive Species Smart Prevention program which classifies Shakey Lakes as "suitable" for zebra mussels based on calcium and conductivity measurements (UW-Madison, 2009). Zebra mussels need calcium levels of 10 mg/L to initiate shell growth and 25 mg/L to maintain shell growth (Benson, et al., 2017).

Follow-up was carried out and included re-sampling for eDNA, several plankton tow samples, and a meander survey of the shoreline and docks. A plankton tow is a fine mesh net with a ring opening on one end and tapering off to a point where a sample bottle can be attached (Figure 38). This device is lowered into the water vertically or towed behind a boat horizontally to sample for microscopic organisms in the water column, including veligers, the larval stage of zebra mussels. Several vertical tows were done on Shakey Lakes late in the season of 2015 but no veligers were discovered in the samples.

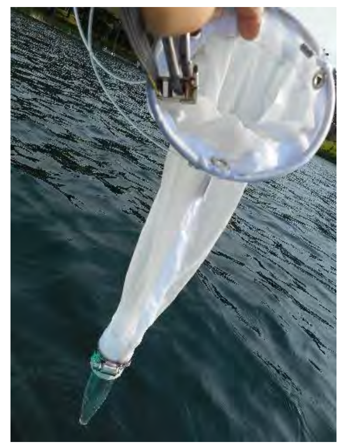


Figure 38. Plankton Tow with sample collection vial attached. (Peterson, 2016)

Simultaneously, a several additional eDNA samplings were performed and a meander survey was conducted to search for any adult zebra mussels. This second eDNA analysis used samples taken from Resort, Long, and Bass Lakes. The second analysis showed a Zebra Mussel presence in Long Lake only, however it was at very low levels, coming back with "1 out of 6 replicates" being positive. The meander survey was directed along the rockier shorelines of the lake, docks, and access sites. No zebra mussels were found during the meander survey. Nevertheless, monitoring should continue for this species. Consider installing zebra mussel monitoring plates underneath docks and check them periodically to see if mussels have attached to the plates. Monitoring plates may be available for loan from the Dickinson Conservation District.

No other invasive species have been reported from Shakey Lakes but it is important to continually monitor for and strive to prevent new introductions. Actions such as inspecting and cleaning watercraft and trailers prior to entering and before leaving a waterbody, as well as draining live wells and drying fishing gear, are vital to preventing the spread of these harmful invaders.

There are several other aquatic invasive species in the region and pose a threat to Shakey Lakes. Therefore it is imperative to know how to react if a new invasive species is discovered. The discovery of a new invasive tends to elicit strong concerns and propels many towards taking action as soon as possible. While concern is appropriate, a systematic, deliberate, and informed approach must be taken in order to effectively address these concerns. Establishing an Aquatic Invasive Species Response Team and detailing a contingency plan can help navigate this event. Appendix F details an aquatic invasive species rapid response plan. This plan establishes points of contact between the lake stewards, in this case the Shakey Lakes Association, and WRISC. The Association should act as the AIS Rapid Response Team and a Rapid Response Coordinator should be designated within the group to serve as the main point of contact regarding AIS concerns.

If a suspect plant is found, a specimen should be collected, preferably at the time of discovery as it is often difficult to pinpoint the exact location of a single plant within a lake. The entirety of the plant should be collected, including roots, stems, and flowers (if present) and placed in a sealable bag with some water to keep the plant from drying out. The observer's name should be included on the bag or on a label, along with the date, time, and location. Ideally GPS coordinates should be provided, but if none are available, the location of the AIS sample should be marked on a lake map. The sample can remain in a refrigerator or cooler for up to 3 days, and should be delivered to the WRISC Coordinator as soon as possible. The WRISC Coordinator will then identify the plant and determine if it is an aquatic invasive species or not.

If the species is determined to not be an invasive species, the WRISC Coordinator will inform the Rapid Response Team Coordinator, who will then inform the original observer. However, if the species is identified to be an aquatic invasive species, the extent of the population will need to be determined. An infestation can fall under two categories, which will ultimately guide an appropriate management response, and include "Established" or "Pioneering." An established invasive is one that has gone unnoticed for some time and has developed a dense or extensive population. A pioneer invasive is one that has only recently been introduced and is present in only small quantities in certain areas. For example, a pioneer could be a few sprigs of milfoil appearing near a boat landing, a "high-risk" area for invasive introductions. This determination can be done jointly by WRISC and the Rapid Response Team and collaboration throughout this process is important.

Once the invasive population has been assessed, appropriate management responses can be discussed. This includes notifying proper authorities or government officials of the occurrence as well as informing riparian landowners. Treatment options, such as hand-pulling or chemical control, need to be decided early in order to enact effective and rapid management. The WRISC Coordinator should be consulted and involved in this decision making process. Follow-up is also essential in invasive species rapid response activities. The Rapid Response Team should work with the WRISC Coordinator to develop a follow-up monitoring plan to ensure that control was effective and to watch for future infestations.

Wildlife

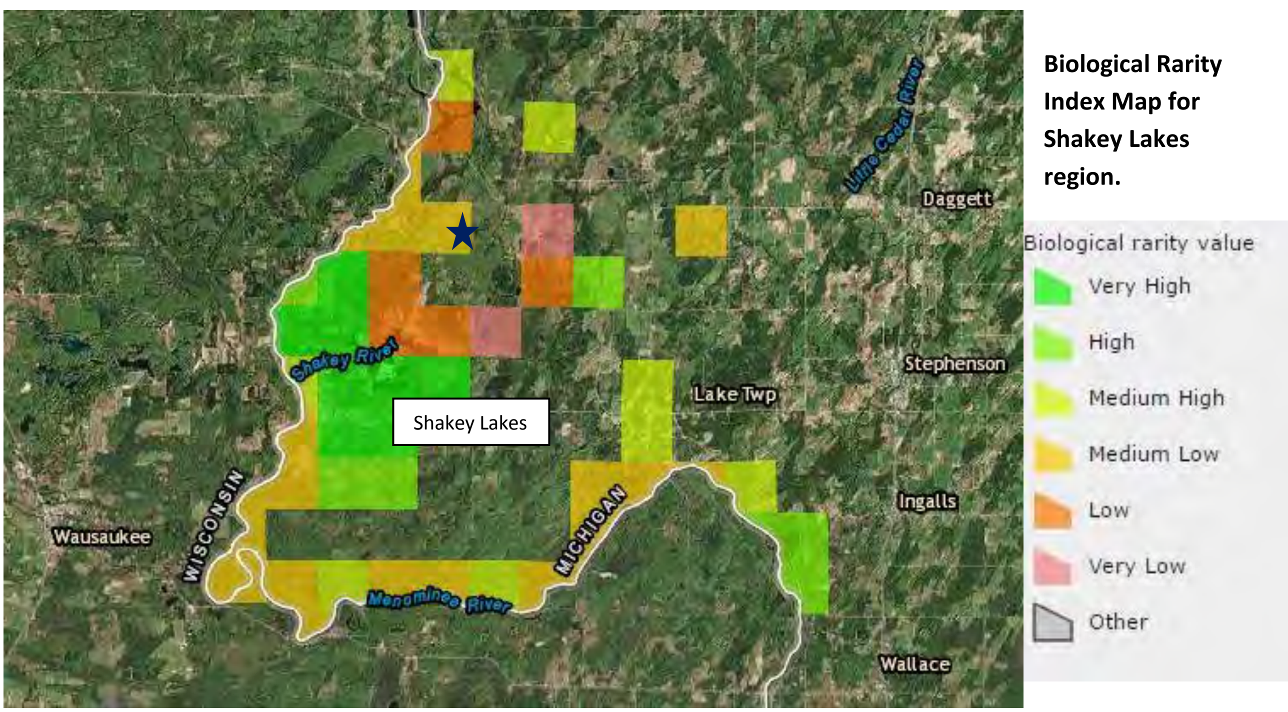
The Michigan Natural Features Inventory (MNFI) was used to determine the presence of threatened, endangered, or other rare status species in the Shakey Lakes region of Menominee County.

Common Name	*Scientific Name*	Status
American Burying Beetle	*Nicrophorus americanus*	Endangered (Federal)
Bald Eagle	*Haliaeetus leucocephalus*	Special Concern (State)
Dwarf Milkweed	*Asclepias ovalifolia*	Endangered (State)
Lake Sturgeon	*Acipenser fulvescens*	Threatened (State)
Hill's Thistle	*Cirsium hillii*	Special Concern (State)
Torrey's Bulrush	*Scirpus torreyi*	Special Concern (State)

Oak-pine barrens are also present in this area, and are an important and valuable ecosystem.

Appendix G contains several letters that address the presence of several of these species and how the regular drawdown of Shakey Lakes may or may not impact these species.

The Biological Rarity (Biorarity) Index model is based on the Michigan Natural Features Inventory database of known sightings of threatened, endangered, or special concern species and high quality natural communities. Figure 40 shows that there is a very high probability that rare species could occur within the immediate vicinity of Shakey Lakes.



Biological Rarity Index Map for Shakey Lakes region.

Figure 40. Biorarity index map for Shakey Lakes and the surrounding area. (MSU, 2017)

Shoreline Assessments

The quality of lake ecosystems is greatly affected by the surrounding landscape, in particular the interface between lake and land, known as the riparian area. However, this area is also subject to shoreline development and this crucial component of the lake system can be impacted. If done improperly, this manipulation can have detrimental impacts to the ecosystem including issues with habitat function, species loss, and water quality impairment. These changes are not always immediate either, but over many years the slightest change to an ecosystem can accumulate to result in irreversible degradation. Thus, it is important to understand the impacts to shorelines and the reverberations these changes can have throughout the lake system.

In 2016, the WRISC staff conducted a shoreline assessment of Shakey Lakes in its entirety, utilizing the CLMP's "Score the Shore" protocol. In this method, the shoreline of the lake is divided into 1000' sections which are individually assessed for a variety of parameters, such as the amount of shoreline vegetation, degree of erosion, or man-made structures present. These parameters provide valuable insight regarding shoreline and riparian health. Shakey Lakes was divided into 37 survey sections (Figure 41) however, only 28 of the sections were actually surveyed. Those that were not surveyed were on Bass and Baker Lakes but observationally these shorelines appeared natural and healthy.

Three passes around the lake were made, each pass focusing on the assessment of different parameters. The first pass assessed the level of development (number of structures, i.e. homes, docks, etc.) and photos were taken of each section (Appendix H). The purpose of the photos, and indeed this survey as a whole, is not to pursue regulatory action. Instead it is used to document the habitat conditions of Shakey Lakes and to educate riparian landowners on the importance of healthy shorelines. During the second pass, the littoral zone, or the near shore waters of the lake, were assessed for vegetative cover, erosion, and the presence of woody debris. The third and final pass focused on the condition of the riparian area and examined shoreline erosion control practices. Lawns, natural areas, and impervious surfaces were all estimated, as was the presence of seawalls, rip-rap, boulders, or bioengineered erosion control structures.

The "score" of the shore is based on a 100-part scale, where zero (0) would indicate a highly developed shoreline, both in the riparian and littoral zones, while a score of 100 would imply completely natural and undeveloped zones. Each section is scored individually but an overall score for the entire lake is calculated as well.

In total, 129 buildings and docks were documented around Shakey Lakes, for an average of approximately 4.6 buildings/docks per section. Individual section scores ranged from 39 to 98, with all but three of the sections scoring higher than 70. The overall lake score was calculated to be 83. The sections that had the lowest scores were Sections 1, 9, and 10, positioned along the park and beach area and then on the point directly across from the beach where there are well maintained lawns and shoreline erosion control structures present. Littoral zone health scores ranged from 38 to 93, riparian zone health scores ranged from 0 to 100, and erosion control scores ranged from 78 to 100. Overall, Shakey Lakes exhibited healthy shorelines and minimal development, which is vital to the health and quality of the lake. Appendix I contains the Score the Shore datasheets which can be used to determine exact areas of impairment or shorelines exhibiting exceptional health.

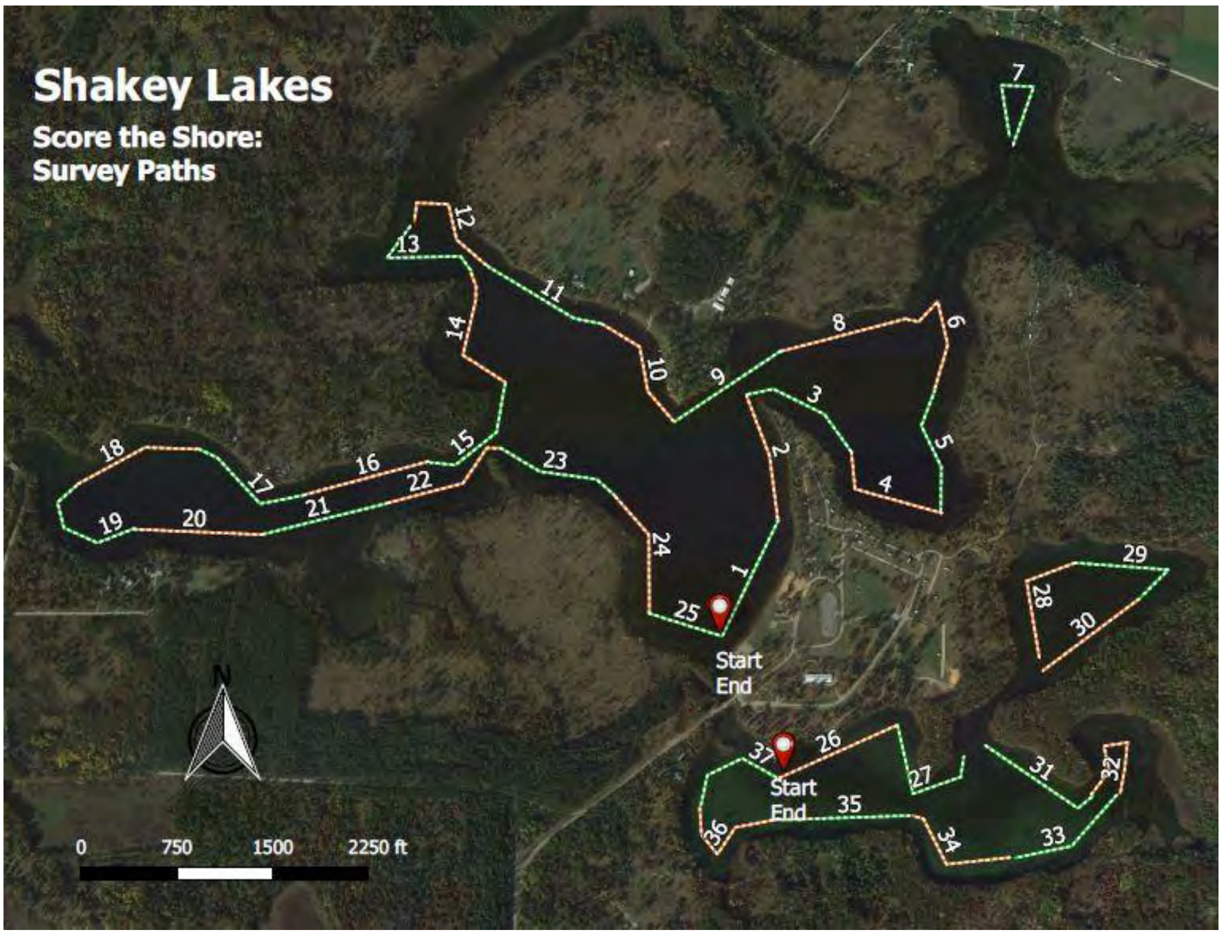


Figure 41. Score the Shore field map showing survey sections, Shakey Lakes, 2016.

Shakey Lakes Management

Since Shakey Lakes is a relatively healthy, functioning ecosystem the recommendation to take a "no action" approach to management could be made. However, the fact that there are many factors that can threaten and impact the quality of Shakey Lakes renders this alternative inapt. Lake stewards have taken great pride in Shakey Lakes and have committed to the responsibility of minimizing the threats posed to the lake system and to conduct rehabilitation where impacts have already occurred. Therefore, several management recommendations are outlined in this section to engage and assist lake stewards through the management process.

Vision and Goals

Developing a vision statement can frame management in a broader context, highlighting the ultimate goals of environmental conservation and ecosystem health as opposed to constantly viewing the process as a matter of cost, permitting, public opinion, etc. The following vision statement was developed after discussion with lake association members and assessing the needs and concerns of the group.

Vision Statement

> *"Shakey Lakes, in its unique setting and valuable role in the region, should be maintained as a recreation destination while striving to protect the lake for impacts associated with such use. It is our responsibility and our desire to conserve, maintain, and improve this unique setting for future generations while engaging as a community around a common goal."*

Goals

The overall goal is to protect, conserve, and improve Shakey Lakes through informed and supported management that maintains or builds the stability, resiliency, and natural beauty of the lake ecosystem.

Additional, more specific goals include: .

- Identify and respond to ecological threats
- Protect, maintain, and improve natural beauty and recreational appeal
- Promote long-term conservation of Shakey Lakes

During the course of the project, a Lake User Survey was distributed to lake stewards and members of the community. The survey (Appendix J) asked several questions about a person's use of the lake and offered the opportunity to rate the importance of several issues that lakes commonly face in management. Due to the low response rate of the survey, no real analysis can be made, but some general trends did present themselves.

Several respondents rated the lake's current quality as "Poor" or "Bad." Plants were also unanimously considered "excessive" and a hindrance to recreation activities, such as swimming, navigation, and fishing. Shoreline and floating leaf plants were those considered problematic. There were mixed responses regarding the level of aquatic plant control ranging from "only plants in problem areas" to "as much as permitted." There were also varying results regarding control methods but a few consistent responses were herbicides, biocontrol, and suction harvesting.

The most important problems that were identified in the survey were the prevention of invasive species, the occurrence of algae blooms and impacts to water clarity, quality of the fishery, beach and boat launch maintenance and access, and water level management. The next section provides strategies and management options aimed at addressing these issues and the management goals of Shakey Lakes.

Strategy Options

Objective 1. Monitor the water quality of Shakey Lakes.

> **Strategy 1.** Monitor the trophic status of Shakey Lakes. Engage in monitoring of the trophic status parameters, including: secchi, spring and summer phosphorus, and chlorophyll-α. Monitoring for trophic status will establish a baseline to be used to detect changes in water quality that affect the overall water quality of Shakey Lakes. Generally, 10 years of data are necessary to detect changes such as a 15% change in average phosphorus or a 20% change in transparency (secchi depth). The Cooperative Lakes Monitoring Program (CLMP) offers volunteer programs which include materials and training for these parameters.
>
> **Strategy 2.** Monitor dissolved oxygen and temperature of Shakey Lakes. These parameters are vital for aquatic life. Dissolved oxygen and temperature can be monitored through the CLMP.
>
> **Strategy 3**. Monitor for the full spectrum of water quality parameters. This monitoring only needs to occur periodically (approximately every 5 years). Parameters involved in full spectrum monitoring include all the parameters sampled for or tested throughout the project, as well as alkalinity, nitrate-nitrite, total Kjedahl nitrogen, magnesium, fecal coliform organisms, and heavy metals. This is not an exhaustive list and the testing of other parameters should be considered.

Objective 2. Protect the current water quality and health of the aquatic ecosystems of Shakey Lakes. Promote and conserve native habitats in and around Shakey Lakes. Strategies for this Objective aim to promote and protect both in-lake and riparian habitats and offer options to monitor for changes

Strategy 1. Minimize erosion and sedimentation into Shakey Lakes by educating landowners on the importance of erosion control and buffer strips of native vegetation. Education materials can be obtained from several sources. Work with local Conservation District and the Michigan Natural Shoreline Partnership (MNSP) to obtain materials.

Strategy 2. Minimize nutrient pollution of Shakey Lakes. Develop a voluntary pledge for riparian landowners, stating they will not use phosphorus based fertilizers on their lawns.

Strategy 3. Promote buffer areas along the shoreline by encouraging riparian landowners not to mow their lawns to the water's edge or by planting native vegetation. Consider hosting a shoreline restoration workshop for riparian landowners surrounding Shakey Lakes and create a native buffer demonstration plot as a lake community. WRISC and/or the Dickinson Conservation District can aid in facilitating such an event.

Strategy 4. Utilize the specific section results of the Score the Shore survey to identify areas that may require or benefit from restoration activities or erosion control measures. Also, use these results to identify healthy shorelines in order to monitor these sites for detrimental changes (increased erosion, etc.).

Strategy 5. Conduct subsequent CLMP Score the Shore surveys every few years to monitor for changes in littoral and riparian habitats.

Strategy 6. Periodically survey the aquatic vegetation community of Shakey Lakes. Plant communities are dynamic and surveying them approximately every 5 years can highlight areas of change, in terms of both improvement and impact. Utilize the CLMP Aquatic Vegetation Survey protocol or similar survey techniques.

Strategy 7. Monitor aquatic plant communities after large-scale herbicide treatments or in areas where non-target plants may be impacted. It is recommended that treatment should not adversely impact diversity and distribution of plants and that 60-90% of the native vegetation should be preserved. Generally large-scale treatments are 10 acres or 10% of the littoral zone of a lake.

Objective 3. Prevent the spread of aquatic invasive species (AIS) to and from Shakey Lakes.

Strategy 1. Utilize WRISC's 2015-2017 and pending 2018-2022 Strategic Management Plan, which provides an existing framework for early detection and rapid response efforts for invasive species.

Strategy 2. Participate in the Clean Boats, Clean Waters programs by training volunteers to provide boat launch education. WRISC can provide training, educational materials, and more information regarding this program.

Strategy 3. Also participate in the AIS Landing Blitz annual event. WRISC can provide training, educational materials, and more information regarding this program.

Strategy 4. Monitor for new aquatic invasive species. Consider enrolling in the CLMP's Exotic Aquatic Plant Watch Program to receive monitoring training and protocols. Combine this program with other annual monitoring efforts.

Strategy 5. Review signage posted at boat landings/access sites and ensure proper signage concerning AIS is posted. Dickinson Conservation District and MDNR can provide appropriate signage if needed. Consider constructing and maintaining an informational kiosk at the lake access site to educate recreationists about AIS and proper decontamination techniques.

Strategy 6. Host an educational presentation or aquatic invasive species workshop to educate lake homeowners and community members on how to identify common AIS, how to properly disinfect fishing gear, boats, trailers, etc. and review the AIS Rapid Response Plan for how to report a potential invasive.

Objective 4. Review Management Strategies for AIS Control

There are no known aquatic invasive species present in Shakey Lakes at this time. Invasive plant species are still a concern though, especially non-native watermilfoils, and it is pertinent to be knowledgeable about management options in the event that an infestation is discovered, seeing as quick action greatly increases the effectiveness of control.

Several management strategies are presented below that aim to address this concern. Despite the course of management, all efforts should follow best management practices and abide by all permitting restrictions and regulations. Metrics for gauging the success of management should be developed. It is important to consider non-target impacts and all other impacts and risks that associated with management activity. Also keep in mind that eradication is not a feasible option and should not be considered an end goal for any management objective or strategy.

Strategy 1. No Action – Do not pursue active management of the EWM population. Monitor and evaluate.

Although this approach may initially seem imprudent, an approach that focuses on monitoring and evaluation is still an active decision. This option also does not exclude the opportunity to pursue management in the future. This method is cost effective, especially if volunteers conduct the annual monitoring efforts. Cost can be incurred if the monitoring is contracted out, however there are plenty of volunteer survey methods and training would be available through WRISC or the Dickinson Conservation District.

Utilizing this method allows the infestation to be monitored for extent, distribution, and if it is impacting recreational use, even if fiscal opportunities for active management are lacking.

Strategy 2. Maintain Recreational Use of Shakey Lake

This management Strategy incorporates the monitoring efforts from Strategy 1, however it also includes the prioritization of specific "thresholds" which would be established based on survey results and current season conditions. These thresholds would be set at a level where EWM would impair waterbody access or recreational use of the lake and once reached or exceeded, more active management strategies would be implemented. The subsequent management actions would be discussed and decided upon by the Shakey Lakes Association. These thresholds would also be placed in prioritized areas, such as boat landings and swimming areas, since this Strategy does not aim to maintain or control all populations but only those that interfere with recreation.

Strategy 3. Integrated Management of EWM

This Strategy uses a combination of the strategies above or a combination of the management strategies discussed in the Aquatic Plant Management section (page 24). An integrated management approach should always follow best management practices, use herbicides wisely, and monitor pre- and post-treatment results. Monitoring is crucial to understanding and evaluating the effectiveness of the chosen management techniques. This monitoring also establishes a level of accountability and the data gathered can aid in justifying funding.

An integrated management approach is typically the most cost intensive of all the Strategies and requires the most effort from managers and volunteers. However, if implemented with careful consideration and thorough analysis of lake conditions, this Strategy may be the most effective. One of the biggest aspects of this Strategy is to recognize that the chosen strategies need to be adaptive, as scenarios and conditions may change, even within one season. For example, if a small infestation of EWM is discovered early in the season, hand-pulling may be implemented to remove the population. However, towards the end of the season the population may have spread and/or reached a density where hand-pulling is too labor intensive and no longer a feasible option. At this point, the management strategy would need to be revisited and a new technique would be determined. For example, perhaps herbicides would be considered to knock the population down to a manageable level where hand-pulling could be used as a follow-up treatment. There are many possibilities for management under this Strategy and it is important to review and consider all available options and consult a professional.

Strategy 4. Maintenance Control

This Strategy is aimed at maintaining AIS at a low or reasonable level by actively managing the infestation. It is important to highlight that this Strategy's goal is not to eliminate aquatic invasive plants, but to prevent the invasive from increasing and to maintain a determined level of infestation. This option is similar to Strategy 2 but whereas that Strategy addresses control of priority areas once the invasives reach nuisance levels, Strategy 4 maintains a continual level of management to maintain a reduction in the invasive species despite whether or not the infestation impacts recreation. This type of treatment could include larger-scale treatments, such as mechanical harvesting of all plant beds comprised of aquatic invasive species.

Objective 5. Review current management strategies

Currently, aquatic vegetation on Shakey Lakes is controlled with the goal of prevent aquatic vegetation from reaching nuisance levels and to maintain recreation on the chain of lakes. The management technique used is a drawdown that occurs every third year. While this management strategy has been reviewed in the past, it has been nearly two decades since the effectiveness of this technique has been assessed. There are many plant species that actually benefit from drawdowns and their growth will increase afterwards. At the same time, several species are particularly sensitive to drawdowns. Susceptibility depends on the biology of the plant and seeing as aquatic plant communities are quite dynamic and change over time, it is important to regularly review and assess management strategies and their effectiveness and impacts to the overall ecosystem.

Strategy 1. Closely monitor the water levels during the drawdown process and detail the weather conditions of the winter months during low water levels. Collect photographic evidence and collect standard measurements at a set location (i.e. the water control structure located at the outlet).

Strategy 2. Monitor aquatic vegetation densities prior to and in the years following the drawdown. Target high-priority areas to monitor (i.e. areas where use is often considered impeded or hindered by aquatic plant growth). Use standard protocol and examine the same locations each year of the survey to ensure accurate comparisons can be made.

Strategy 3. Review results of the surveys and consult a professional to aid in the assessment of drawdown effectiveness.

Strategy 4. Based on evidence presented in the survey comparisons, the SLA should review and discuss management strategies and proceed from there. It is important to be adaptive while striving to manage such an ecologically dynamic system.

Objective 6. Actively monitor potential nuisance aquatic plant species of Shakey Lakes.

Several species of aquatic plants have been expressed as reaching nuisance levels by the Shakey Lakes Association and in responses to the lake user survey. Many of these species are near-shore species, such as water lilies, wild celery, some pondweeds, dense native milfoils, and coontail. Monitoring the population density and distribution of these species annually will aid in determining if the population is indeed increasing and reaching nuisance levels. It is important to note that several of these species are beneficial species in the aquatic ecosystem and removal from the system can result in a decline in ecosystem function. The removal could also create an opportunity for the establishment of a more aggressive, possibly invasive, species. By gathering data on the extent and density of the species, informed management decisions can appropriately be made.

Strategy 1. Annually monitor all plants beds containing potential nuisance species present in Shakey Lakes. Photograph the beds and provide comment on their condition (density, health, depth of growth, etc.).

Strategy 2. Measure the perimeter of the nuisance beds and compare extent annually to determine if plant beds are growing and expanding.

Objective 7. Develop an education campaign for Shakey Lakes

Strategy 1. Host an educational presentation or workshop to educate lake property owners and the community about the Plan, general lake ecology, and the ways to maintain or improve Shakey Lakes' condition.

Strategy 2. Develop a lake brochure or similar document that highlights the unique aspects of Shakey Lakes, showcases natural shorelines, and potentially discusses on-going management activities. This document could also include a basic summary of the management plan.

Strategy 3. Involve the community in these activities. Education leads to engagement. The more informed someone is about an issue, the more passionate they can be towards that issue. The community should be actively recruited to protect, maintain, and improve Shakey Lakes.

Objective 8. Update the Shakey Lakes Integrated Management Plan

Strategy 1. Update the Shakey Lakes Integrated Management Plan as new information or data is collected or after 10 years. It is recommended that the plan be thoroughly reviewed every 5 years in order to assess the relevance of the information presented, management recommendations, etc.

Primary Action | Secondary Action/"As Needed or Decided"	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Objective 1. Monitor Water Quality										
Strategy 1.1. Trophic status monitoring (CLMP)										
Strategy 1.2. DO and Temp. Monitoring (CLMP)										
Strategy 1.3. Full spectrum water quality										
Objective 2. Protect Current Water Quality										
Strategy 2.1. Minimize erosion and sedimentation										
Strategy 2.2. Mimimize nutrient pollution										
Strategy 2.3. Promote buffers										
Strategy 2.3. Host restoration workshop										
Strategy 2.4. Identify specific healthy/impaired shoreline areas										
Stategy 2.5. Conduct CLMP Score the Shore survey(s)										
Strategy 2.6. Conduct Aquatic Vegetation Survey										
Strategy 2.7. Monitor plant communities post -treatment										
Objective 3. Prevent spread of AIS										
Strategy 3.1. Utililze AIS Framework										
Strategy 3.2. Participate in Clean Boats, Clean Waters										
Strategy 3.3. Participate in AIS Landing Blitz										
Strategy 3.4. Monitor for AIS										
Strategy 3.5. Update Boat Launch Signage										
Strategy 3.6. Host AIS Presentation										
Objective 4. Review AIS Control Strategies										
Strategy 4.1. No Action										
Strategy 4.2. Maintain Recreational Use										
Strategy 4.3. Integrated Management										
Strategy 4.4. Maintence Control										

Objective 5. Review Current Management										
Strategy 5.1. Monitor, document drawdown										
Strategy 5.2. Survey aquatic vegetation										
Strategy 5.3. Review survey resultsfor effectiveness										
Strategy 5.4. Review/discuss management options										
Objective 6. Monitor for Nuisance Plants										
Strategy 6.1. Photographic documentation, assessment										
Strategy 6.2. Delineate area										
Objective 7. Develop educational campaign										
Strategy 7.1. Present plan										
Strategy 7.2. Lake brochure/plan summary										
Strategy 7.3. Community engagement										
Objective 8. Update Management Plan										
Strategy 8.1. Update/review management plan										

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Appendix A

Advantages and Disadvantages of Aquatic Plant Management Options

Advantages and Disadvantages of Various Aquatic Plant Management Options		
Management Option (Type)	***Advantages***	***Disadvantages***
Shoreline Protection & Restoration	Reduces wave action and erosion along shoreline	Low-cost restoration projects may take several years to become established/mature and for benefits to be noticeable
	Provides a buffer or barrier which filters runoff which limits introduction of excess nutrients, minimizes establishment of invasive species, and provides habitat	Require maintenance until plants are mature and established
	Improves ecosystem function, resilience, and stability	Can be costly, depending on scale of the project
	Require minimal maintenance, once established	
Benthic Barriers (Physical)	Useful for controlling small pioneer populations	Not cost effective for areas greater than 1 acre
	Can be used to maintain open water around docks, boat ramps, and swimming areas	Require seasonal maintenance, which can be costly and installation can be difficult
	No water use restrictions, as with some herbicides	Gases accumulating under the barrier can dislodge it from the bottom, creating a recreational hazard
		Non-selective, will impact all benthic organisms covered by the barrier
Drawdowns (Physical)	Cost effective if water level control structure exists	Some emergent invasives species, such as Phragmites, may spread during drawdowns due to low water levels
	Consolidates loose sediments	Expensive if water level control structure does not exist, requiring water to be pumped or siphoned
	Can offer opportunities for dock or shoreline structure repair during low water levels	Can negatively impact adjacent wetlands and wells
	Submergent plant species that reproduce through roots and vegetative means may be controlled for a several years	In not selective and all plants within the affected area will be impacted

		Several aquatic plant species actually benefit from drawdowns and will experience increased growth. Includes species with large seed banks, propagules, or those growing in deep water not strongly impacted by drawdown
Hand pulling/cutting (Physical/Mechanical)	Hand removal is selective, little to no impact to adjacent, non-target species Can be used as a follow-up to herbicide treatments Effective for small populations or pioneer infestations No water use restrictions, as with some herbicides Can be done without a permit on small scales Affordable	Labor intensive Rakes and cutters are not selective Plants can fragment when pulled Only effective as small-scale control
Diver Assisted Suction Harvesting (DASH) (Mechanical)	Selective of target vegetation Suction hose limits spread of fragments Effective for small populations or pioneer infestations Can be done in deeper water than other hand pulling methods	Labor intensive Sediment composition can impact visibility Not practical for large areas, small scale control only
Mechanical Harvesting (Mechanical)	Results are seen immediately Aquatic habitats are maintained since plants are not harvested to lake bottom Site selective, no offsite impacts Ability to capture fragments is improving	Not selective Other aquatic life could be harvested by accident Can be expensive depending on scale, accessibility, and transport Several cuts are typically required as harvested areas re-grow Fragmentation can spread invasive species and increase infestation levels

Insects (Biological)	Purple Loosestrife beetles (*Galerucella*) are easy to raise and release *Galerucella* beetles have proven to be very effective at controlling Purple Loosestrife Weevils (*Eurychiopsis*) are naturally occurring in Michigan and prefer EWM to native milfoils	Weevil (*Eurychiopsis*) stocking can be quite expensive and needs to be repeated for several years so population can establish at appropriate levels Weevil programs have had mixed results and success is dependent on several factors (shoreline development, winter conditions, etc)
Pathogens (Biological)	May be species specific Could provide long-term control Natural control option – "contact bio-herbicide"	Largely experimental at this time Impacts not entirely understood
Aquatic Herbicides (Chemical)	Practical in large-scale management scenarios Cost effective Does not require much volunteer effort Certain herbicides can exhibit selectivity if properly applied	Opinions of herbicides are varied, especially among stakeholder groups (controversial) Water use restrictions accompany many herbicides Large-scale treatments can deplete oxygen levels in the lake as large amounts of plant matter decompose rapidly Impacts to non-target species can occur to native plants and herbicides can drift to offsite areas Small-scale applications can produce varied results, as there are many factors affecting efficacy of these treatments Follow-up or repeat treatments are often necessary to achieve management goals

Appendix B

Commonly Used Aquatic Herbicides

Common Aquatic Herbicides

There are several approved aquatic herbicides available that are frequently used for the management of aquatic vegetation. The following includes brief descriptions of a few commonly utilized aquatic herbicides. For more information on these herbicides, statutory regulations regarding the permitted use of certain herbicides, and restrictions dependent on individual treatments scenarios, please contact a licensed professional applicator.

2, 4-D

- Weedar, Navigate, Sculpin, etc.

2, 4-D is a systemic herbicide which is commonly used in the control of non-native watermilfoils, also effective against water hyacinth. The herbicide is selective for broadleaf plants however selectivity can be dependent on concentrations applied and seasonal timing of the treatment. 2, 4-D is a synthetic auxin that mimics a naturally occurring growth hormone in the plant and induces uncontrolled growth in the in the tissues that carry water and nutrients. The exposure time for 2, 4-D is considered intermediate, ranging from 18-72 hours, and results can be seen in 1-2 weeks. 2, 4-D comes in two different formulations, a liquid butoxythyl etser formulation which generally has higher toxicity to fish and invertebrates as compared to the granular dimethyl amine salt formulation. However, 2,4-D has not shown signs of significant bioaccumulation in fish. pH of 8 or higher may impact the effectiveness of control.

Copper Compounds

- Cutrine Plus

Copper compounds are broad spectrum, systemic herbicides that aim to reduce algae growth by preventing photosynthesis. The results are typically short-term, especially since increased water clarity can ultimately increase plant growth. Copper also persists in lake sediments and the long-term effects of repeat treatments is largely unknown, although there can be toxicity to fish depending on water hardness. However, there are no recreational or agricultural restrictions on water use following treatments with copper compounds. Exposure times are intermediate (18-72 hours) and results can be seen in as little as one week or up to 4-6 weeks later.

Diquat

- Reward, Weedtrine-D

Diquat is a fast acting contact herbicide that disrupts a plants ability to photosynthesize. Since it is a contact herbicide, it will not move throughout the entire plant, but rather kill any plant material it comes in contact with. Diquat is considered a broad spectrum herbicide and is typically used for the control of Duckweed or watermilfoils, although due to the low selectivity of this herbicide, other options are generally utilized for watermilfoils instead. Localized treatments or small sites where immediate results are desired could see effective control with the use of Diquat. However, cold or muddy waters will inactivate the herbicide quickly and decrease efficacy. Exposure times are considered short to intermediate (12-36 hours) and results are seen in 5-7 days. Diquat is toxic to aquatic invertebrates and may affect non-target plants, such as native pondweeds, coontail, and naiads.

Endothall

- Aquathol (dipotassium salt), Hydrothol 191 (monoamine salt)

Endothall is similar to Diquat, being a broad spectrum contact herbicide. Endothall acts by inhibiting protein synthesis and plant respiration. It is typically used at small sites and is not as effective in dense vegetation beds unless multiple applications are made. Large scale applications have been known to be conducted in the early spring when waters are cool as water temperature can affect the degradation of the product. Endothall is particularly effective on Curly-leaf Pondweed and Eurasian watermilfoil, however it will affect many native pondweed species, which are valuable to the aquatic communities. Applications of Endothall have varying water use restrictions. Ensure that labels are read thoroughly. Exposure times are considered short to intermediate (12-36 hours) and results are typically seen in 1-2 weeks.

Fluridone

- Sonar, Avast

Fluridone is a systemic herbicide that acts by inhibiting photosynthetic processes. It can be considered broad spectrum or selective depending on the concentrations applied. Fluridone requires extended exposure times of at least 45 days. Due to this, special permitting is required and typically only whole lake treatments utilize this product since the dilution can be controlled and the herbicide will remain on-site for the required exposure time. Fluridone can be effective on Eurasian watermilfoil for several years but will impact native species, even at low levels. There is a low toxicity to aquatic life and the effected plant material decomposes slowly, which prevents dramatic decreases in oxygen levels.

Glyphosate

- Rodeo

Another broad spectrum systemic herbicide, Glyphosate acts by disrupting enzyme formation and function in plants. This product is utilized in the treatment of emergent and floating vegetation only, such as Phragmites, cattails, or purple loosestrife. Can be selective if care is taken during application. Results are typically seen in 7-10 days but can be up to 4 weeks.

Imazapyr

- Polaris AC, Habitat, Ecomazapyr 2sl

Imazapyr is a systemic herbicide that is used to control shoreline, emergent, and floating leaf plants (not recommended for submersed vegetation). Imazapyr prevents the target plant from producing a necessary enzyme, known as acetolactate synthase (ALS), which causes the plant to stop growing and they will develop a reddish discoloration. The plants will die slowly over the course of a few weeks to months. It is important to note that resistance to this type of action (ALS inhibiting herbicides) is one of the more common forms of resistance and therefore it is important to avoid repeating treatments with the same chemical for more than a few years.

Triclopyr

- Renovate

Triclopyr functions as a systemic herbicide that disrupts cell growth and division similar to 2, 4-D, and it is also selective to broadleaf plants. This product is frequently used for the control of Eurasian watermilfoil, although it can impact native species such as native milfoils, watershield, pickerelweed, and lilies. It can also be used to treat emergent species as well (purple loosestrife, etc). Exposure times are considered intermediate (12-72 hours) and results can be seen in 1-2 weeks.

Appendix C

Shakey Lakes Management Article – *The Michigan Riparian* (1992) – Pages 7-9, 22

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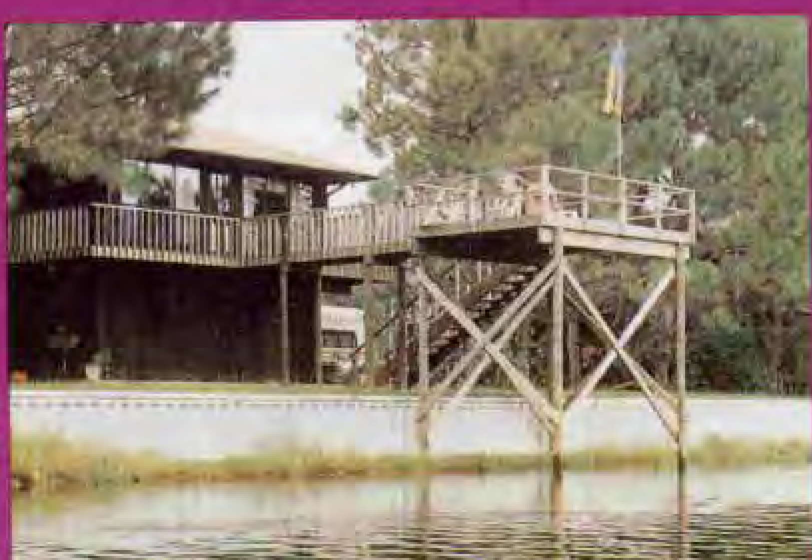

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The Michigan RIPARIAN is the only magazine devoted exclusively to protection, preservation and improvement of Michigan waters and to the rights of riparian owners to enjoy their waterfront property.

The Michigan RIPARIAN is published quarterly and is mailed to subscribers during February, May, August and November.

In This Issue:

Pictures on Front Cover

The pictures on the front cover were taken by the Editor on August 22, 1992.

If you have not visited the Soo Locks or taken the Boat Tour in recent years, you owe it to yourself and your family to do so as soon as you can arrange it.

The history of the building of the locks and their use by industry would fill many volumes. Conversation topics include Indians of the Area, Boats and Shipwrecks, Wheat and Iron Ore Transportation, and much more.

Why not plan your next vacation to include the locks and visit the enchanting falls in the Upper Peninsula and around Lake Superior?

GUEST EDITORIAL

Lakes Preservation League
THE PRESERVER
October, 1992

By Ann McKie

As a private citizen of Lenawee County, Michigan, I submitted this communication to the Woodstock Township Board at their monthly meeting on August 3, 1992:

I would like to speak as a private citizen in behalf of an entity which cannot speak for itself — the gifts which were bequeathed by Nature to fortunate areas of our state — the inland lakes of Michigan. The desirability of these gifts has been demonstrated in recent decades by the proliferation of "man-made" lake development.

Were the 2,000 acres which Devils and Round Lakes cover evaluated as commercial holdings I would maintain that their value would far exceed 2,000 acres of farm land in this county. At $1,000 per acre the lakes ticket would amount to $2,000,000. But I am not speaking in an attempt to assess the specific value of these lakes. I am here to persuade that their protection and preservation is worth your attention.

Were anyone capable of buying these beautiful expanses and moving them to another site, as manufacturing plants can be relocated, how much would governing bodies such as Woodstock and Rollin be willing to concede in persuading the owners to remain in your township? Here is an asset which is better than a commercial establishment with no start-up cost and minimal upkeep.

The Department of Natural Resources is attempting to enforce the laws which protect our lakes, but what are the governing bodies and citizens doing to assist the DNR in its effort?

In these tight economic times mistakes are being made — monumental errors which could devastate our environment. Pressure is being applied by commercial enterprises to relax our regulations in the name of recovery.

I think I need only remind you of the devastation visited upon the Great Plains states during the 1929-1941 depression. Have they yet recovered from the over cultivation which created the "Dust Bowl?"

I plead with you to support and encourage vigorously the efforts of the DNR. Enact protective regulations and invest in their enforcement!

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Shakey Lakes Association Strives for Solution to Aquatic Weed Problem

By: *T. M. Burton, Professor, Departments of Zoology and Fisheries and Wildlife, Michigan State University, East Lansing, MI 48824 (Ph.D in Aquatic Ecology from Cornell University, 17 years teaching at MSU - 1975-92);*
M. J. O'Malley, Department of Zoology, MSU (at the time of the study — currently working with wetlands mitigation with the Department of Transportation, Lansing, MI) (B.S. in Environmental Science from MSU);
R. E. Kinnunen, District Extension Sea Grant Agent, Michigan Sea Grant Extension, Michigan State University, Upper Peninsula Extension Center, 1030 Wright Street, Marquette, MI 49855.

Introduction

In the mid-1980's, the Michigan State University Cooperative Extension Service and Michigan Sea Grant Extension were invited by concerned property owners of Shakey Lakes to examine the aquatic weed problem in their lake system. The aquatic weed problem was beginning to interfere with a variety of recreational activities such as boating, fishing, and swimming.

The Shakey Lakes system consists of five lakes located in the southwestern part of Menominee County in the Upper Peninsula of Michigan a few miles inland from the mouth of Green Bay near the Wisconsin border *(Figure 1)*. The interconnected lakes making up the system are Bass and Baker (92 acres), Becker (8 acres), East (70 acres), Resort (100 acres) and Long (80 acres) Lakes. The depths of these lakes

Figure 1 — **Map of the Shakey Lakes system. Drawn by D.A. Burton from a USGS topographic map with 10 feet contours (dotted lines) drawn by eye from the Institute of Fisheries maps of the lakes available from the Michigan United Conservation Clubs.**

range from 8 feet to 43 feet with all of Becker, most of Bass and Baker, and a substantial part of East Lake being less than 10 feet deep (Figure 1). Depths of less than 10 feet, water of reasonable clarity (Secchi depths usually exceed 10 feet), and nutrients brought in by the Shakey River make growth of rooted aquatic plants in these areas of Shakey Lake almost a certainty. In fact, the 1942 map of the lake by the Institute of Fisheries Research showed that most of the shallow areas supported weed growth at that time. The deeper, central portions of Resort and Long Lakes have minimal weed problems. Riparian owners around Becker Lake, in particular, have difficulty keeping access to the rest of the lake system because of the aquatic weed problem. Bass and Baker Lakes are separate lakes, although they are connected to Resort Lake by a culvert, while the other four "lakes" are all a part of a single lake system on the Shakey River, a tributary of the Menominee River. The Shakey River enters the shallow Becker Lake and exits from Long Lake at an outlet structure that controls water level in the system.

Several of the property owners of Shakey Lakes expressed an interest in forming a lake association so that the aquatic weed problem could be addressed from a unified front. The Michigan State University Cooperative Extension Service and Michigan Sea Grant Extension hosted several meetings to assist property owners in forming a lake association. Shortly after the Shakey Lakes Association was formed, some of the members wished to explore the effects of a winter water drawdown on the aquatic weeds in the lake system. A partial drawdown could be accomplished by removing the water level gates at the outlet structure from Long Lake.

T. M. Burton of the Departments of Zoology and Fisheries and Wildlife at Michigan State University was contacted in early 1986 by the Shakey Lakes Association about the possibility of conducting a study on the effects of a drawdown on aquatic weed control in Shakey Lakes. Burton and M. J. O'Malley agreed to conduct such a study with 1986 being a season of data collection before the drawdown, tentatively planned for the winter of 1986-87, and with data collection on the effects of the drawdown to be conducted in 1987 and beyond. The total membership of the Shakey Lakes Association failed to support a vote for the drawdown because of its controversial nature. Thus, the original purpose of the study could not be fulfilled.

The results from these studies were presented orally in 1986 and 1987 to the annual meeting of the Shakey Lakes Association and were also presented in 1987 to the Menominee County Board of Commissioners (they had provided partial support for the project). Aquatic weeds continued to be a problem in Shakey Lakes and, in November 1991, the Shakey Lakes Association requested the formation of a working committee to review the aquatic weed problem and prepare a recommendation for action for the Association. Besides members of the Shakey Lakes Association, various county and state agency representatives were present at this working committee meeting. The results of the 1986-87 Michigan State University studies were presented to the committee by R. E. Kinnunen at the November meeting and a list of recommendations were developed to address the aquatic weed problem. This paper includes a synopsis of the findings and recommendations presented to the committee.

Results — Chemical Indications of Lake Stress

In most lakes in temperate regions such as in Michigan, the lake stratifies in the summer because of density differences between the cold, heavy bottom water and the warmer, lighter top water into a circulating warm top layer in contact with the air above the lake and into a relatively stagnant colder bottom layer that has no contact with air. In the deeper part of Shakey Lakes in Resort Lake, this thermal stratification had already taken place by the start of the study on May 16, 1986 *(Figure 2)*. Thermal stratification took place some time between March 6 and May 5 in 1987. This thermal stratification eliminated reoxygenation of the bottom water below the top 4-5m

(Continued on Page 8)

Shakey Lakes Association Strives for Weed Solution

(Continued from Page 7)

circulating layer resulting in oxygen in the bottom water being depleted over the spring and summer by respiration of animals and microbial populations in this layer. This deoxygenation was essentially complete below 7m by mid-June in 1986 and continued this way through mid-August *(Figure 2)*. Deoxygenation of bottom water took place by May 20, 1987, and continued through the final sampling date on August 28, 1987. From mid-August until early October, 1986, the upper layer cooled enough to allow reoxygenation of the water deeper and deeper into the water column *(Figure 2)*. By October 20, temperature and dissolved oxygen was essentially the same throughout the water column.

If oxygen is totally depleted in the bottom water during the summer as occurred in Shakey Lakes in both 1986 and 1987, the lake is usually classified as eutrophic meaning that too much plant growth has occurred in the circulating, top well-lighted layer. This plant material settling into the bottom layer decays and depletes oxygen as it is respired by microbial and animal consumers. This oxygen depletion resulted in numerous negative changes including release of phosphorus from bottom sediments (soluble reactive phosphorus increased in the bottom water from values of 10-15 µg P/L that were characteristic of the top layer to 20-30 µg P/L after oxygen values approached zero) and inability of fish and many insects to use

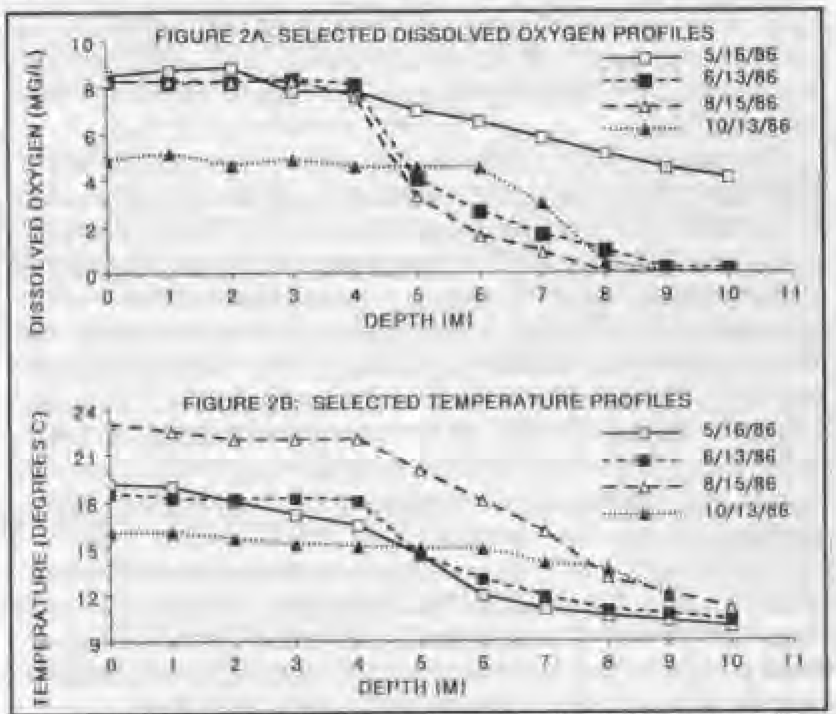


Figure 2 — **Selected dissolved oxygen and temperature profiles for Resort Lake in 1986.**

this deoxygenated bottom layer. Soluble reactive phosphorus (the form of phosphorus that is available to plants for growth) values in the upper circulating layer of Shakey Lakes suggested that the lake could be classified as either eutrophic or in advanced stages of mesotrophy and corroborate the classification based on dissolved oxygen loss in the bottom water. Other chemical changes including decreases in pH and changes in alkalinity also accompanied loss of oxygen from the bottom water just as they are often described in limnology texts.

A substantial drop in dissolved oxygen in Shakey Lakes occurred between September 10 and October 3, 1986, from normal summer readings of 8-9 mg/L in the top 4m of the lake to values of 4-5 mg/L in the top 6m of the lake on October 3 *(Figure 2)*. The most likely explanation is that respiration and decay of aquatic weeds during autumn cooling and plant die-back was responsible for this drop. Alternate explanations include blooms of algae in the water column or substantial loading of organic matter from the watershed. Dissolved oxygen levels below 5 mg/L are known to be stressful to many species of fish. The lake recovered to near saturation of the entire water column with dissolved oxygen (10-11 mg/L) by mid-November.

After the lakes became ice covered, dissolved oxygen declined gradually throughout the winter from the 10-11 mg/L in November to 2-3 mg/L below 2m in March, probably as a result of decay of the aquatic weeds over the winter. Dissolved oxygen values of 4-5 mg/L from the ice surface to 1m occurred, probably as a result of plant production just under the ice surface. The winter of 1986-87 was relatively mild. A thicker or more opaque layer of surface ice and/or increased production of aquatic weeds could lead to winter kill of fish in Shakey Lakes. Local anglers report that such fish kills have occurred in Bass Lake in recent years. This loss of oxygen over the winter also means that a winter drawdown of the lakes would be risky. A drawdown would mean that plant decay would be concentrated in less water and could increase the likelihood of a fish kill.

Soluble reactive phosphorus values as discussed above were above the 10 µg P/L needed to support excessive plant growth, as were values for inorganic nitrogen (mean of 57 µg N/L in 1987) in the surface water. Concentrations of these nutrients from the Shakey River inlet water rarely exceeded the concentrations in the lake or in the outlet water indicating that the lake may have been receiving substantial inputs of nutrients from other sources. No attempt was made to conduct a complete nutrient budget for the lake. However, likely additional sources of nutrients include septic systems of the substantial number of homes and cottages around the lake; inputs from the campground and county fair activities that take place in Shakey Lakes Park; groundwater inputs and internal recycling of nutrients from the sediments. Present and past agricultural practices in the Shakey Lakes drainage could have contributed to the nutrient loading of the lake system. Currently, there are 10 active farms in the Shakey Lakes drainage basin with farm practices including dairy, beef, row crops, hay, and Christmas trees. An additional 8 farms were active in the past with farm practices including dairy, row crops and hay. Even the reasonably low concentrations of nutrients now being received in the inlet waters coupled with other likely sources mean that more than enough nutrients are stored in the sediments to support high levels of aquatic weed growth in the shallow areas of the lake. This is especially true in the shallow inlet area of the lake system known as Becker Lake *(Figure 1)*.

Aquatic Plants

Four plant transects (one in Becker Lake, two in shallow areas of Resort Lake, and one in a shallow bay of Long Lake) were sampled with 10 samples being taken at random points along each transect. The greatest plant biomass was recorded from Becker Lake and the least from Resort Lake. Biomass varied from 124g dry weight/m^2 in Becker Lake to 35 g/m^2 for

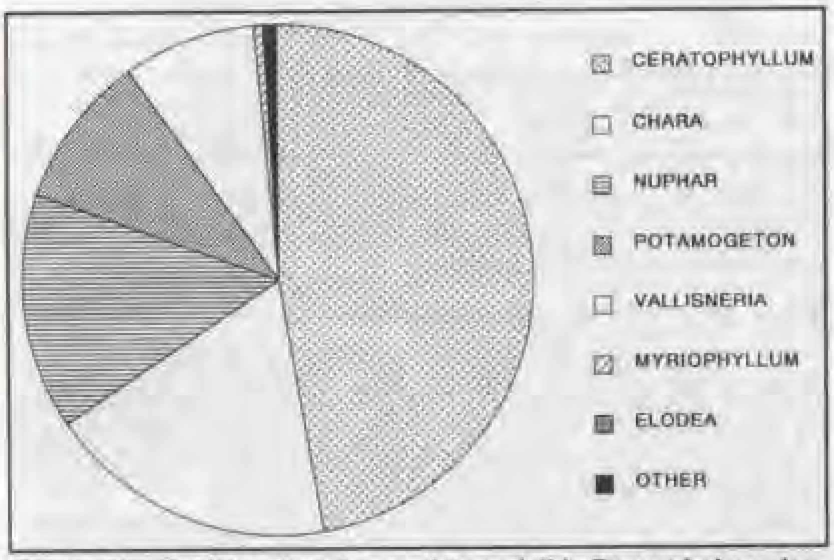


Figure 3 — **Relative abundance of "weeds" in Resort Lake calculated from an average of two transects across the northern arm of the lake (see *Figure 1*). Note the dominance of coontail *(Ceratophyllum)* and the presence of asian pond weed *(Myriophyllum).***

one of the Resort Lake transects. This biomass is moderate to high. The good news is that these values could be much worse; values as high as 600g dry weight/m^2 are reported in the literature.

Species composition was quite diverse with most plants that grow in lakes in Michigan being found. However, plant biomass was dominated by coontail *(Ceratophyllum)*, muskgrass *(Chara)*, the "water lily" *(Nuphar)*, and several species of pondweed *(Potamogeton) (Figure 3)*. Coontail is a floating submerged species. Reports from Wisconsin suggest that it simply floats with the receding water during drawdowns and comes back even stronger after drawdown. Apparently, reduction in competing species during drawdown can lead to increases in this species after drawdown. Thus, a drawdown might even make the situation worse. Eurasian pondweed, *Myriophyllum*, was also present in Shakey Lakes but was not a major factor in species composition. Another management technique to be considered for Shakey Lakes is harvesting and removal of the aquatic weeds. There are reports that harvesting can lead to increases in *Myriophyllum*, since it can regenerate from all the small fragments produced and left in the water during harvesting.

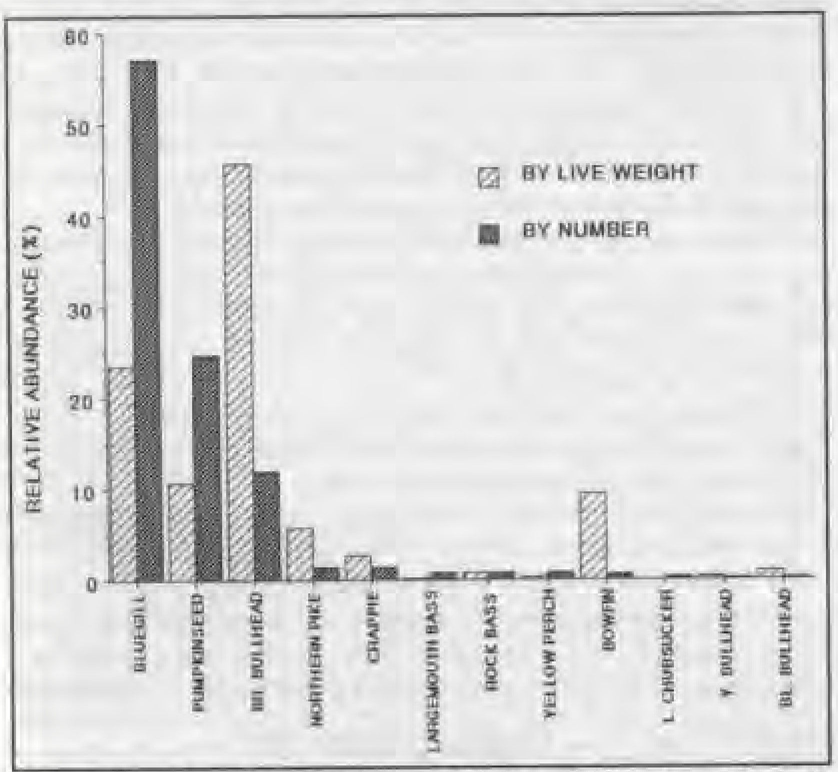


Figure 4 — **Relative abundance of fish caught in weed beds in Shakey Lakes in 1986 with fyke (hoop) nets.**

Fish

A large variety of fishes use the weedy margins of the lake either as a habitat for adults (bluegill) or as a nursery area for juvenile fish (large mouth bass). Fyke (hoop) nets were borrowed from the Michigan DNR offices at Crystal Falls and set in weedy margins of the lakes in 1986 and 1987. More than 1100 fish were caught and released back into the lake in 1986 *(Figure 4)* and more than 1200 were caught in 1987. Bluegill sunfishes dominated the catch by numbers in 1986 *(Figure 4)* and 1987, while brown bullhead were more important in terms of the total weight of fish caught *(Figure 4)*. Average weights and lengths of fish caught indicated that stunting was not a major problem in the lake.

Conclusions

The conclusions of this study are as follows:

(1) The main lake is eutrophic and has little oxygen below 6m (19.5 feet) during most of the summer.

(2) Nutrients in the water column are adequate for plant growth especially when combined with internal recycling of nutrients from the sediments by rooted plants. Adequate nutrients and large areas of the lake system with depths less than 5-6 feet result in an inevitable weed problem. This weed problem cannot be eliminated, only managed.

(3) Aquatic weed beds include a high diversity of plant species. The most common species are coontail and water lilies.

(4) Nutrients in inlet water were not consistently higher than nutrients in lake water indicating that it may not be the only source of nutrients for the lake. Likely, but unsampled sources, include septic systems of the many homes and cottages around the lake, inputs from the heavily used campground and other activities associated with Shakey Lakes Park, leaf fall and rainfall into the lake and groundwater inputs. The septic systems and runoff from the Park are likely to be the most serious problem other than agricultural runoff into the Shakey River inlet. There are 10 active and 8 retired farms in the drainage basin with farm practices including row crops, dairy farming and hay production. Row crops and dairy farming are sources of substantial nutrient inputs to streams according to the literature. The fact that concentrations of phosphorus and nitrogen in inlet water was not very high indicated that present farming practices are reasonably successful in controlling runoff to the Shakey River. Past practices may not have been as successful. Phosphorus release from the bottom sediments into the overlying water was indicated, as expected, during periods of deoxygenation of bottom water in the summer.

(5) The weedy areas of the lake contain a high diversity of fish species. The most common species caught were bluegill and pumpkinseed sunfishes and brown bullhead. Juveniles of the potentially larger fish (large mouth bass, bowfin, northern pike) were caught in the weedy areas of the lake indicating the importance of these areas for smaller fish as a nursery area and/or as a refuge from predation by larger fish.

(Continued on Page 22)

MLSA Annual Meeting
"When is it Appropriate to Use Aquatic Herbicides?"

By Dr. Charles P. Cubbage, Agriculture Environmental Coordinator, Michigan Department of Agriculture, 10/3/92.

Introduction

It is a distinct pleasure to be invited to participate in Michigan Lake and Stream Associations' annual meeting. MLSA has provided its members strong leadership for many years, focusing on a variety of issues and critically examining all aspects of those issues, in part because of the diverse interests represented by the associations. Your credibility also stems from the involvement of people like Leighton Leighty, Cliff Humphrys, and Wally Fusilier, as well as many other experts. Last, but certainly not least is the unselfish leadership, dedication, and knowledge provided by Don Winne, without whom MLSA would not be what it is today.

I had prepared my notes for the meeting shortly before Director Schuette received a letter asking for our comments on a presentation by Dr. Hargett of Sandoz, Ltd. There were so many similarities, that I felt compelled to include his perspectives as a representative of the chemical industry. At the June, 1992, Joint U.S. Environmental Protection Agency (EPA) and U.S. Department of Agriculture's (USDA) National Integrated Pest Management (IPM) Forum in Arlington, Virginia, Dr. Hargett emphasized the need to increase the use of integrated pest management. Extensive use of a single management tool because it is easy or convenient has produced counter productive results.

This over reliance on pesticides has resulted in resistance among insect, "weed" and other pest populations. From the manufacturers' perspective, resistance limits the usefulness of a product that took millions of dollars and years of research and testing before it could become registered for use. Users will switch to other products as resistance develops and hence cut profits if they shift to a competitor's product. Aquatic weeds are part of this pest control issue.

Setting the stage

Dr. Hargett noted that if pest management is to be successful, we need to take into account the biology of, not only the pest but, the biological system in which the pest creates the problem. The "management" includes cultural, mechanical, biological, and chemical techniques and the concept of tolerable but controllable levels of the pest. Chemical management involves the use of pesticides and fertilizers. As an aside, I am using the legal definition of the term pesticide. In "legalese" the term pesticide includes herbicides, fungicides, insecticides, and redenticides. Mechanical control refers to practices such as aquatic weed harvesters and dredging. Examples of biological control would be the use of the bacteria, *Bacillus thuringensis*, or Bt which is used to control gypsy moth or the white amure, a fish reputed to be a voracious eater of aquatic weeds. The remaining category, cultural controls, refer to making changes in our practices, behavior, or regulations that impact the problem, such as the use of non-phosphate fertilizers, green belts, prohibition of motors on lakes, or sewer construction.

Not all the options that can be developed under each of these categories are equally useful, but "useful" is a relative term depending on who benefits, who pays and a host of other considerations. Before making choices, you must ask a wide range of questions and evaluate the responses. For example:

When is the pest most susceptible to each of the control options? How do the economics of each compare? What are the environmental risks? Is there a potential for resistance development? Are the solutions socially acceptable? What are the relative trade-offs, etc.?

The People Problem

Dr. Hargett recognized the need to move away from the confrontational approach we so often see when affected interest groups are at odds. Our present local and state political infrastructure does not necessarily lend itself to conflict resolution. In fact, it may contribute to the conflict.

However, you should realize that the governmental framework is only a formal process, and not the only way by which problems can be resolved. A great deal is known about more effective techniques. And that was one of the points he made, i.e., we must develop and use communication methods that involve all who have a stake or responsibility in the issue. For lake issues, the stakeholders could include the township and county officials, environmentalists, lake management firms, lake boards, and state agencies (DNR & MDA).

There are techniques that ensure faster, more reasonable, and less costly solutions. "Getting to Yes" by Fisher & Urey, two professors at Harvard, is an excellent reference. These two gentlemen developed the protocol that was used for the Camp David Peace Accord and also were involved in securing the release of our Iranian hostages. The other item is "Improving Dialogue with Communities", put out by the New Jersey Department of Environmental Protection. I will provide a copy of the New Jersey material to MLSA for inclusion in your newsletter or publication if you find it useful.

Options

Although some may be surprised by Dr. Hargett's comments because he is employed by the chemical industry, I find that his points represent enlightened self-interest on the part of the industry and are consistent with their long term success. He emphasized the need to evaluate cultural and biological options and that the best approach is often to select the methods which increase the "clout" of your effort. I would strongly warn you against being pressured into the "either/or" mentality often presented. Think in terms of combinations of solution options that will best solve your concern.

The concept of Integrated Pest Management (IPM) is nothing more than having you look at the control options and using them alone or in combinations. Your task should be to:

(1) identify the users and use(s) of your lake or stream,

(2) define the problem,

(3) identify the causes, the biology of the aquatic pest or "weed", the ecology of the system in which the pest lives, your (and other affected persons') priorities,

(4) select the times and tool(s) to address the problem,

(5) and of course, cost (but over what time frame?).

Solutions may include cultural (limiting nutrients via lawn care, run-off management), mechanical (drawdown, harvesting), biological controls (white amure, duck and geese removal), and chemical options used alone or in combination.

Pesticides — Department of Agriculture: Role and Policy

The Michigan Department of Agriculture (MDA) regulates the use of pesticides under the authority of the Michigan Pesticide Control Act of 1976 P.A. 171, as amended in 1988, and from the Federal Insecticide Fungicide and Rodenticide Act (FIFRA) that U.S. Environmental Protection Agency (EPA) is responsible for at the federal level.

The MDA director is charged with ensuring that a pesticide's use "will not cause unreasonable, serious, chronic hazard to human health or long-term environmental damage". If there is sufficient data to suggest that a product has potential to cause problems, the director has the responsibility to not register it or to revoke an existing product registration. Michigan has been responsive, having been the first state to ban DDT, chlordane, and tributyl tin. Through Michigan's leadership, the use of mercury in latex paint was halted.

Inherently, pesticide use has the potential for release beyond the environment for which it was intended. And although modern pesticides are generally shorter lived and more pest specific, non-target species damage and other impacts are of concern. Thus, MDA encourages the reduction of pesticide use whenever possible, a policy echoed by Dr. Hargett in his presentation at the IPM Forum this summer.

Both federal and state law spells out what is needed to ensure proper pesticide product use. Over the last 4 years, MDA has worked closely with the agricultural community, industry, environmental groups, and other interested persons to develop regulations that protect the public, applicators, and the environment. The newly adopted state regulations (636 & 637) include better training for pesticide applicators by requiring that they understand the pesticide label, mixing and loading directions, safety precautions, use and calibration of equipment, target organisms, environmental fate, etc.

In addition to working with industry to insure qualified applicators, MDA also investigates all complaints of pesticide misuse or exposures. We are one of the few state departments of agriculture that has its own toxicology unit, and hence the ability to review, respond, and participate directly in pesticide related health incidents or issues.

The amount and type of information EPA now requires for the registration of new products or re-registration of current pesticides is more comprehensive than earlier requirements, in part due to the increased public concern for safety. The cost of animal testing to estimate human risk or doing epidemiological studies is prohibitive. Needless to say society frowns on human testing, although we unfortunately find accidental exposure data valuable. Without human information, the process of risk assessment attempts estimate what could happen to humans based on extrapolations from animal test results. Not an easy task for the public to understand.

Relative to herbicide applications and pesticide safety in general, let me provide you with my opinion (as a biologist and environmental scientist with a background in environmental epidemiology). I believe that better testing is needed particularly on old products. Properly used, I believe very few people are at risk of acute illness. There are valid questions about more subtle, long term health and ecological impacts, which are very costly to determine. MDA will continue to be alert to health and environmental information that might indicate a need to re-examine a products registration status.

MDA investigations clearly show that the people most at risk are those who handle, mix and load, and make pesticide applications. Perhaps even more at risk is the homeowner who obtains herbicides and applies it by him or herself. They have none of the training or access to the personal protective equipment available to certified applicators.

With respect to the aquatic herbicide application industry, MDA shares joint but separate responsibilities with the Michigan Department of Natural Resources (DNR). Application permits are secured from the DNR, while pesticide manufacturers must annually register their products with not only EPA, but with MDA. Also, to operate in Michigan, commercial firms must be licensed and have properly certified or registered applicators. To insure compliance, MDA conducts Planned Use Investigations that involve observing applications, and checking equipment and noting credentials and records. The department also prides itself in initiating investigations of complaints within 24 hours.

Points to Consider regarding Aquatic Pesticide Uses

What are your management objectives? Wht might other's objectives be? Are they compatible objectives? Fishers, sailors, powerboaters, skiing are only a few. Far and away, the most common activity is just viewing.

There are implications for non-riparians. Agricultural activities in a lake or stream drainage basin may have an impact. If you expect to have success in eliminating or reducing such an impact you need to be ready to protect the farmer's livelihood also.

Putting an herbicide in water releases it into an invisible environment, one in which drift is likely. The direction and extent of drift is seldom given any real consideration. Rain, irrigation, release of water from a dam, lake inlet direction and flow rate, lake-bottom river channels, wind speed and direction, and other factors make drift impact on areas outside the treatment zone an uncertainty. Because their use is invisible, we run into the "out of sight, out of mind" phenomenon. Personally, I believe there should be an assessment of these factors before using aquatic herbicides. The use of dye tracers would seem useful either as a pre-application evaluation or of actual drift if used concurrently with the application.

The interaction of chemicals in water is dependent on a number of factors, any given dose of Sonar, for example, is likely to have a much greater impact in Michigan than in the south where its use was piloted. There, the higher water temperatures cause it to break down much faster than here, and hence its effects are more pronounced in our colder waters. Other properties of water such as alkalinity, dissolved oxygen (DO) level, pH, iron content and others may affect the efficacy of a given product.

With respect to the use of any of the IPM tools, I would suggest you should seek answers to the following questions:

(1) Are there any implications for other property owners or water users?

(2) What are the seasonal and long-term after effects and results? With some chemicals, there might be sediment build-up, bioaccumulation, return to the water column, changes in the types of species present in the food web, e.g., trading algal blooms for rooted plants, etc.

(3) Would drift constitute trespass if damage occurred to property others?

(4) Does the person or firm offering a service have a bias or vested interest in any particular solution? That is not necessarily wrong, you just need to be aware of it in your evaluation of options.

(5) Given the affected parties in your situation, have you set clear priorities? Are they IPM based? Are the options realistic? Do they fit in with a 5 or 10 year plan?

(6) Does the management strategy include the assessment of the impact on the ecology?

MICHIGAN LAKE AND STREAM ASSOCIATIONS

MICHIGAN LAKE & STREAM ASSOCIATIONS, INC.
Business Office: P.O. Box 249, Three Rivers, Michigan 49093
Office Address: 124½ N. Main St. Phone: (616) 273-8200
Donald E. Winne, Executive Director Fax: (616) 273-2919

New ML&SA Members

Forest Lake Association, Arenac County
Ralph Kelly, President - 1720 Members

Goshorn Lake Property Owners Association, Allegan County
David Howells, President - 44 Members

Nevins Lake Improvement Association, Montcalm County
Jack Bosch, President - 65 Members

Beretha Lake Property Owners Association, Clare County
Vern Osgood, President - 64 Members

Selkirk Lake Improvement Association, Allegan County
Frank DeVos, President - 40 Members

Hunter Lake Heights Association, Alcona County
Martin Stuck, President - 30 Members

Shawnee Shores Civic Improvement Association, Lenawee County
Harvey Hawkins, President - 97 Members

Middleboro Lake Association, Kent County
Dennis Williams, President - 97 Members

Lone Pine Association, Oakland County
Marilyn Maker, President - 300 Members

Diamond Lake Association, Mecosta County
Craig Turnbull, President - 40 Members

Union Lake Shore Association, Oakland County
Ron Sesvald, President - 75-100 Members

Richard L.S. Brown, elected President of Michigan Lake & Stream Associations for 1992-93. More information about Dick on the next page.

Thank You

*A special thanks to the following businesses and individuals for their contributions to the **"Silent Auction"** held at the 31st Annual ML&SA Conference:*

Boyne Highlands Resort, Harbor Springs
Mr. & Mrs. Joe Landis, East Lansing
Mr. & Mrs. Richard Brown, Fenton
Aerial Graphics, Grand Rapids
Clarion Hotel, Big Rapids
Lake Weed-Away, Ada
Shanty Creek Resort, Bellaire
Sixty Lakes Marina, Long Lake
Stoney Creek Trout Farms, Grant
Water Quality Investigators, Dexter

Michigan Lake & Stream Association's 31st Annual Conference Lauded

We are very pleased with the attendance of 190 persons representing 65 lakes at our Annual Conference.

We have had calls and letters from some of the 14 companies that set up exhibits, saying that it was one of the best facilities they had seen.

Comments about the rooms and food were very positive, and we could not have asked for better weather.

Michigan Lake & Stream Associations has moved forward this year. We now have 225 lake association members, which is 24 better than last year, and last year with 201 had set a record.

We have expanded our Secchi Disk water clarity measuring program which now includes 98 lakes.

We have begun a water quality testing program and 27 lakes have joined this program. The water quality testing includes six parameters. They are: Alkalinity, Chlorophyll-a, Conductivity, Nitrates, Phosphates and pH. We expect to carry out a spring phosphorous study with participating lakes next spring. Individuals on lakes are to collect the water samples, freeze them and deliver them to the nearest DNR office. If you want to get in on this program, we need to hear from you or your lake association. You will need to participate in the Secchi Program to be eligible to participate in the phosphorous program. The cost for the Secchi program is $35.00 and the phosphorous program is an additional $15.00 for a total of $50.00.

ML&SA Awards Presented

1992 Outstanding Regional Director Award

JACK VANDENBERG - REGION 4

1992 Outstanding Vice-Presidential Award

DENNIS ZIMMERMAN

Clifford Humphrys Honorary Award

BARBARA AND CHARLES DOTTERRER

Richard L.S. Brown

The President of Lake Fenton Property Owner's Association becomes President of Michigan Lake & Stream Associations Inc.

Dick was elected President of Michigan Lake & Stream Associations by the Board of Directors at their Annual Meeting held on Sunday, October 4, 1992, at Boyne Highlands Inn at Harbor Springs, Michigan.

Dick is the thirteenth person to serve the office of President during the thirty-one years that ML&SA has existed.

We believe that Dick's experience in supervisory and administrative responsibilities in his 29 years with General Motors will mean that ML&SA will move forward in its efforts to help lake associations protect and preserve the water resources of Michigan.

Dick, and his wife Sharon, live at 13355 Lakeshore Drive, Fenton, Michigan. Sharon is very active in the Lake Fenton Association, and believes strongly in the objectives and projects of ML&SA.

Merrill "Pete" Petoskey Sworn In As A Public Member Of The Michigan Oil & Gas Advisory Board On September 22, 1992

"As a Board, it is our responsibility to keep the Supervisor of Wells (Roland Harmes, Director, DNR) informed and advised on oil and gas activities in Michigan, as permitted by Public Act No. 61, 1939, as amended.

My wife and I reside near Lewiston in southwest Montmorency County. As such, we are quite familiar with activities in Oscoda, Crawford and Otsego counties, as well as our own.

I ask that any person who wishes to express a feeling or opinion on oil and gas activities in Michigan should write down your ideas and send them to me. Of particular interest will be your comments on Antrim Gas development in Northern Michigan. Your comments will be transmitted to members of the Advisory Board, and to the supervisor of wells.

Merrill L. Petoskey, 2829 Cobb Road, Lewiston, MI 49756

ML&SA Member News

BARRON LAKE ASSOCIATION — Cass County
Bruno Eidietis, President

Sewers for Barron Lake Being Studied

At our July meeting, our members posed numerous questions to the candidates for Howard Township Supervisor about the possibility of extending sewer lines into our Township. Opinions varied, both among our members and the candidates. What became very clear was that no one present had a good idea of just what was involved in the process of bringing in sewers.

With the help of Fred Leet, our current supervisor, we have arranged to bring Tom DeNeau of Wightman & Associates to our September meeting. Wightman & Associates has been involved in designing a number of sewer systems in our County. He will address both the process of requesting sewers and the typical cost of such a project.

DEWEY LAKE ASSOCIATION — Cass County
James Wardlaw, President

Lake Management

Dr. Ervin of Freshwater Physicians, Inc., has done some testing and the data collected in the lake indicates that the lake is a very soft water lake, which may explain the freshwater jellyfish and bryozoans. There is also substantial oxygen deficit in the bottom waters. Soft water lakes are *sensitive* to nutrient enrichment, so more effort will be needed to keep the lake from really showing further signs of eutrophication. *This is a preliminary report* and more testing is to be done by Dr. Ervin before a final report is completed in late winter, 1993. The cost for this study will be $1,900.

A Special Request for Fishermen from Dr. Ervin:

"I'd like to get the fishermen organized ASAP. Have them scrape some scales from the left "shoulder" area of the fish, measure it and release it if they want. If they are going to eat the fish, tell them to cut out and freeze the stomach and intestines. Put the scales and stomach in an envelope, put the fish species and length on the outside. Date and bait would be useful, too. We can use anything they catch." Please contact Bruce Nevins at Shady Shores Resort with your findings.

Our new board and officers agreed at our last meeting to facilitate the extension of the No Wake Law to 8:30 p.m. Michigan time on Friday and Saturday nights. These types of grievances must be addressed so we can all work together on permanent solutions to water quality of Dewey Lake.

ELK-SKEGEMOG ASSOCIATION — Antrim, Grand Traverse and Kalkaska Counties
Ed Krigbaum, Vice President

ESLA continued its water quality monitoring program in several ways last year. Watson Hogarth and his helpers continued the secchi disk readings work in each lake. Their weekly readings were compiled for the DNR and add to data going back over some twenty years.

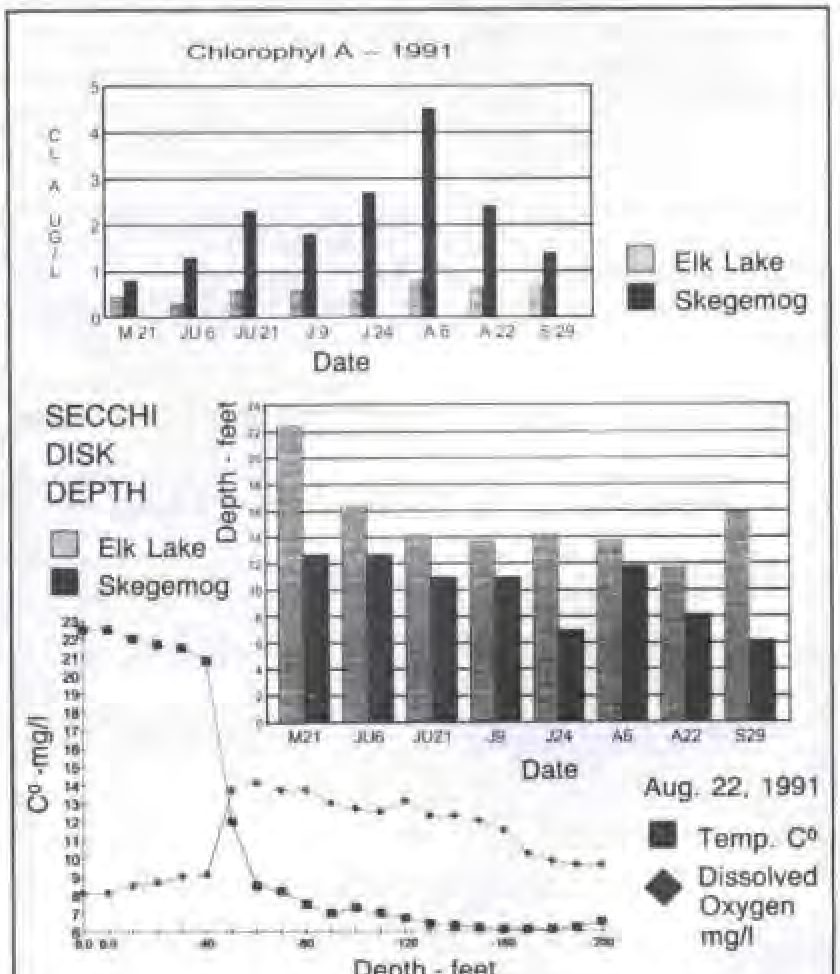
Resource Director Bill Weiss resumed the sampling program begun last year. Approximately every two weeks data was collected at a 'station' in the middle of Elk and Skegemog. Readings of date, time, air temperature, weather conditions, wave height, and wind direction, and secchi disk depth were recorded.

A "chlorophyll A" sample was collected by dropping the "integrated depth sampler" (a bottle with a small hole in the top) to a depth twice that of the secchi reading. This approximates collection of plankton in the upper part of the lake where the sunlight penetrates integrated over that distance. This sample was transferred to a covered bottle (to keep sunlight out) and stored in a cooler.

Next a profile of the temperature and dissolved oxygen was taken using the Three Lakes meter and the 200 feet of cable purchased last year by ESLA. A reading was taken each ten feet of depth and recorded.

The Association authorized three phosphorus samples taken on the first sampling run of spring. The results were North Elk - 1.8 ug/l, Mid-Elk - 4.7 ug/l, and Skegemog - 2.3 ug/l. In a lake system where the growth of plankton is "limited" by the amount of phosphorus, these are extremely low levels and reflect the good water quality of the system. By contrast, a tertiary wastewater treatment (the best) might discharge water with a concentration 100 times this level. A secondary wastewater plant might discharge water 1,000 times higher in phosphorus.

The graph of chlorophyll-a illustrates the difference between a deep cold lake like Elk and a shallow warm lake such



as Skegemog. Both start out in May below 1 ug/l. By the first week in August, plankton have reached their peak growth. Chlorophyll A has almost doubled in Elk but remains below 1 ug/l. Skegemog's warm sunlit waters have grown a lot more plankton and produced a high of 4.5 ug/l. As hours of sunlight begin to recede, chlorophyll A in Skegemog declines.

Secchi disk depths show reductions through the summer as pollen and suspended sediments stirred up by boats add to the plankton concentrations to cloud the water. Skegemog loses about one-half and Elk one-third of their original values.

A profile from August 22, 1991 for Elk Lake illustrates several typical seasonal changes in the lake. Between 40 and 60 feet, the temperature drops 13 degrees C. This is the summer thermocline formed by a layer of warm surface water over the cold deep water. The thermocline acts as a barrier for the passage of dissolved oxygen as well. Because plankton at that depth are using their chlorophyll to produce oxygen, the data shows an increase (or supersaturation) of dissolved oxygen below thermocline.

Because Elk has a low productivity, there is less fish or bottom life to reduce this oxygen through respiration. In a productive lake like Bellaire with a shallow secchi reading, respiration would remove the existing oxygen as well as some produced after formation of the thermocline. Lake Bellaire usually shows a declining oxygen pattern at depth to values often below 2 mg/1 (off the page of this graph). Skegemog is too shallow for this and remains well mixed all summer.

If you have any questions about the water quality program, please feel free to contact Water Quality Chairman, Dick Volk (264-8288) or Resource Director, Bill Weiss (322-2187).

GLEN LAKE ASSOCIATION — Leelanau County
Barney Glettler, President

Waterfowl/Swimmers' Itch

Committee chairpersons: Barbara Siepker 334-4395; Bill Peppler 334-3435.

A very active Spring program was completed with the assistance of about 12 volunteers, who chased Mergansers, manned shore boomers, and did bird surveys. We especially thank Ken Bryce, Clarence Hartman, Tom Dean, Jerry Giffen, Sis Miller, Bill Peppler, Bill Post, Shanna and Bob Senk, Bob Seward, and all those who chased the Mergansers from their shores. Sixteen-year-old Mike Freeman spent his Spring vacation earning an Eagle Scout Service Project Award.

Although largely successful, we anticipate a couple of Merganser broods on the lake. Please call 334-3722 or 256-7039 if broods or adult Mergansers are spotted. We are hopeful that the cool Spring and lighter than normal number of Mergansers will foretell fewer cases of itch this Summer. We want to hear from you should you contact the itch, so call Barbara Siepker at 334-3722.

Zebra Mussels

Committee chairpersons: John DePuy 334-4443; Scott and Ellen Gravelie 1-676-0359.

The Association is coordinating with Dr. Ladd Johnson at the Great Lakes Environmental Research Laboratory, Ann Arbor, relative to a program for Glen Lake. There are three main goals for this program:

Education — Keep riparians aware of the latest information of Zebra Mussels, and how they could impact Glen Lake. Also, take reasonable efforts to educate boaters at the DNR launch site on Little Glen and the boat ramp in Glen Arbor.

Monitoring — Inspect boats and fishing equipment for the presence of mussels. Install substrates for sampling Glen Lake for mussels. Review monitoring findings, and change methods as required.

Intervention — If mussels are found, make arrangements for high pressure wash stations conveniently located for the public use.

Implementation of this program this summer depends on volunteer help and funds for materials and labor to supplement the volunteers on specific tasks. Persons volunteering locations for the substrate study should contact John DePuy.

Additional information will be distributed as it is developed. In the meantime, we urge all boat owners who transfer their boats between lakes to thoroughly inspect their hulls, engines and fishing gear before the boat enters Glen Lake waters.

LAKES PRESERVATION LEAGUE — Lenawee County
Ron Wyman, President

Lakeview Development Mobile Homes Park

At Woodstock Township's June 1 meeting, further plans were revealed of this development which lies west of Devils Lake Highway near Walnut Hill. This development will have an evaluation of approximately $2,000,000. It will consist of homes 16'x80', each to be hooked through a main line with a pumping station and paying hook-up charges and monthly fees at the same rate as other new housing in the township. The wooded area and wetlands will not be disturbed.

New Directors In Action

Several of our Directors have already delivered over 50 packets to the residents of their area. Margaret Brighton reports that she has received several new memberships which reflect their work.

One of the ancillary benefits of their work is its potential for direct contact with our membership. Although Linda Fritz has full time employment she still finds time to distribute her packets on her walk regimen. As she contacts residents she takes time to listen to their questions. She also takes note of what may be happening on her circuits. Then she contacts one of the Board Members if she needs answers. Although we have only 7 of our 10 districts covered by a Director, each of you have access to a Director or Board Member.

Sea Wall Permits

Some of the residents seem unaware that the Department of Natural Resources controls our inland lakes.

No one may alter the lake by filling, dredging or building a sea wall without a permit from the Department of Natural Resources.

The Lakes Preservation League receives copies of these permits and reviews them. If a violation is apparent or suspected the DNR will be contacted.

The two townships have zoning regulations. Anyone who wishes to alter their buildings must apply for approval of many alterations. The two townships have very similar controls, but what is legal in one may be illegal in the other. It can be very costly to ignore these laws.

PJC LAKES ASSOCIATION — Cass County
Bob Blake, President

Lake Resident Concerns:

- Fallen trees are impeding travel on horseshoe channel
- Access Site abuse (over-utilized, mess from refuse)
- Unlawful parking

Bob Blake stated that he has some printed warnings and asked for help in monitoring the access site. In the past, he has been able to deter some people from parking wrongfully.

The meeting was turned over to Mike Wenkel, Soil and Water Conservation District Technician. Mike gave an excellent definition of non-point source pollution. It means simply; we can't find the exact source. In addition to the work with the farmers, Mike told us that there are many things that lake residents can do. He gave us handouts that listed some of these things.

Area Representatives serving on the Executive Board are:
Jack Durben, 70462 Sunrise Dr. - 699-5478
Ronald King, Painter Lake Marina - 699-7555
Pat Marshman, 68345 Eagle Lake Road - 699-5558
Dutch Storm, 68270 Channel Pkwy. - 699-7209

(Continued on Page 16)

ML&SA Member News

(Continued from Page 15)

Ruth Trotsky, 68333 George Smith Ct. - 699-7348
Marilyn Wooden, 68938 Twilight Dr. - 699-7312

LAKE ORION LAKE ASSOCIATION — Oakland County
Richard Hennessy, President

General Membership Meeting

We had a pretty good turnout for last month's general membership meeting. Those who didn't make it missed an excellent presentation by Ron Spitler of the DNR on the installation of the bottomdraw tube and a summary of the effects that the DNR has been able to document to date.

Bottomdraw Tube

The tube seems to be doing what it is supposed to do (mix cold water from the bottom of the lake with warmer water going over the top of the dam to provide a cool enough temperature in Paint Creek to satisfy the trout) without any observed negative side effects at this time. It was able to maintain a mixed water temperature in Paint Creek last year of below 70°, even during the higher than average water flows while the lake was being lowered for the drawdown. The water temperature from the tube, which draws from a depth of 62 feet, is a constant 55°.

Testing that was done last fall determined that the tube has an adjustable flow range of from zero to 14 cubic feet per second (about 105 gallons per second or 6250 gallons per minute). The DNR has also installed a stream flow gauge at the Broadway Street bridge and a lake level gauge near the dam bypass tube just south of the dam.

At this time the DNR is very happy with the results of the tube and plan on using it to point up the advantages of such a project. Time will tell if there are any long term effects not currently observable.

Directors: Mark Basso, Lynn Boyd, Jim Clark, Larry Marlin, Ralph Reseigh, Gerry Richards.

President: Richard Hennessy. President Elect: Mike Basso. Past President: Joanne Dowell. Treasurer: Lisa Demian. Secretary: Tom Klingler.

MORTON TOWNSHIP TRI-LAKES ASSOCIATION — Mecosta County
Russ Klumpp, President

Banner Year for District 9 Walleye Plants

1991 Proved to be an exception year for Walleye plants in West Michigan's 9th district. According to John Trimberger, the eight-county 9th district benefited from a "bumper crop" of walleye fingerlings, reared in the many walleye ponds throughout the district. John says that much of the credit for the increased production of the ponds is in part due to a change in fertilization methods and constant supervision by new fisheries supervisor Cary Gustafson.

Trimberger estimates that 80% of the 1½ to 2 inch spring fingerlings will survive the three to four years it will take them to reach the 15 inch minimum length requirements for harvesting by West Michigan sportsmen.

Most of these walleyes being planted are the product of the egg harvesting program on the Muskegon River. However, according to Trimberger, many of our inland lakes are now being stocked with Lake Erie walleyes in an effort to establish a lake spawning variety of walleye that are more inclined to reproduce naturally in our inland lakes.

Hats off to the district 9 fisheries crew for a job well done. Keep up the good work!

PLEASANT LAKE ASSOCIATION — St. Joseph County
Judy Johnson, President

Water Clarity — Our lake is in good shape and the weed growth is about average. Thanks to Hank Null for taking time each week to check the lake for clarity. Thanks to all lake residents who are using phosphate free fertilizers for keeping septic systems in good working order!

A Guide to Safe Boating in Michigan — Booklets are available from your area reps, the association secretary, and at the breakfast. Michigan boating rules and regulations are important for each of us to know. Ignorance of the law does not get you out of a citation.

Marine Complaint Procedure — According to our guest speaker, Marine Patrol Officer Bill Dobrowski, if you have a concern about a particular boat: 1) get the numbers from the boat, 2) alert sheriff's department (467-9045), 3) they will follow up.

Just a Reminder — On Pleasant Lake it is a law that skiing may take place from 11:00 a.m.-7:30 p.m. each day. We have a gentleman's agreement of no high speed boating between 7:30 p.m. and 11:00 a.m. Be sure to remind any guests of this information. *Thanks!*

Lake Association Constitution to be Reviewed — A motion was approved for the officers to appoint a committee to review and bring our constitution up to date.

Wamplers Lake Property Owners Association — Lenawee & Jackson Counties
Emery Jonas, President

Public Sewer Feasibility Study

We are concerned regarding the long-term impact septic systems may have on the water quality of Wamplers Lake. Studies have shown that septic systems can be a major source of nutrients and pollution to lakes in Michigan. As our existing systems age and more cottages are converted to year-round use, the potential for lake pollution will continue to increase. The septic systems also discharge to our groundwater. As the flows continue to grow and accumulate, there is potential that the groundwater quality could be adversely impacted. The groundwater is the sole source for our water well supplies. To protect the lake and property values, we feel it wise to consider a public sewer for Wamplers Lake.

In order to get information to allow lake residents to make an informed decision on this issue, the Wamplers Lake Association has retained an engineering consultant experienced in the construction of new sewer systems to prepare a sewer feasibility study for Wamplers Lake. The study evaluates alternative collecting sewer and sewage treatment facility systems and provide a detailed cost estimate for the project. The study has been completed and a public informational meeting has been scheduled to present the findings of the study, answer questions, and seek input on whether there is interest in proceeding with a sewer project.

The information meeting will be held on Saturday, August 29, 1992, at 10:00 a.m. at St. Joseph's Hall.

WALLOON LAKE ASSOCIATION — Charlevoix & Emmet Counties
Bill Fairhurst, President

Water Quality is Job #1

The purpose of the Walloon Lake Association is, simply stated, "to preserve and improve the environment of Walloon Lake for its members and the general public." The Water Quality Committee, through its annual Lake Monitoring Program, and in conjunction with the Tip-of-the-Mitt Watershed Council, has been carrying out this charge and, in the summer of '92, will undertake two new monitoring programs and restart yet another. Here is a brief description of the programs your Association has in place for 1992:

Lake Monitoring: Weekly Secchi Disc depth readings are taken to record the water clarity, plus bi-weekly chlorophyll-a samples are gathered to measure algae concentrations. The two results are used to classify our water, which in the past has been "good to excellent" (see May *Wallooner* for graphic '91 results).

Dissolved Oxygen Study: Dissolved oxygen depletions can have an adverse impact on the fisheries and other aquatic organisms in the lake. We have purchased a sophisticated Dissolved Oxygen Meter to scientifically measure the dissolved oxygen concentrations. This work will be done with our own monitors and readings will be compiled and interpreted by the Watershed Council.

Cladophora Survey: A water resources consultant has been hired to conduct a shoreline survey of Walloon Lake for cladophora. The presence of this green, rootless plant normally indicates septic system problems and the need for remedial action. Results obtained this year will be compared with similar surveys done in prior years.

Swimmer's Itch Data Collection: This is a new program designed to produce weekly updates to inform both residents and Lake users about the current status of the swimmer's itch problem. The results will be shared with Dr. Harvey Blankespoor, who has developed a swimmer's itch treatment. It should be noted that Blankespoor's method is still in the experimental stage, and it is not known exactly when it will become available for widespread use. Association members will be kept advised of all the findings relating to these projects.

THREE LAKES ASSOCIATION — Antrim County
Ed Oshaben, President

Al Priebe Steps Down — Ed Oshaben Elected President

An era in Three Lakes history ended at this year's Annual Meeting when Al Priebe relinquished the gavel to new President Ed Oshaben. On the Board of Directors since 1974, Al had served as President for eight years — longer than any predecessor. He was presented an engraved desk set commemorating his years of service.

Al became President at a turbulent time when the Association could hardly pay its bills. His direction has provided Three Lakes with a firm financial foundation. During his tenure, TLA instituted a continuing water quality baseline sampling program, hired a part-time Executive Director, provided officers liability insurance, established relations with the Tip-of-the-Mitt Watershed Council, and began our popular pot-luck Annual Meetings. Al spent countless hours attending zoning meetings and led the Association's efforts to limit large scale development at Kathy's Kampground, Rosemary's Dockage and numerous others. There is no way to adequately thank him for his years of dedication. The Board of Directors looks forward to his continued participation and counsel as immediate Past-President. Thanks again Al!

News Notes

Eight Three Lakers attended the Forest Home Planning Commission meeting on September 23 to support approval of their new wetland ordinance. It was adopted.

Three Lakes donated two "No Wake" buoys to the Kalkaska County Sheriff Marine Patrol which set them in Torch Lake at the entrance to Torch River.

OBJECTIVES OF MICHIGAN LAKE & STREAM ASSOCIATIONS

1. To inform riparian property owners and the public at large of **Riparian rights in Michigan.**
2. **To disseminate information about pending legislation** which will have an impact on riparian rights.
3. **To inform Riparians of applications to dredge, fill or change the shoreline** of lakes and streams in Michigan.
4. Sponsor **conferences and workshops** for riparians and the public to provide information regarding the **protection of lakes or streams.**
5. **To assist Riparians to establish an Association** to deal with problems which call for unity in action to prevent the degradation of the water quality of lakes or streams and to prevent their misuse.
6. **To assist Associations in the presentation** of their respective positions regarding riparian rights and water resource management before **courts, municipalities and government agencies.**
7. **To review and submit proposals to administrative and legislative bodies** considering bills, ordinances and regulations impacting riparian property owners and water resources.
8. **To develop a library of information** including books, pamphlets, documents, research studies of Michigan's water resources and make the same available to riparians and the public at large.
9. **To sponsor studies and research** designed to expand the fund of knowledge about Michigan's water resources.
10. **To instruct Lake & Stream Association members** how to monitor land and water development within the watershed.
11. **To assist local associations in obtaining help** from local and state governing units in their efforts to protect their water resource.
12. **To support all efforts of state and federal governments to maintain water quality standards** established by state and federal law.

What Are The Most Urgent Needs Of Michigan's Inland Lakes?

Michigan Lake and Stream Association's Board of Directors would like to know what shoreline property owners feel are the most urgent needs of Michigan's inland lakes. We have listed 17 different items that have been mentioned by waterfront property owners, and have left space for listing others at the bottom. We will be grateful to you if you would take the time to identify the most serious problems you think exist on your lake, and mail the form to the ML&SA Office at 124½ North Main Street, Three Rivers, MI 49093. We will use this information to guide us in selecting speakers for the Regional meetings and the Annual Meeting for 1993.

Number the ten most needed activities you feel are needed on your lake. Write the numbers 1-10 in the blank spaces to the left of the item. Write number 1 in front of the item you feel most needed, number 2 in front of the second most needed item, and continue until you have identified the ten most needed. This information will help ML&SA in organizing topics for next year's Regional and Annual meetings. If you know of speakers that are knowledgeable about any of these topics, write their name to the right of the topic and under speaker.

Number 1-10	Activity	Speaker
________	STOCKING OF FISH	________________
________	ENFORCING BUILDING CODES	________________
________	ENFORCING ZONING ORDINANCES	________________
________	INSPECTING SEPTIC SYSTEMS	________________
________	REGULATING SKIING AND BOATING	________________
________	STOPPING SHORELINE EROSION	________________
________	CONTROLLING AQUATIC WEEDS	________________
________	COLLECTING GARBAGE AND TRASH	________________
________	DREDGING	________________
________	PATROLLING FOR VANDALISM	________________
________	MONITORING FOR SOURCES OF POLLUTION	________________
________	REGULATING SNOWMOBILES & ORVs	________________
________	STABILIZING WATER LEVELS	________________
________	IMPROVING WATER QUALITY	________________
________	EQUALIZING PROPERTY TAX ASSESSMENTS	________________
________	PATROLLING FOR WATER SAFETY	________________
________	PREVENTING WETLAND DESTRUCTION	________________

OTHERS NOT LISTED:

The Michigan Riparian Magazine — A Short History

The following quote is from the second issue of The Michigan Riparian, *Spring 1966, Volume 2, Number 1:*

"*The Michigan Riparian* is the official publication of the Association of Michigan Lakes and Streams Associations. It is edited by riparian owners to inform other riparian owners of trends in the management of lakes and streams and of legislation either existing or proposed that affects the rights of waterfront owners. Particular emphasis is placed on accomplishments and methods used by local organizations and individuals. The editors, publishers and reporters are not experienced and our efforts will at times seem amateurish...but our intent is to give the benefit of all possible information. Material submitted for publication will be protected by copyright." The editorial Board included: E.W. Pattison, Managing Editor and Editorial Director: S.B. Henry, Editor and General Manager; S.B. Severance, Editorial Consultant; and Forrest B. Smith, Editorial Consultant.

The following article appeared in the first issue of The Michigan Riparian, *which was the Winter 1965-66 issue:*

About *The Michigan Riparian*

This is our first issue of *The Michigan Riparian*. It has taken a long time to give birth to a publication which is suited to the needs of waterfront organizations and individual riparian owners, alike. We think we have taken a giant first step toward our goal.

Much time has been spent in the development of a basic format and in the selection of balanced news items of interest to the many riparian interests around the state.

We feel that there is great need to inform riparian owners of trends in the management of lakes and streams, and of legislation either existing or proposed that affects the rights of waterfront owners. We know that the interest exists and want to furnish a news media that will reach as many owners as possible.

Without experienced reporters and editors, and in the absence of paid help, our efforts will at times seem amateurish — but our intent is to give you the benefit of all possible information.

News items from local associations or individuals are needed, and we will print them if at all possible. We also need local reporters and salesmen, and we offer them the same wage that we receive as publishers — the satisfaction of getting the job done!

Little effort has been made to solicit advertising for this first issue. Most of our effort has been directed toward development of the basic format. Since advertising provides a service to our subscribers, we want to expand this portion of the publication.

The Michigan Riparian will reach a broad spectrum of waterfront organizations and individuals. Many of these people are seasonal and are at somewhat of a loss to know where various products and services may be obtained. This publication will reach many such persons during all periods of the year and your advertisement will distinguish you as wanting to do business with them.

General Offices

The General Offices of *The Michigan Riparian* have been located at the following addresses during the 27 years that the magazine has been published:

1965-66 — 11269 Hi-Land Court, Pinckney, Michigan 48169
1967-76 — 9610 East Shore Drive, Portage, Michigan 49081 (at the home of Henry Westerville)
1976-80 — 9620 East Shore Drive, Portage, Michigan 49081 (at the home of Cecile Harbour)
1980-92 — 11262 Oak Avenue, Three Rivers, Michigan 49093 (at the home of Don Winne)

Editors and Publishers

The following persons have been editor and/or publisher of the magazine during the 27 years that the magazine has been published:

1965-66 — S. B. Henry
1966-67 — Herschel B. Rochelle
1967-77 — Henry Westerville
1977-79 — Robert Charles
1979-92 — Don Winne

Information about the Editors and Publishers

Henry Westerville (1967-77)

We have reviewed former issues of *The Riparian* magazine to find information about Henry. The following information is lifted from an editorial that Henry wrote for the January 1972 issue of the magazine.

"The year 1972 will have special significance to the Editor. In July — God willing — he will have completed six years as Managing Editor and nearly seven consecutive years as President of Michigan Lake & Stream Associations, Inc., and 35 years as a general insurance agent. Life has not been dull.

Half of his waking hours are spent earning a living, and the other half serving as President and Managing Editor. During the above-mentioned years we have had the pleasure of seeing the Association grow from less than 40 to more than 100 lake and stream association members. *The Michigan Riparian* magazine circulation from 500 to 6,500 and with paid subscribers in 34 states..."

Henry decided to retire from Michigan Lake & Stream Associations and as Managing Editor of *The Michigan Riparian* in October, 1976. The October issue carried the following note of appreciation for the many years that Henry had devoted to ML&SA and to *The Riparian* magazine.

"In regretfully accepting Mr. Westerville's resignation, the Directors of *The Michigan Riparian*, Inc., feel a definite loss. No words can express the deep appreciation we have for Henry's efforts of the past years. During his tenure as Managing Editor he has given unstintingly of his time and talents. He has almost singlehandedly managed the affairs of *The Riparian*. His efforts have been responsible for the increase in the circulation and the success of the publication. Our heartfelt thanks go to Henry and his good wife, Jodie, for their faithful work. We hope that his talents, knowledge and wisdom will continue to have impact on future issues of *The Riparian*. We are sure that his efforts to secure sound legislation in the environmental field will continue."

Robert Charles (1977-79)

The April, 1977, issue of *The Michigan Riparian* magazine carried the following information about Robert Charles, the new publisher.

"Robert Charles, 57, President of Eagle Printing Co., Inc.,

(Continued on Page 20)

A Short History

(Continued from Page 19)

Coldwater, is a past President of the Greater Coldwater Chamber of Commerce; founder of Adapt, Inc., the Branch County sheltered workshop; a member of the Coldwater Zoning Review Board; a founder of the Branch County 4-H Foundation and currently its Vice-President; a member of the Coldwater Exchange Club, and Publicity Chairman of the Michigan District Exchange Clubs. Prior to moving to Coldwater, he was Family Home Editor of Parent's Magazine based in New York City for 10 years. As a spokesman for the magazine, he appeared on NBC Today Show and dozens of other TV and radio programs; received numerous national editorial awards for his stories about the housing industry. Prior to joining Parents Magazine in 1960, he was Vice President of Fulton, Morrissey Advertising Agency in Chicago for seven years. He is a graduate of Medill School of Journalism, Northwestern University; was a combat marine in the South Pacific during World War II, surviving the sinking of the U.S.S. Houston, then 3 1/2 years in Japanese prison camps.

Don Winne (1979-92)

The following statement appeared in Robert Charles' Editorial that appeared in the October, 1977, issue of the magazine:

"Don Winne, a long-time educator and Vice President of Region IV of Michigan Lake and Stream Associations, and who helped Corey Lake establish a natural lake level and helped build a dam to maintain that level, will add to the voice of ML&SA serving as editor of *The Michigan Riparian* beginning with the January (1978) issue. His column will appear in this space in future issues; many of the stories in the future will be under his editorial supervision. We are pleased to add an active ML&SA member of his stature to the masthead. To become further acquainted with Don, see the story on page 10 of the April, 1977, issue."

Don has held the position of editor continuously since 1978 and in 1979 became Publisher of the magazine by Board action. Robert Charles introduced the idea of the front cover being in color when he was Publisher, and that practice has been continued under Don Winne. Don's experience in photography goes back to his early teaching days at Elkhart Public Schools, Elkhart, Indiana. He was the supervisor of audio-visual aids at Elkhart High School, and assisted in the taking of pictures for Elkhart High School Annuals. Many of the pictures which have appeared on the front of the magazine since 1979 have been pictures which he has taken.

Don encourages members of ML&SA member associations to submit pictures which they think should be considered for printing on the front of the magazine. Two by two color slides are preferred. If you have a slide you would like to submit, you may call the office number (616) 273-8200 and discuss it with him.

— IN APPRECIATION —

Words cannot express our heartfelt thanks to Joseph H. Hollander, who has given unselfishly of his time to serve on the Board of Directors of the Michigan Riparian for the past 16 years.

Hayes Township Resurrecting Waterfront Zoning Law

By Lisa Babcock, Petoskey News Review, July 22, 1992

Township planning commission members might have felt a sense of deja vu as they read the waterfront zoning law they easily approved Tuesday night.

They approved exactly the same wording that was in the township ordinance before — before developer William Fox took the township to court and before a state appeals court ruled the law was illegal.

Since then, the state Supreme Court has ruled on a similar law from West Bloomfield Township in Oakland County — and called the restrictions legal.

In the wake of that case, Hayes Township officials started putting waterfront zoning back on the books.

"We took it out because we were ordered to take it out," township clerk Ethel Knepp told the planners, recalling the court decision against the township.

The controversial zoning, created in the mid 1980s, limits boat docks to one mooring, slip or dock per 100 feet of lake frontage. Power boats fall under the ordinance, but rowboats, dinghies, rubber boats, canoes and small sailboats do not.

The second part limited housing to one home, cottage, condominium or apartment for every 100 feet on the lake.

The waterfront zoning does not apply to public access sites. It is intended to prevent "funnel" developments, where many people are deeded access to a small portion of lakefront.

A handful of township board members and six township residents attended a public hearing Tuesday night. Their comments favored reinstating the waterfront zoning.

"I think it's a good idea to put it back in," township treasurer Robin Kraft said.

Planning commission member Mary Lee Huber agreed.

"I'd like to see both (portions) reinstated," she said.

Planning commission chairman Tim Boyko warned fellow planners that the zoning is "large lot zoning," although it prevents funneling.

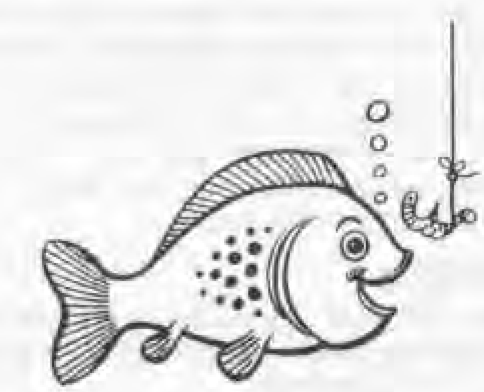
"It's working in the sense that it keeps people from being on top of each other," he said.

The public hearing Tuesday night was the first of three steps the township will have to take to reinstate the ordinance.

The township planning commission recommended the township board reapprove the law.

The issue is now handed to the county planning commission, which also will review the law and make a recommendation to the township board.

The third and last step is the township board, which will decide whether to make waterfront zoning the law of the land again.



Michigan Cooperative Extension Service Reaches Out To Lake Residents

George Byelich, Cooperative Extension Director for Alcona County, held two meetings for lakefront property owners in Elcona County on August 12, 1992. The meetings, one at Glennie and another at Hubbard Lake, were designed to inform and assist waterfront property owners of the 236 bodies of water in the county in understanding the value of their water resource and things they need to consider in protecting that resource.

What is the Cooperative Extension Service?

The Cooperative Extension Service is an educational outreach arm of Michigan State University. It is part of a national network of Extension Services in every state in the United States. Each one is based at the state's land-grant university.

The job of Extension is to get practical, university-tested information into the hands of people who need it. It's really like having a little bit of MSU in your home county.

It's "cooperative" because it is jointly funded by federal, state and county governments. "Extension" means extending the educational resources of MSU beyond the East Lansing campus. "Service" means Extension is in the business of helping people.

At Michigan State University, Extension is part of the College of Agriculture and Natural Resources. Extension draws support from every department in the college, from crop and soil sciences to animal science. It also uses resources available in other MSU colleges, including Human Ecology and Veterinary Medicine.

The Cooperative Extension Service gets much of the information and knowledge it brings to you from the MSU Agricultural Experiment Station. Researchers from the Experiment Station help generate up-to-date solutions to today's problems.

In all, 29 academic departments and eight colleges at MSU back up the cooperative Extension Service.

Where is the Cooperative Extension Service?

Extension offices and staff people are located in every county in Michigan. Also, Extension subject-matter specialists at MSU translate research results into educational programs and act as resource people for Extension staff members in the counties. Together, the campus staff and the field staff make sure the Cooperative Extension Service is accessible to everyone.

What does the Cooperative Extension Service do?

Extension provides information and offers educational programs in four main subject areas:

- Agriculture and Marketing
- Home Economics
- 4-H Youth Programs
- Natural Resources and Public Policy

All of these programs have similar goals — they're designed to help people better understand the world around them, use their resources more effectively and make wise decisions. This is helping people help themselves.

These programs come to you from the MSU campus through your local Extension office and the agents who work there. These agents schedule programs to talk about current problems, meet with groups and individuals and plan educational programs. Information based on MSU research is also available through printed bulletins, which you can get through your county Extension office. Extension also works extensively with the news media to get information to the public.

How can I find out more about the Cooperative Extension Service?

The best place to start is in your own county. Your Cooperative Extension Service office is listed in the white pages of your telephone book under "County Government." Drop in at your local Extension office, look around and meet the agents. They're glad to be of help.

The administrative headquarters of the Cooperative Extension Service is located at Michigan State University. Our address is:

Cooperative Extension Service
Office of the Director
106 Agriculture Hall
Michigan State University
East Lansing, MI 48824-1039

Local input is important to Extension; advisory committees at state and county levels help us direct our efforts toward the areas of the greatest need.

If you have suggestions or comments, tell us!

To Learn More...

For a catalog listing the Extension publications available from your Cooperative Extension Service, just write to us:

MSU Bulletin Office
10B Agriculture Hall
East Lansing, MI 48824-1039

Shakey Lakes Association Strives for Weed Solution

(Continued from Page 9)

Recommendations and Management Options

Many of the problems observed in Shakey Lakes are common to most lakes in Michigan having problems with aquatic weeds. The following recommendations and problems to be discussed during formulation of management options will apply to many other lakes. These recommendations and problems include:

(1) Once a lake has excessive nutrients in its sediments, it is very difficult to return it to a less nutrient rich status without dredging. Dredging is usually not a management option, because it is prohibitively expensive and creates problems associated with disposal of dredge spoils. Control of nutrient inputs into the lake will prevent the problem from getting worse and is a desirable goal. Complete elimination of excessive nutrient inputs is usually not feasible. Thus, management primarily becomes one of minimizing the problem by reducing nutrient inputs to the lowest practical level and managing the weed problem in the lake.

(2) Options for management of the weed problems include (a) drawdowns of lake level every few years; (b) harvesting and removal of the weeds from the lake; (c) herbicide control of weeds; and (d) living with the problem as it exists. Options b and c are expensive; Option a costs some money for the permits and monitoring often required by DNR; while Option d is usually not acceptable to most citizens. Thus, a source of funds must be identified such as assessments of each lakefront owner, user fees, county taxes, etc.

(3) Potential problems accompany each management option. Reports in the literature show that drawdowns, when feasible, have caused a decrease in the aquatic weed problem for some lakes. However, there are also several reports that drawdowns made little impact on the weed problem. There are also some reports that suggest that the weed problem can become even worse after drawdowns, especially if floating, submerged species of weeds such as coontail are common, as is the case in Shakey Lakes. The drawdown may also cause fish kills during the winter since decay of aquatic weeds takes place in a concentrated volume of water. Shakey Lakes are already near the verge of winter kill, and the drawdown could induce this to happen. There is no way for residents of Shakey Lakes to know whether a drawdown will be a positive or negative without trying one.

(4) The other two options are the two that most lake associations ultimately end up choosing between. These are (a) mechanical harvesting and weed removal or (b) treatment of the lake with herbicides. Costs are about equivalent for these two options and vary from $200 to $300/acre per treatment. Both options often have to be repeated annually or more often as both are cosmetic and do not solve the problem of excessive nutrient inputs and excessive nutrients in the sediments. An advantage of harvesting and weed removal is that it eliminates the decaying plants which could deplete the water's dissolved oxygen and kill fish. Some nutrients are also removed from the system with weed removal, but this is normally small in relation to annual inputs to the lake and the amount stored in sediments and cannot be expected to result in weed control. Disadvantages of harvesting include the possibility that it may cause an increase in Eurasian pond weed. Fragmentation of this weed during harvest can lead to regeneration of a new plant from each fragment and to greater amounts of the weed being present. Another disadvantage of harvesting is that it may lead to nuisance algal blooms as more nutrients become available due to less nutrient uptake and shading by the aquatic weeds. Harvesting has worked for most situations where it has been tried for keeping the lake open for recreation without most of these problems showing up. Unless a commercial mechanical harvester operator is located nearby and can be hired on a contract basis, the Lake Association will also have to come up with a sizeable initial investment for purchasing the harvester. Herbicide treatment does not require the initial capital outlay that harvesting sometimes requires. However, it has all the disadvantages of harvesting except for the fragmentation of Eurasian milfoil. In addition, the poisoned weeds sink to the bottom and deplete oxygen. These decaying weeds also contribute to the buildup of layers of undesirable organic ooze on the bottom. The potential for a nuisance algal bloom is greater for herbicide treatment than for harvesting since all nutrients in the dead weeds are ultimately released back into the lake water.

In conclusion, there is no magic solution for solving weed problems in lakes. A drawdown is a somewhat risky but relatively cheap option and could be implemented to see if it would work. If winter kill occurred, the lake would have to be restocked. If coontail growth were enhanced, the harvesting or herbicide options could be tried. Rather than risk a drawdown, residents might prefer to initiate a harvest program or treat the lakes with herbicide. The best preference would be to go to a harvesting treatment. It is the most environmentally neutral option but is expensive. For example, if fifty acres of Shakey Lakes with excessive weeds were harvested, the Lake Association would have to raise $10-15,000 per treatment. Herbicide treatment is an equally expensive but less environmentally friendly option. Herbicide treatment might not require as much initial capital outlay as harvesting. Any of the three potential management options would have to be repeated periodically to be successful. Harvesting and herbicide treatment are often required annually or more often (costs = $10-15,000+/year), while drawdowns, when they work, have to be repeated every 3-5 years to be effective and are much less expensive.

All back issues of *The Michigan Riparian* magazine have been microfilmed by Microform Systems of Lansing, Michigan. If you want more information, please contact *The Michigan Riparian* Office at 124½ N. Main St., Three Rivers, MI 49093. Telephone: 616-273-8200

(Note to Subscribers: So that you will not miss a single issue, please notify us promptly of any change in address.)

THE MICHIGAN RIPARIAN
P.O. BOX 249
THREE RIVERS, MICHIGAN 49093

2nd Class postage paid at Three Rivers, Michigan and additional mailing offices.

Appendix D

Shakey Lakes Aquatic Plant Survey – MSU (2001)

Reccomended
Draw down

Shakey Lakes 2001 Aquatic Plant Survey

Ronald E. Kinnunen
Michigan Sea Grant Extension
MSU-Upper Peninsula
702 Chippewa Square
Marquette, MI 49855

and

Michael Erdman
Michigan State University Extension
S904 U.S. Highway 41
Stephenson, MI 49887

May 15, 2002

Introduction

In 1986 and 1987 Michigan State University conducted a study on Shakey Lakes which focused on water quality parameters, aquatic plants, and fish (Burton et al. 1992). After this study was completed three fall/winter (1996-97, 1998-99, 2000-01) water drawdowns of Shakey Lakes were conducted in an attempt to control high aquatic plant densities. In an effort to determine the effectiveness of these winter drawdowns on controlling aquatic plants a follow-up study was conducted in the summer of 2001 to determine the existing structure of the aquatic plant community in Shakey Lakes.

Methods

Aquatic plant surveys were conducted in Shakey Lakes on June 29 and August 24, 2001. The survey sites included the Becker and Resort Lakes inlets, five transects in Resort Lake in addition to the lake center, and five transects in Long Lake. Survey site locations were recorded in a global positioning system to assure a return to the same sampling locations in the future. Aquatic plants at each transect were collected at approximately the 1 foot, 4 foot, and 8 foot depths following sampling methods as described by Wandell and Wolfson (2000). Secchi disk readings were taken at the Becker and Resort Lakes inlets, at the transect 8 foot depths in Resort and Long Lakes, and at the center of Resort Lake. Aquatic plant density ratings were determined for all aquatic plants collected in the survey following methods as described by Wandell and Wolfson (2000). Don Herson, a lake property owner, piloted his air boat to assist with data collection.

Results

Secchi disk readings are reported in Figure 1. The Becker Lake inlet secchi disk reading was 4.3 feet in June and was seen all the way to the bottom at 3.3 feet in August. The Resort Lake inlet secchi disk readings were 5.0 feet and 6.0 feet in June and August, respectively, but in both cases the disk was seen all the way to the bottom. Resort Lake had an average secchi disk reading of 7.3 in June, but in three of the five 8 foot depth readings along the transects the secchi disk could be seen all the way to the bottom. In August Resort Lake had an average secchi disk reading of 7.8 feet, but in three of the five 8 foot depth readings along the transects the secchi disk could be seen all the way to the bottom. At the center of Resort Lake the secchi disk readings were 12.0 and 11.0 feet for June and August, respectively. Long Lake had an average secchi disk reading of 7.8 feet in June, but in four of the five 8 foot depth readings along the transects the secchi disk could be seen all the way to the bottom. In August Long Lake had an average secchi disk reading of 7.2 feet, but in two of the five 8 foot depth readings along the transects the secchi disk could be seen all the way to the bottom.

The aquatic plant survey in June at Becker Lake inlet showed that both coontail (*Ceratophyllum*) and pondweed (*Potamogeton*) had a heavy density rating, while yellow water lily (*Nuphar*) and wild celery (*Vallisneria*) had a sparse and found density rating, respectively (Figure 2). The Becker Lake inlet in August showed a heavy density rating for pondweed, a moderate density rating for bladderwort (*Utricularia*), and a sparse density rating for wild celery and milfoil (*Myriophyllum*).

The aquatic plant survey in June at Resort Lake inlet showed a moderate density rating for coontail, and a sparse density rating for wild celery and milfoil. The August survey showed a found density rating for coontail, muskgrass (*Chara*), pondweed, and yellow water lily (Figure 3).

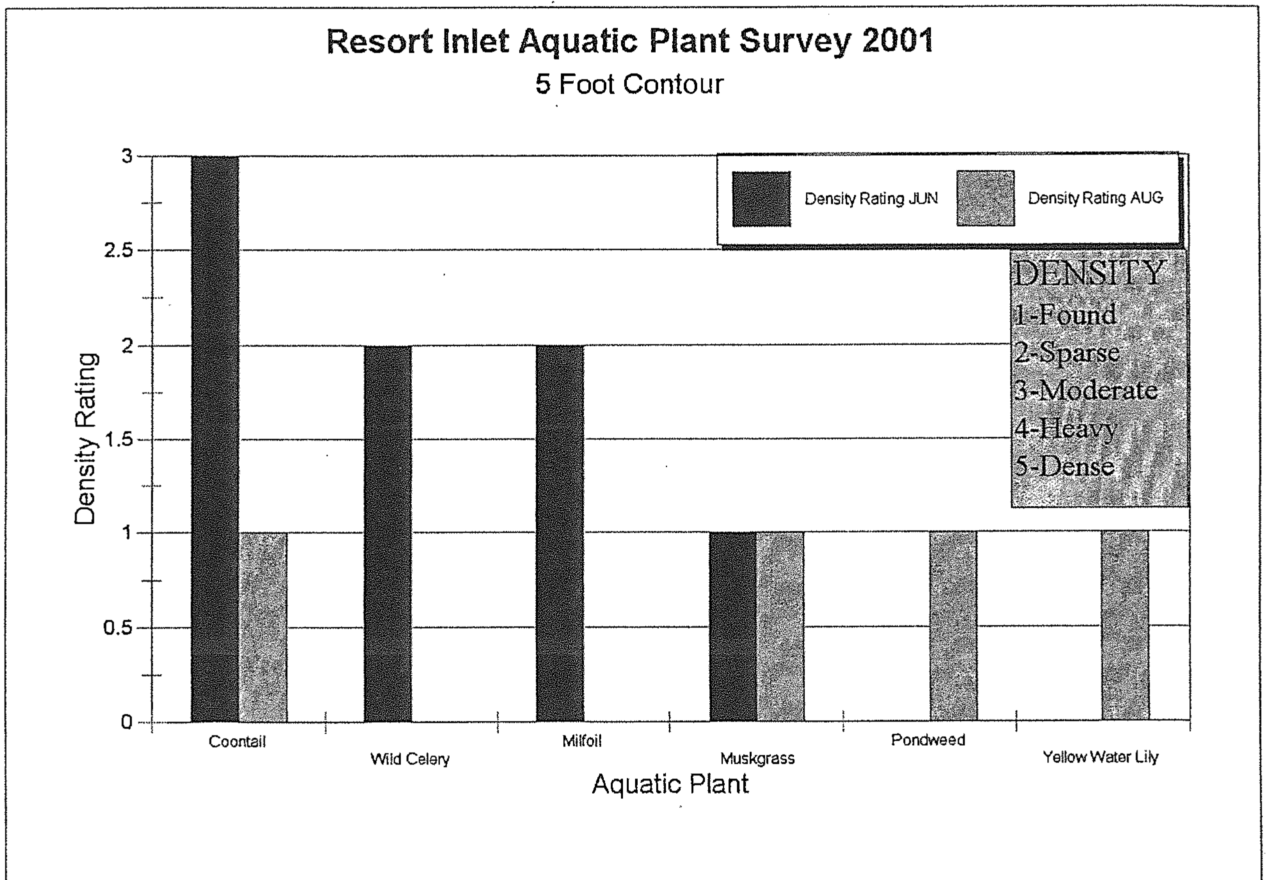


Figure 3. Density rating of aquatic plants found at Resort Lake inlet.

The June and August aquatic plant surveys in Resort Lake showed a lakewide density rating of sparse to moderate for wild celery and muskgrass. In June coontail and pondweed had a sparse lakewide density rating. The other aquatic plants were found in lower densities in the lakewide June and August surveys (Figure 4). At the 1 foot depth contour muskgrass had a density rating of moderate in June and heavy in August. The other aquatic plants at this 1 foot contour in Resort Lake were found in lower densities (Figure 5). Muskgrass was found to have a moderate density rating in June and a heavy density rating in August in the 4 foot depth contour. Wild celery was found to have a moderate density rating in both June and August in the 4 foot depth contour of Resort Lake, while the other aquatic plants were found at lower densities (Figure 6). At the 8 foot depth contour in June coontail, wild celery, and pondweed were found at moderate to heavy densities while in August they were either found or sparse (Figure 7).

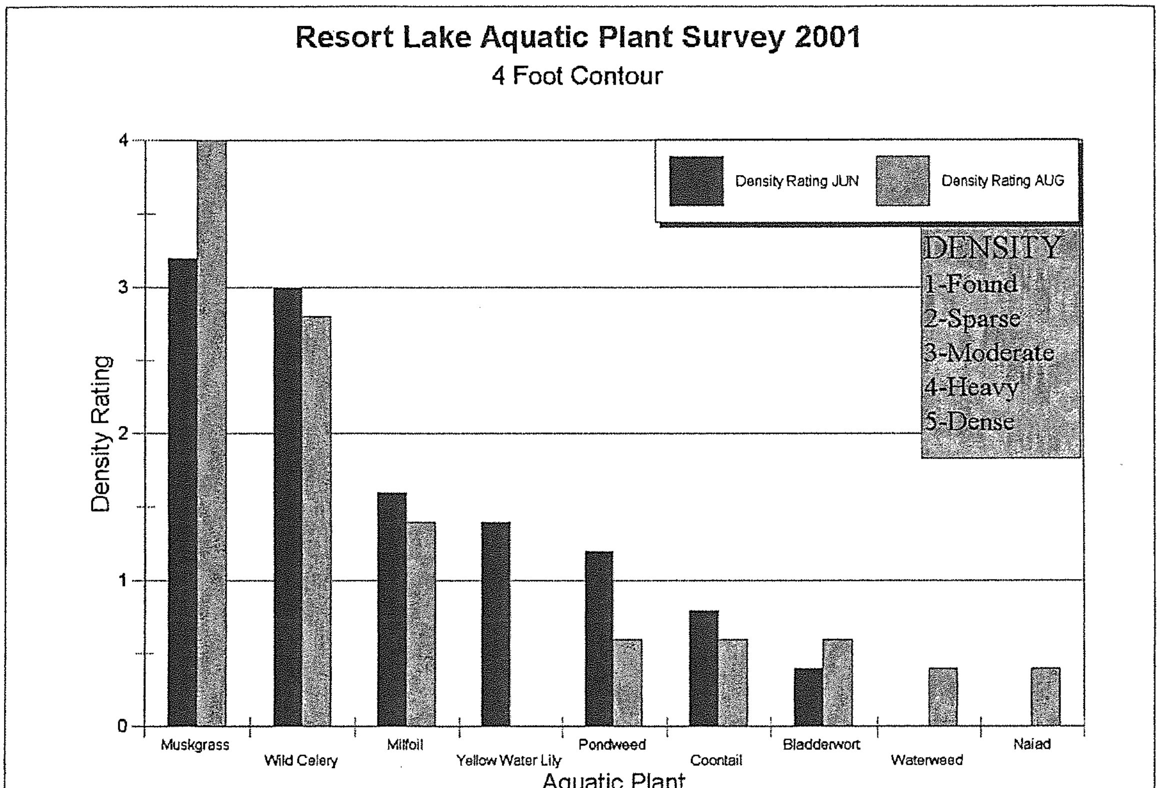


Figure 6. Density rating of aquatic plants found at the 4 foot depth contour in Resort Lake

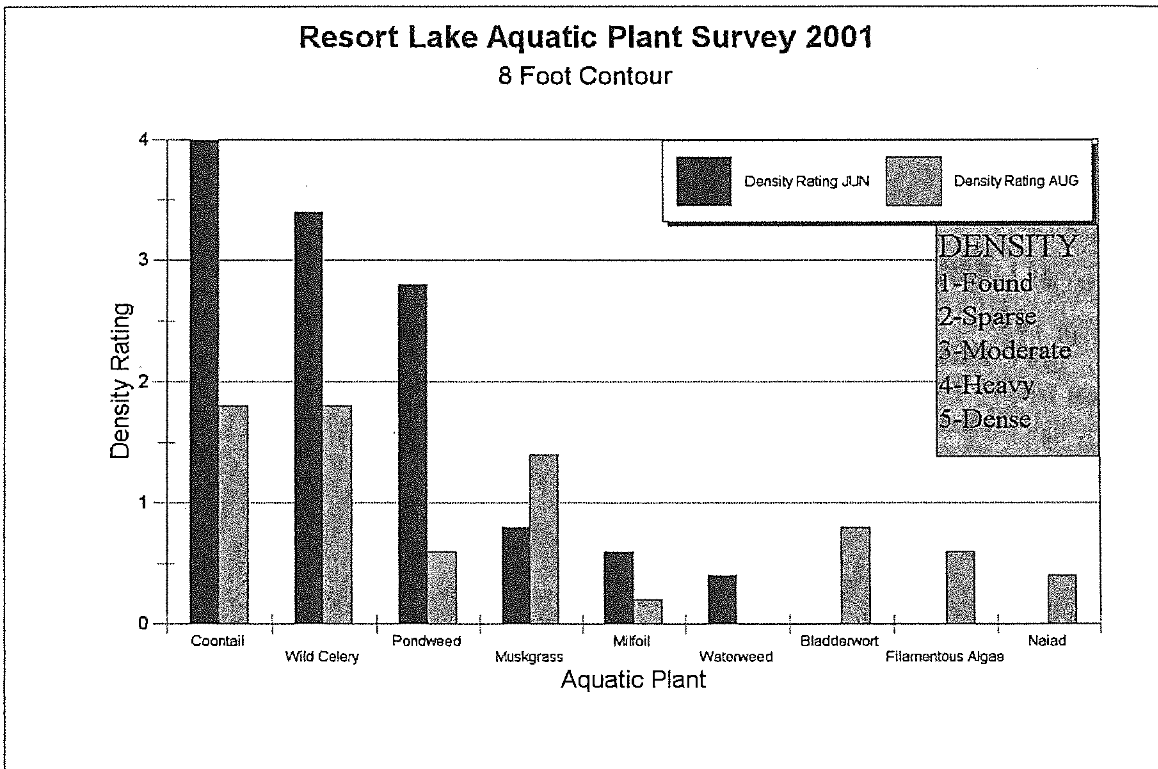


Figure 7. Density rating of aquatic plants found at the 8 foot depth contour in Resort Lake

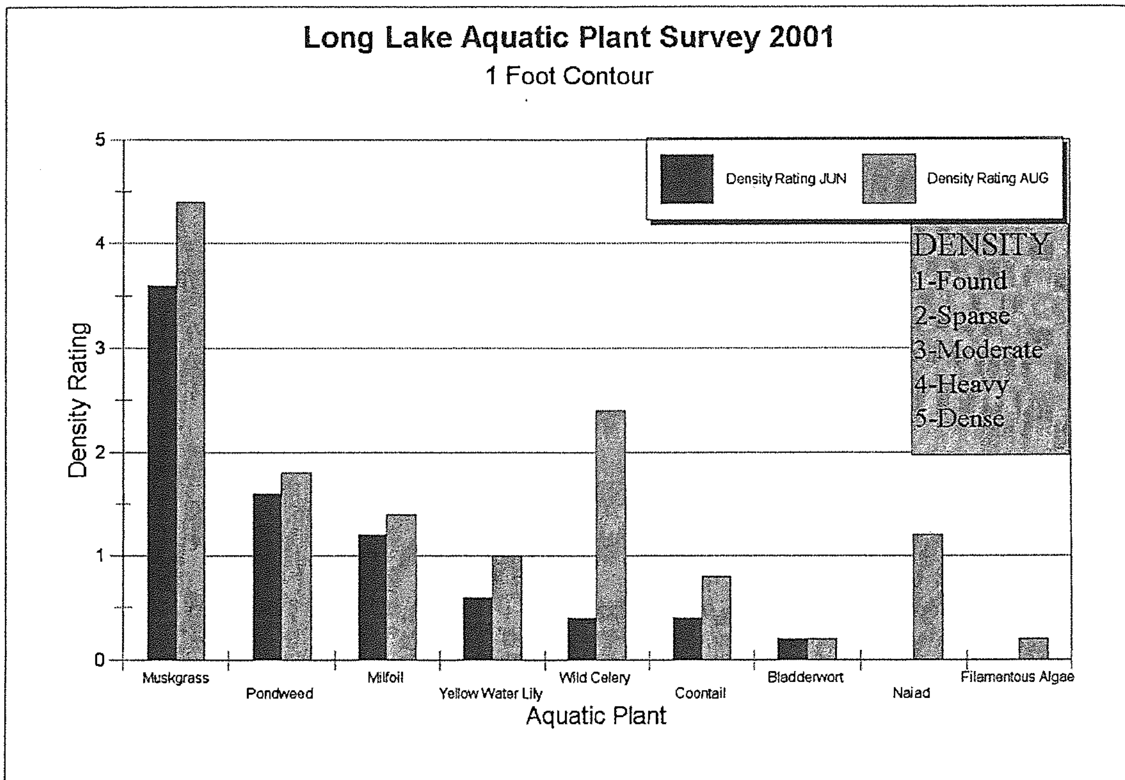


Figure 9. Density rating of aquatic plants found at the 1 foot depth contour in Long Lake.

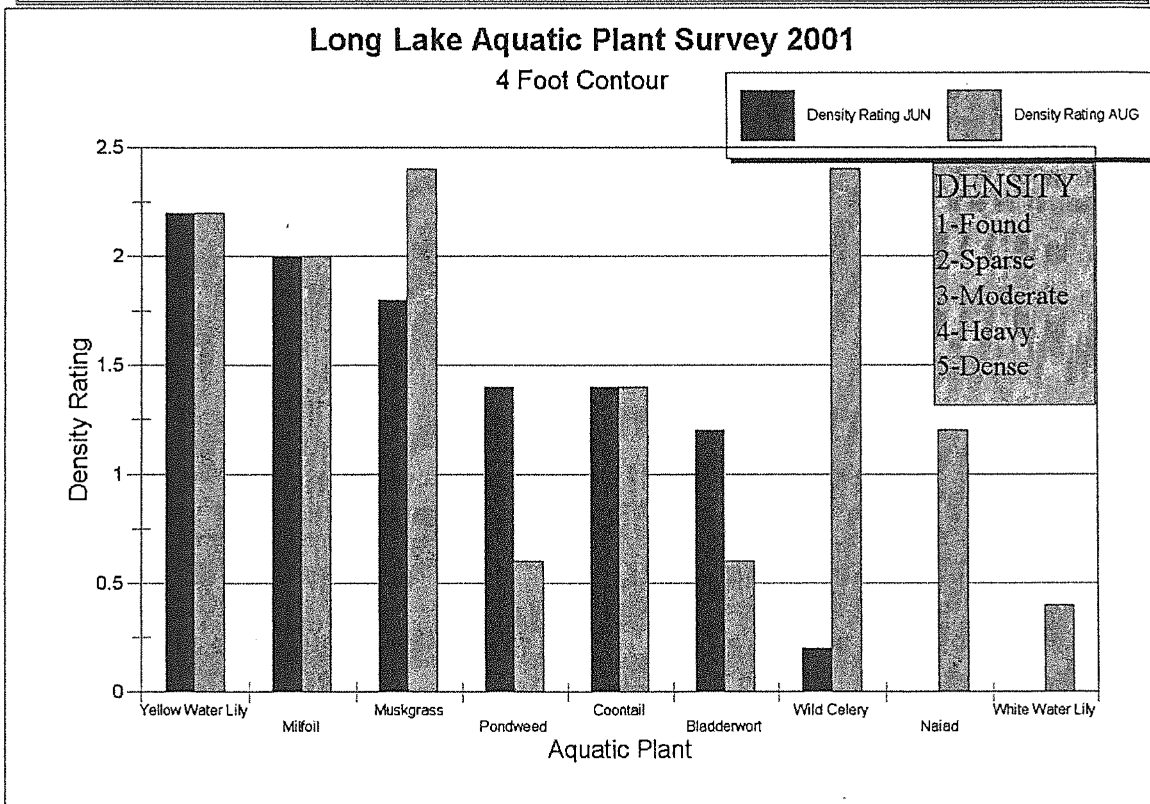


Figure 10. Density rating of aquatic plants found at the 4 foot depth contour in Long Lake

determine density ratings. These procedures cover a larger geographic area of the lake and are now being incorporated in more aquatic plant surveys. Thus we cannot make direct relational comparisons from what we found in this aquatic plant survey to what was found in the 1986-1987 study. However, the present study did find that many of the dominant plants found in the 1986-1987 study were still present and included coontail, muskgrass, water lily, and several species of pondweed.

The aquatic plant survey in June at Becker Lake inlet showed that both coontail and pondweed had a heavy density rating, while in August a heavy density rating for pondweed was found. In June the Resort Lake inlet showed a moderate density rating for coontail. Thus coontail was the dominant aquatic plant found at these lake inlets.

The June and August aquatic plant surveys in Resort Lake showed a lakewide density rating of sparse to moderate for wild celery and muskgrass. In June coontail and pondweed had a sparse lakewide density rating. These are lakewide averages and many of these aquatic plant species are more concentrated at specific water depths. At the 1 and 4 foot depth contours muskgrass had a density rating of moderate in June and heavy in August. Wild celery was found to have a moderate density rating in both June and August at the 4 foot depth contour. At the 8 foot depth contour in June coontail, wild celery, and pondweed were found at moderate to heavy densities while in August they were either found or sparse. Thus in Resort Lake, muskgrass was more dominant in the 1 to 4 foot depth contours in both June and August, while coontail, wild celery, and pondweed was more dominant at the 8 foot depth contour in June.

The June and August aquatic plant surveys in Long Lake showed a lakewide density rating of sparse for muskgrass, milfoil, and coontail. These are lakewide averages and many of these aquatic plant species are more concentrated at specific water depths. At the 1 foot depth contour muskgrass had a density rating of moderate to heavy in June and heavy to dense in August. Yellow water lily, milfoil, and muskgrass were found to be sparse at the 4 foot depth contour in June and August. Coontail and milfoil had a moderate and sparse density rating, respectively, in both June and August at the 8 foot depth contour in Long Lake. Thus in June and August in Long Lake muskgrass was the dominant aquatic plant at the 1 foot depth contour, while coontail and milfoil were the more dominant aquatic plants at the 8 foot depth contour.

The water lily was not a dominant aquatic plant in the present study as compared to the previous study conducted in1986-1987 which could indicate that the winter water drawdowns have had a negative effect on this aquatic plant. Observations during the present study revealed excellent growth of wild rice in Becker Lake which may have been enhanced by these winter water drawdowns.

Muskgrass was the dominant aquatic plant species in the shallow zones of both Resort and Long Lakes through the summer months. Muskgrass is an algae and has no roots and thus obtains its nutrients from the water and competes against other algae. It enhances water clarity and retards the growth of taller rooted aquatic plants thus reducing recreational conflicts. Muskgrass which has abundant aquatic invertebrates associated with it makes it an excellent waterfowl food and food provider for fish. Because muskgrass has few negative qualities it should be encouraged wherever found. Only heavy growth in active swimming areas is a problem. Removal may encourage more obnoxious, alien plants, such as Eurasian watermilfoil to move in.

Coontail was one of the dominant aquatic plant species in the deeper zone (8 foot depth) of both Resort and Long Lakes in June. Its tall growth can conflict with many recreational activities and when it is very dense it can result in a localized problem. Coontail has no root system and thus minor wave action can dislodge large masses which float to another part of the

Appendix

Shakey Lakes Property Owners Attitude Survey On Aquatic Plants

Introduction

The management of aquatic plants not only requires a good information base on the existing aquatic plant community but it also requires input from property owners around the Shakey Lakes system. To determine how the lake property owners perceive the lake system and its condition we conducted a mail survey.

Methods

Ownership addresses for the Shakey Lakes riparian owners were obtained from the Menominee County Equalization Office. A cover letter, 13 question Aquatic Plant Survey Questionnaire (APSQ), and return addressed envelope was mailed to 56 riparian owners. The survey was modified from the survey by Wandell and Wolfson (2000) and was designed to evaluate overall riparian opinions on the lake and drawdown options.

Results

A total of 35 (62.5%) of all APSQ were returned and used in the data presented. The data presented in Figure 1 shows the riparian land ownership. Property ownership remained quite stable over time with almost 70% owning their lakefront property for 20 years or more.

Riparian lake usage is presented in Figure 2. Swimming, fishing, boating and water skiing represent more than 75 % of the water use. The majority of the riparian owners view the quality of Shakey Lakes to be average to very good, while approximately 30 % view the water quality to be poor to bad (Figure 3).

The majority of riparian owners thought there was a problem with aquatic plants in Shakey Lakes (Figure 4). Excessive plant populations were perceived as hindering water recreation and being unsightly. The plant population was perceived to be a problem in specific areas by 20 % of the riparian owners. Underwater plants, shoreline plants and floating plants appeared to cause the greatest problem on the lakes. Algae was also considered to be a biological problem in the lakes (Figure 5). Aquatic plants interfered primarily with swimming, navigation and off shore boating as perceived by almost three quarters of the lakefront property owners (Figure 6).

Approximately 36 % of riparian owners preferred to control the aquatic plant population as much as possible while 10 % of the owners preferred to do no aquatic plant control (Figure 7).

Riparian owners were mixed in their method to control aquatic plants. Thirty-one percent preferred to use the drawdown method, while others recommended harvesting, herbicide usage, and hand raking, or doing nothing (Figure 8).

Figure 2. Shakey Lakes riparian lake usage

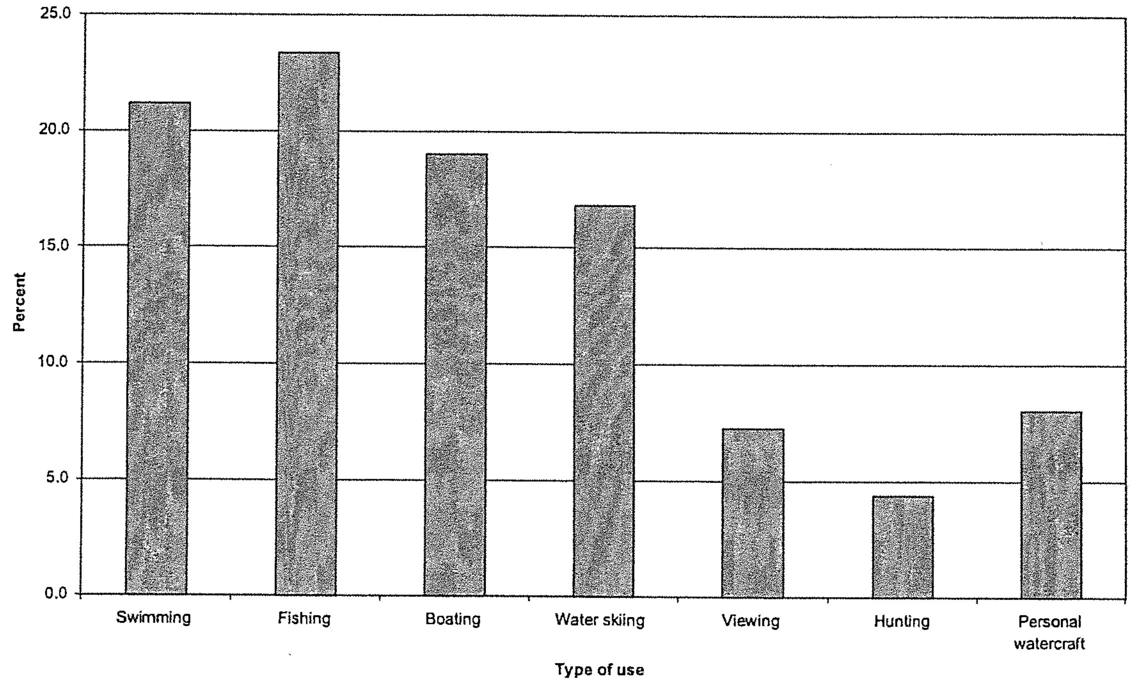


Figure 3. Riparian ranking of quality of Shakey Lakes

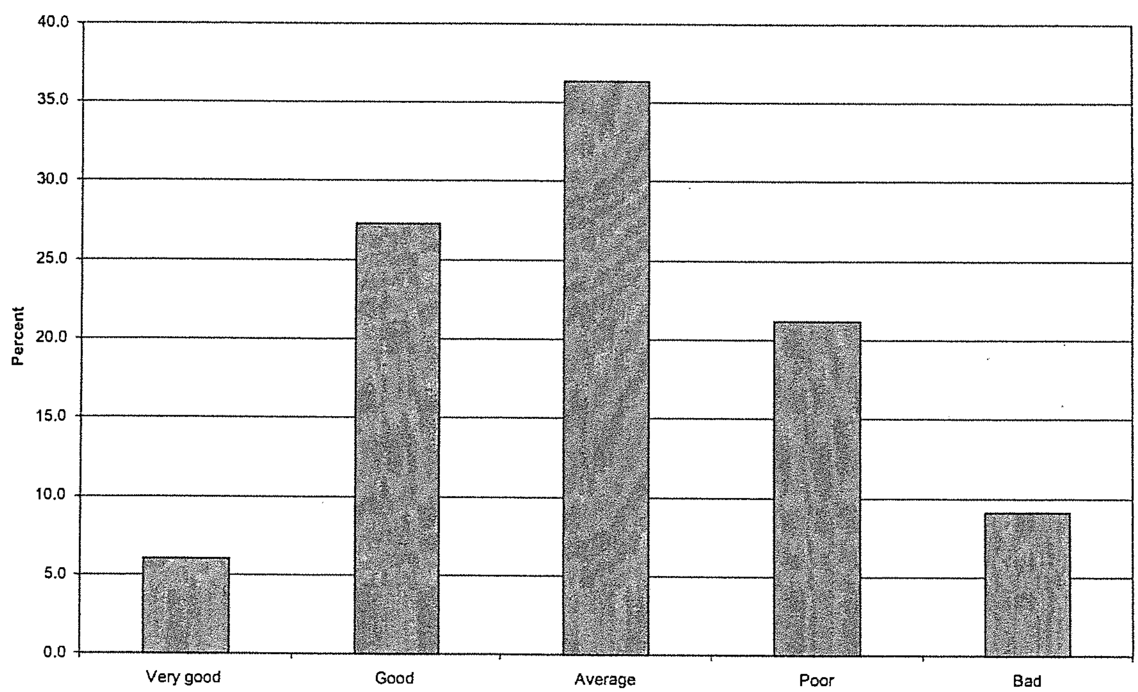


Figure 6. Shakey Lakes riparian preception of aquatic plant interference

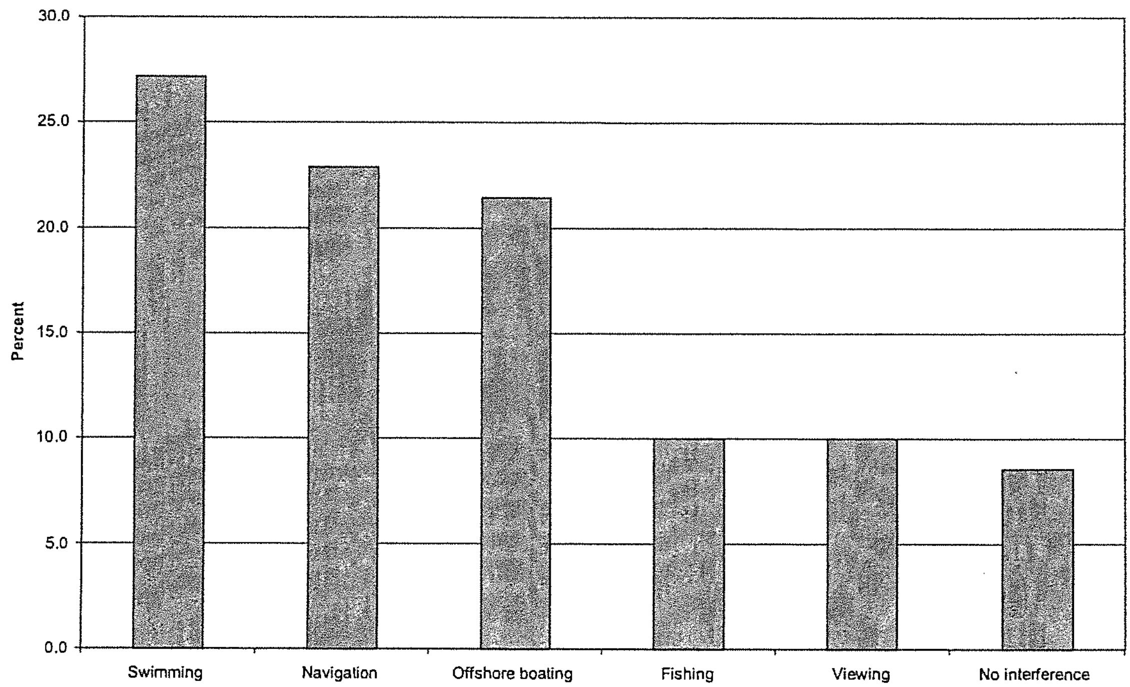


Figure 7. Shakey Lakes riparian recommendation for controlling aquatic vegetation

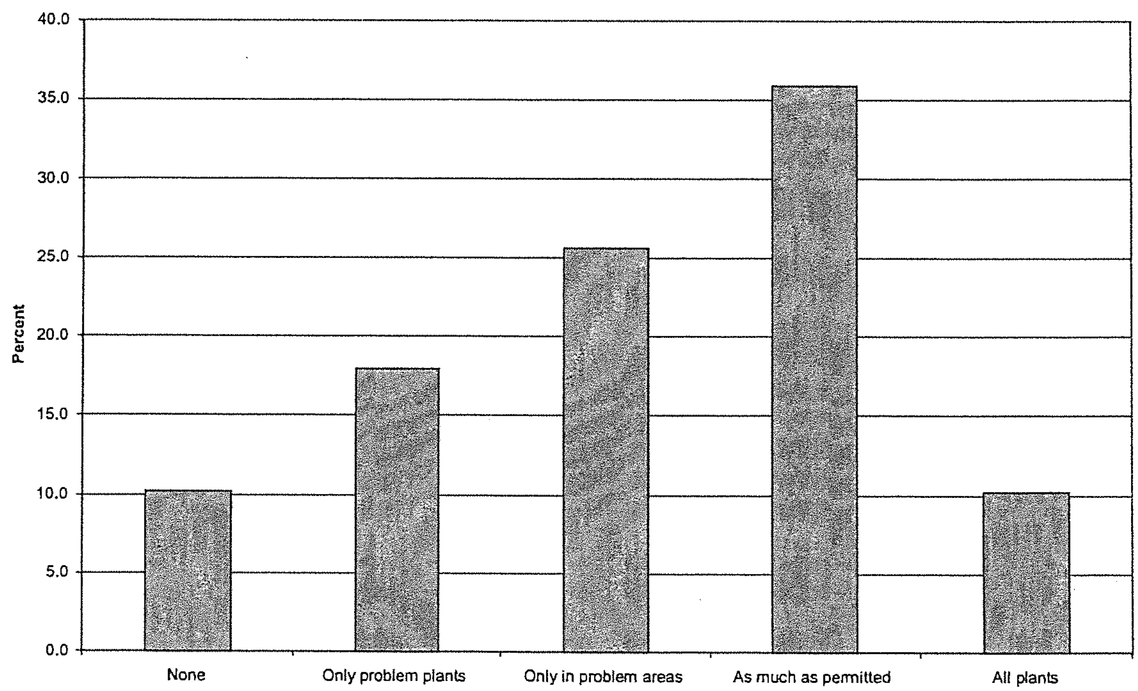


Figure 10. Shakey Lakes riparian use of lawn fertilizer

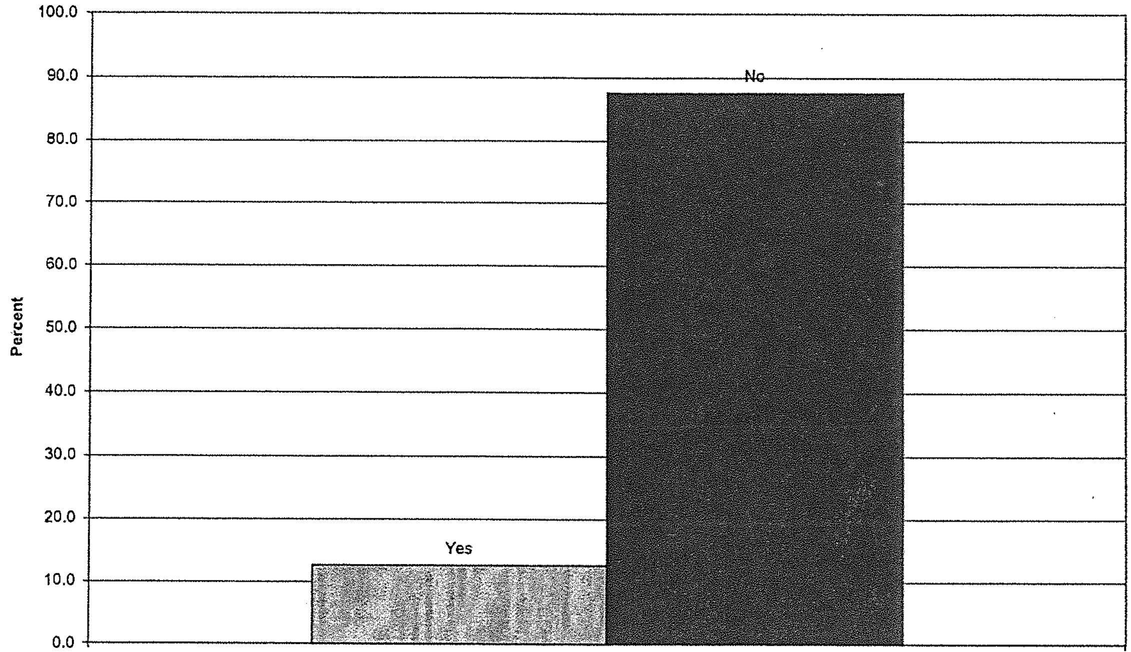


Figure 11. Shakey Lakes riparian support of good voluntary septic system maintenance

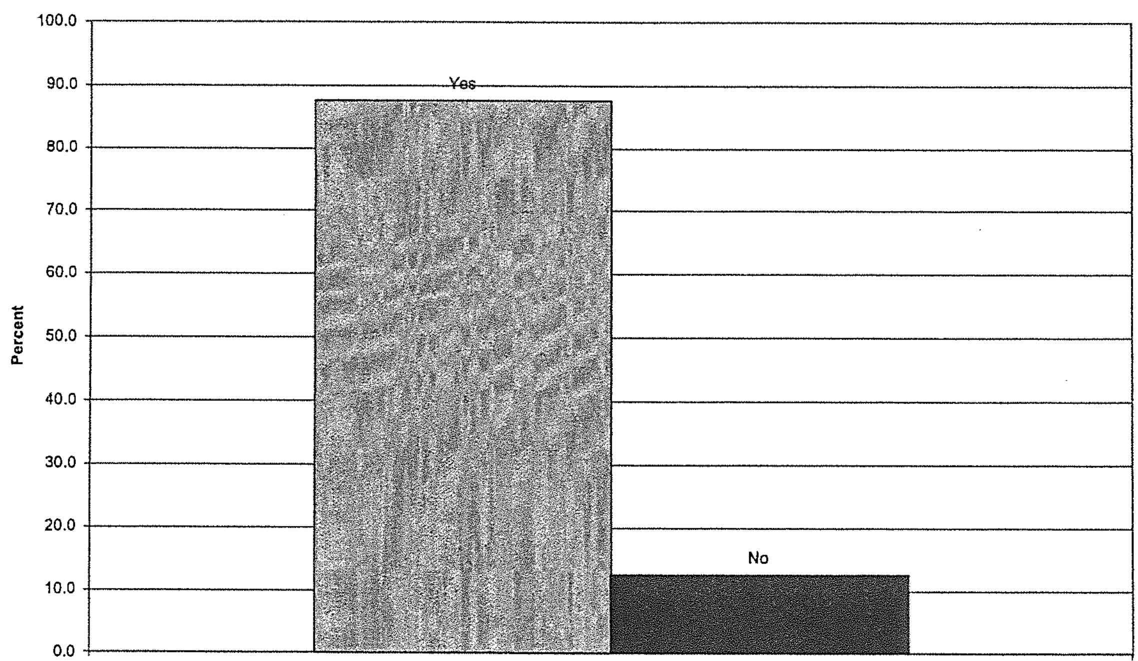


Figure 14. Shakey Lakes riparian support for raising the water level

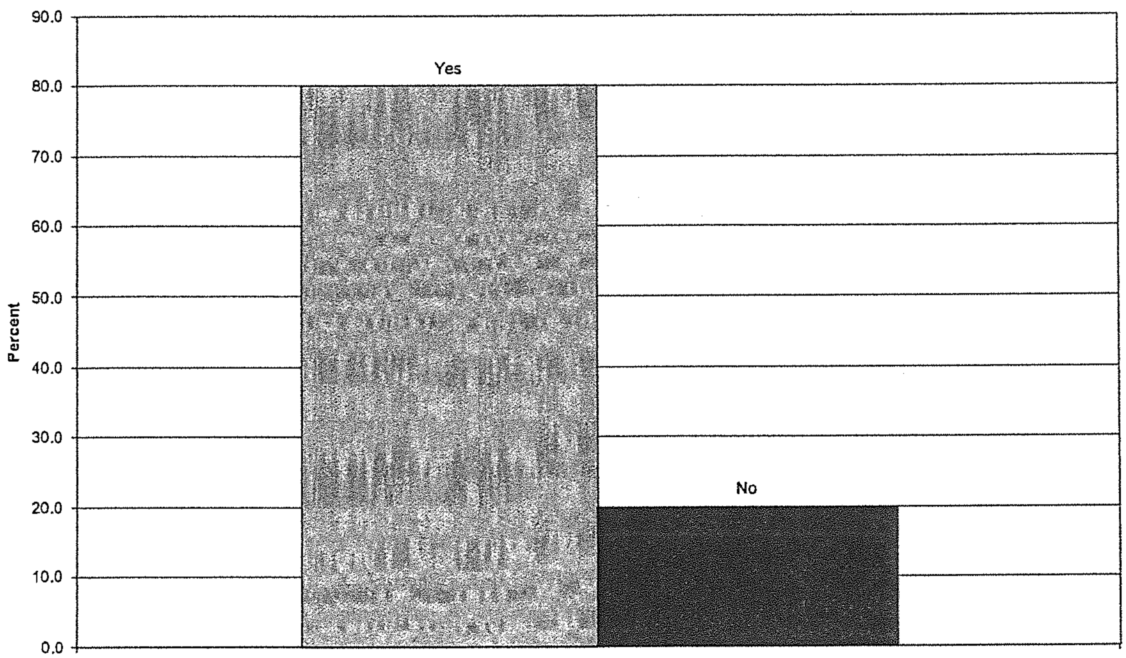
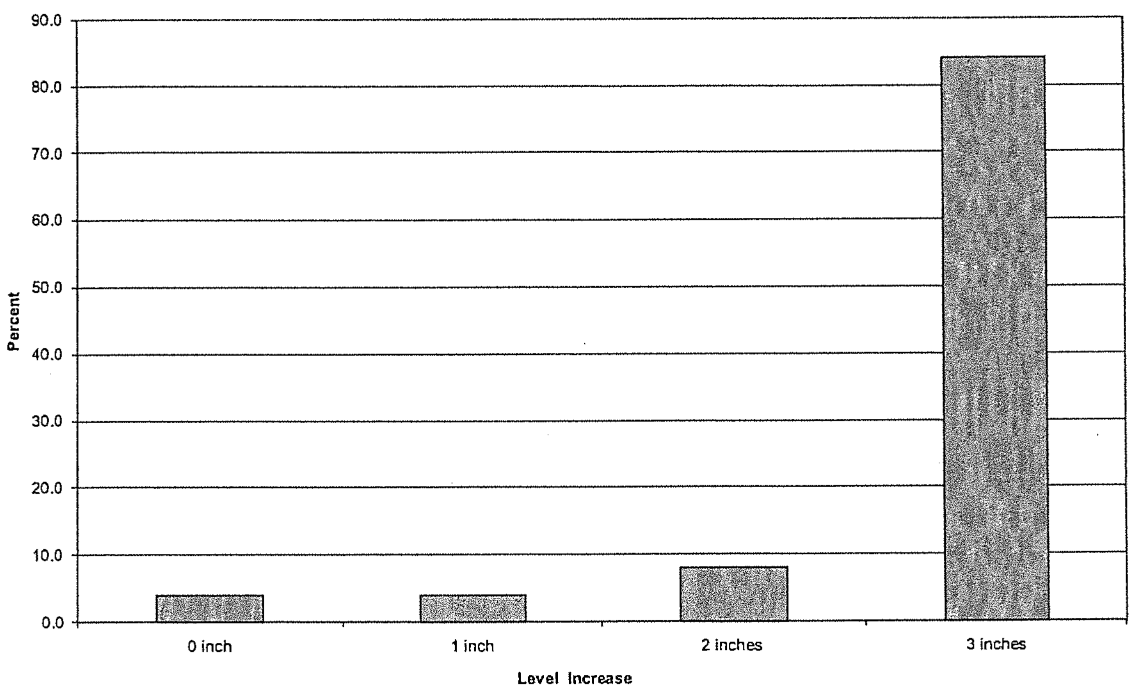


Figure 15. Shakey Lakes riparian preferred lake level increase



Question 6 - Do aquatic plants interfere with activities?

Years	*Response*	*%*
Swimming	19	**27.1**
Navigation	16	**22.9**
Offshore boating	15	**21.4**
Fishing	7	**10.0**
Viewing	7	**10.0**
No interference	6	**8.6**
	70	

Question 7 - How much of the lake's vegetation should be controlled?

None	4	**10.3**
Only problem plants	7	**17.9**
Only in problem areas	10	**25.6**
As much as permitted	14	**35.9**
All plants	4	**10.3**
	39	

Question 8 - What method should be used to control lake vegetation?

Drawdown	15	**30.6**
Harvesting	9	**18.4**
Herbicides	11	**22.4**
Hand raking	8	**16.3**
No preference	6	**12.2**
	49	

Question 9 - What do you think are the sources of pollution in the lake?

Agricultural runoff	9	**22.0**
Residential runoff	12	**29.3**
Urban runoff	1	**2.4**
Septic seepage	12	**29.3**
Other (gas & oil from motors, Park, dying vegetation	7	**17.1**
Storm sewers	0	**0.0**
	41	

Question 10 - Do you fertilize your lawn?

Yes	4	**12.5**
No	28	**87.5**
	32	

Question 11- Would you support good voluntary septic system maintenance?

Yes	28	**87.5**
No	4	**12.5**
	32	

Question 12 - Would you support a scheduled drawdown?

Yes	23	**76.7**
No	7	**23.3**
	30	

Appendix E

eDNA Results

Sample Collected By:	Ann Hruska
Date Collected:	6/17/2015
Lake Name:	Shakey Lake
Lake Location:	Menominee County
Date Analyzed:	6/23/2015
eDNA Analysis By:	Salach
Sample ID:	H182

Scientific Name	Common Name	Gene Targeted	Results
Cercopagis pengoi	Fishhook Waterflea	COI	eDNA below detection limit
Daphnia cristata	Daphnia	hsp90	eDNA below detection limit
Orconectes rusticus	Rusty Crayfish	COI	eDNA below detection limit
Petromyzon marinus	Sea Lamprey	18S rRNA and nd3	eDNA below detection limit
Limnoperna fortunei	Golden Mussel	COI	eDNA below detection limit
Dreissena bugensis	Quagga Mussel	COI	eDNA below detection limit
Bythotrephes longimanus	Spiny Waterflea	COI	eDNA below detection limit
Hydrilla verticillata	Hydrilla	hvme1	eDNA below detection limit
Dreissena polymorpha	Zebra Mussel	18S rRNA and COI	eDNA detected
Channa argus	Northern Snakehead	NADH and cytb	eDNA below detection limit
Dikerogammarus villosus	Killer Shrimp	COI	eDNA below detection limit
Didymosphenia geminata	Didymo or Rock Snot	18S rRNA	eDNA below detection limit
Cylindrospermopsis raciborskii	Cylindro	rbcL	eDNA below detection limit
Corbicula fluminea	Asian Clam	COI	eDNA below detection limit
Potamopyrugus antipodarum	New Zealand Mudsnail	cytb	eDNA below detection limit
Neogobius melanstromus	Round Goby	COI	eDNA below detection limit
Procambarus clarkii	Red Swamp Crayfish	int2	eDNA below detection limit
Positive Control			
Zebra Mussel DNA Spiked in Reaction			eDNA detected

Sample Collected By:	Ann Hruska, Ashley Harris
Date Collected:	8/3/2015
Lake Name:	Resort Lake (Shakey Lakes)
Lake Location:	Menominee County
Date Analyzed:	9/16/2015
eDNA Analysis By:	Kronlein
Sample ID:	H273

Scientific Name	Common Name	Gene Targeted	Results
Cercopagis pengoi	Fishhook Waterflea	COI and 28S rRNA	eDNA below detection limit
Daphnia cristata	Daphnia	nd2	eDNA below detection limit
Orconectes rusticus	Rusty Crayfish	COI	eDNA below detection limit
Petromyzon marinus	Sea Lamprey	nd3 and COI	eDNA below detection limit
Limnoperna fortunei	Golden Mussel	COI	eDNA below detection limit
Dreissena bugensis	Quagga Mussel	COI	eDNA below detection limit
Bythotrephes longimanus	Spiny Waterflea	COI and 28S rRNA	eDNA below detection limit
Hydrilla verticillata	Hydrilla	matK	eDNA below detection limit
Dreissena polymorpha	Zebra Mussel	18S rRNA and COI	eDNA below detection limit
Channa argus	Northern Snakehead	NADH	eDNA below detection limit
Dikerogammarus villosus	Killer Shrimp	COI	eDNA below detection limit
Didymosphenia geminata	Didymo or Rock Snot	18S rRNA	eDNA below detection limit
Cylindrospermopsis raciborskii	Cylindro	rbcL	eDNA below detection limit
Corbicula fluminea	Asian Clam	COI	eDNA below detection limit
Potamopyrugus antipodarum	New Zealand Mudsnail	cytb	eDNA below detection limit
Neogobius melanstromus	Round Goby	COI and cytb	eDNA below detection limit
Procambarus clarkii	Red Swamp Crayfish	int2	eDNA below detection limit
Positive Control			
Zebra Mussel DNA Spiked in Reaction			eDNA detected

Sample Collected By:	Ann Hruska, Ashley Harris
Date Collected:	8/3/2015
Lake Name:	Long Lake (Shakey Lakes)
Lake Location:	Menominee County
Date Analyzed:	9/16/2015
eDNA Analysis By:	Kronlein
Sample ID:	H272

Scientific Name	Common Name	Gene Targeted	Results
Cercopagis pengoi	Fishhook Waterflea	COI and 28S rRNA	eDNA below detection limit
Daphnia cristata	Daphnia	nd2	eDNA below detection limit
Orconectes rusticus	Rusty Crayfish	COI	eDNA below detection limit
Petromyzon marinus	Sea Lamprey	nd3 and COI	eDNA below detection limit
Limnoperna fortunei	Golden Mussel	COI	eDNA below detection limit
Dreissena bugensis	Quagga Mussel	COI	eDNA below detection limit
Bythotrephes longimanus	Spiny Waterflea	COI and 28S rRNA	eDNA below detection limit
Hydrilla verticillata	Hydrilla	matK	eDNA below detection limit
Dreissena polymorpha	Zebra Mussel	18S rRNA and COI	eDNA detected in 1/6 replicates
Channa argus	Northern Snakehead	NADH	eDNA below detection limit
Dikerogammarus villosus	Killer Shrimp	COI	eDNA below detection limit
Didymosphenia geminata	Didymo or Rock Snot	18S rRNA	eDNA below detection limit
Cylindrospermopsis raciborskii	Cylindro	rbcL	eDNA below detection limit
Corbicula fluminea	Asian Clam	COI	eDNA below detection limit
Potamopyrugus antipodarum	New Zealand Mudsnail	cytb	eDNA below detection limit
Neogobius melanstromus	Round Goby	COI and cytb	eDNA below detection limit
Procambarus clarkii	Red Swamp Crayfish	int2	eDNA below detection limit
Positive Control			
Zebra Mussel DNA Spiked in Reaction			eDNA detected

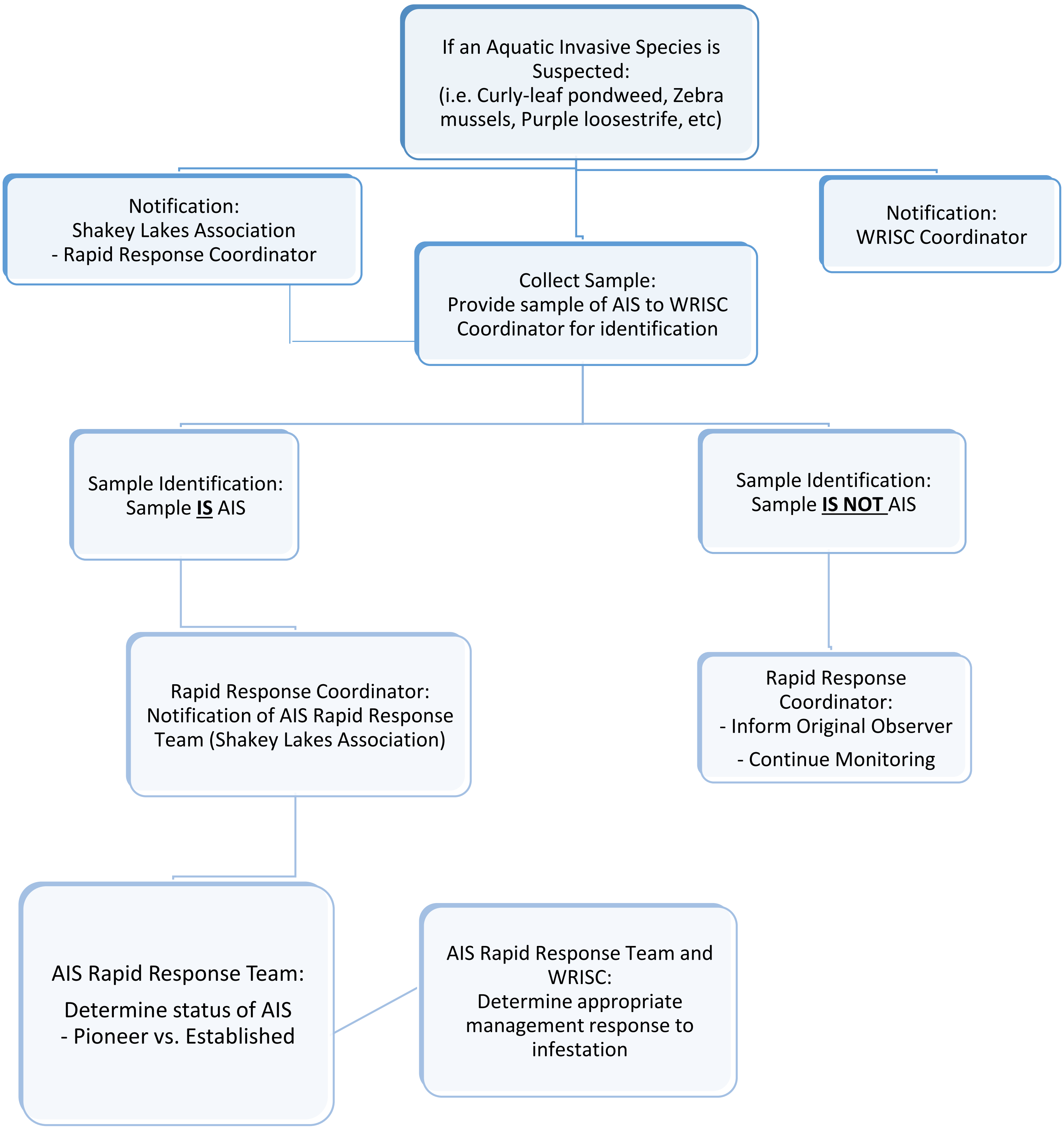
Sample Collected By:	Ann Hruska, Ashley Harris
Date Collected:	8/3/2015
Lake Name:	Bass Lake (Shakey Lakes)
Lake Location:	Menominee County
Date Analyzed:	9/16/2015
eDNA Analysis By:	Kronlein
Sample ID:	H274

Scientific Name	Common Name	Gene Targeted	Results
Cercopagis pengoi	Fishhook Waterflea	COI and 28S rRNA	eDNA below detection limit
Daphnia cristata	Daphnia	nd2	eDNA below detection limit
Orconectes rusticus	Rusty Crayfish	COI	eDNA below detection limit
Petromyzon marinus	Sea Lamprey	nd3 and COI	eDNA below detection limit
Limnoperna fortunei	Golden Mussel	COI	eDNA below detection limit
Dreissena bugensis	Quagga Mussel	COI	eDNA below detection limit
Bythotrephes longimanus	Spiny Waterflea	COI and 28S rRNA	eDNA below detection limit
Hydrilla verticillata	Hydrilla	matK	eDNA below detection limit
Dreissena polymorpha	Zebra Mussel	18S rRNA and COI	eDNA below detection limit
Channa argus	Northern Snakehead	NADH	eDNA below detection limit
Dikerogammarus villosus	Killer Shrimp	COI	eDNA below detection limit
Didymosphenia geminata	Didymo or Rock Snot	18S rRNA	eDNA below detection limit
Cylindrospermopsis raciborskii	Cylindro	rbcL	eDNA below detection limit
Corbicula fluminea	Asian Clam	COI	eDNA below detection limit
Potamopyrugus antipodarum	New Zealand Mudsnail	cytb	eDNA below detection limit
Neogobius melanstromus	Round Goby	COI and cytb	eDNA below detection limit
Procambarus clarkii	Red Swamp Crayfish	int2	eDNA below detection limit
Positive Control			
Zebra Mussel DNA Spiked in Reaction			eDNA detected

Appendix F

Aquatic Invasive Species (AIS) Rapid Response Plan

Aquatic Invasive Species Rapid Response Plan
Shakey Lakes



Appendix G

Letters regarding Threatened/Endangered Species of the Shakey Lakes Region

JENNIFER M. GRANHOLM
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES
LANSING

REBECCA A. HUMPHRIES
DIRECTOR

October 25, 2007

Ms. Charlene Peterson
Shakey Lakes Association
N8650 #21.75 Road
Stephenson, MI 49887

RE: **Proposed drawdown of Shakey Lakes impoundment; DEQ File No. 07-55-0028-P**

Dear Ms. Peterson:

Regarding the drawdown of the Shakey Lakes impoundment, we have received three letters that describe the potential impacts, or lack thereof, on three State-listed species: bald eagle, lake sturgeon and dwarf milkweed. These letters were provided by: 1) Dr. William Bowerman of Clemson University; 2) Mr. Fred Binkowski of the Great Lakes WATER Institute; and 3) Dr. Ronald E. Kinnunen of Michigan Sea Grant Extension and Dr. Michael Erdman of Menominee County Extension.

After reviewing these letters, we do not expect the drawdown of the Shakey Lakes impoundment, as proposed, will cause adverse impacts to threatened or endangered species. As a result, the drawdown may proceed legally without a Michigan Threatened & Endangered Species Permit.

Thank you for coordinating your activities with us. If you have any questions, please contact me at 517-373-1263.

Sincerely,

Todd C. Hogrefe

Todd C. Hogrefe
Endangered Species Coordinator
Wildlife Division

cc: Mr. James Caron, DEQ Land & Water Management Division
Ms. Lori Sargent, DNR Wildlife Division
Mr. Craig Albright, DNR Wildlife Division

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MICHIGAN STATE UNIVERSITY
SEA GRANT EXTENSION
Ronald Kinnunen
Michigan Sea Grant Agent
710 Chippewa Square, Ste. 202
Marquette, MI 49855
Phone/Fax: 906-226-3687
kinnune1@msu.edu

October 24, 2007

Lori G. Sargent
Endangered Species Specialist
Michigan Department of Natural Resources
Wildlife Division-Natural Heritage Program
PO Box 30180
Lansing, MI 48909

Dear Ms. Sargent:

This letter is in response to your letter to Charlene Peterson (Shakey Lakes Association) regarding the proposed drawdown of Shakey Lakes impoundment (DEQ File No. 07-55-0028-P). You requested a statement from knowledgeable sources stating that suitable habitat is or is not present for bald eagle, lake sturgeon, and dwarf milkweed and why the project will not impact any of these species or their habitats. You will find attached letters from highly recognized scientific experts on bald eagles and lake sturgeon stating why this drawdown will have no impact on bald eagles or lake sturgeon.

The Michigan Natural Features Inventory (MNFI) identified *Asclepias ovalifolia*, commonly known as dwarf milkweed on 4 occurrences in southern Menominee County in 2006. The slender perennial forb is listed as Endangered in Michigan. The MNFI reports the plant is only known from southern Menominee County, where it occurs in a mix of oak barrens and oak-pine barrens (oak-jack pine savanna). The MNFI report also indicates that their data may not reflect the true distribution since much of the state has not been thoroughly surveyed. *A. ovalifolia* is reported to be associated with black oak, white oak, jack pine, red maple, black cherry, pin oak, hickory, sassafras, service berry, New Jersey tea, sweetfern, beaked hazelnut, wintergreen, huckleberry, sand cherry, dwarf chinquapin oak, low sweet blueberry, little bluestem, big bluestem, sky-blue aster, false foxglove, tickseed, nut grass, flowering spurge, hair grass, tall sunflower, dwarf dandelion, blazing star, wild bergamot, goats-rue, wood betony, needle grass, and birdfoot violet. MNFI also reports *A. ovalifolia* likely requires natural disturbances associated with prairie habitat such as prescribed fire or brush removal to prevent woody plant succession. The Michigan Natural Features Inventory website reported upon above can be observed at: http://web4.msue.msu.edu/mnfi/.

Although *A. ovalifolia* has been reported to be in the Shakey Lakes area of Menominee County, it is not an aquatic plant and thus there will be no effect upon the plant specie/population due to the temporary drawdown of Shakey Lakes. The US Department of Agriculture identifies the plant as an obligate upland plant and no negative impacts upon *A. ovalifolia* due to destruction of species and disturbance of critical habitat will occur by performing the temporary drawdown. Furthermore, the drawdown will take place in late fall when the plant is entering dormancy and the lake system will be refilled early next spring prior to plant germination.

Family Related Author Publications

Erdman, M. D., K. S. Gregorski, and A. E. Pavlath. 1984. Fuel characteristics and pyrolysis studies of solvent extractables and residues from the evergreen shrub Calotropis procera. Trans. ASAE 27: 1186-1189.

Erdman, M. D. 1983. Nutrient and cardenolide composition of unextracted and solvent-extracted Calotropis procera. J. Agric. And Food Chem. 31: 509-513

Erdman, M .D., and B. A. Erdman. 1981. Calotropis procera as a source of plant hydrocarbons. J. Econ. Bot. 35: 467-472.

Family Related Author Abstracts

Erdman, M.D., K. S. Gregorski, and A. E. Pavlath. 1984 Fuel characteristics and pyrolysis studies of solvent extractables and residues from the evergreen shrub Calotropis procera. Solar and Biomass Energy workshop, USDA-DOE, Atlanta, GA.

Erdman, M.D. 1983. Calotropis procera, a potential fuel and feed resource in arid and semiarid regions. Solar and Biomass Energy Workshop, USDA-DOE, Atlanta, GA.

If you have any specific questions, please feel free to contact us.

Ronald E. Kinnunen, Ph.D.
Michigan Sea Grant Extension
Michigan State University
710 Chippewa Square, Ste. 202
Marquette, MI 49855

Michael D. Erdman, Ph.D.
Menominee County Extension Director
Michigan State University
S904 US 41
Stephenson, MI 49887

Enclosures: 2

Sargent letter

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October 23, 2007

Dr. Ronald Kinnunen
MSU-Sea Grant
710 Chippewa Square, Suite 202
Marquette, Michigan 49855

Reference: Shakey River Bald Eagles

Dear Dr. Kinnunen:

We discussed the drawdown of the Shakey Lakes complex in Menominee County, Michigan today and what, if any, effects this would have on the pair of eagles that nest nearby. The basic facts that you presented were: a periodic fall-winter draw-down of up to 48 inches, occurs at Shakey Lakes; this is regulated by agreement with the county and a local judge; the drawdown has increased wild rice in the area; no impact to the fishery in the lakes has been noted, and locals are reporting better fishing now; and, impacts to bald eagles needs to addressed as it relates to the drawdown.

This letter to you is intended to address the potential impact to nesting bald eagles at the Shakey River nest, Mm-04. As in any expert opinion, it is important that you have documentation of my credentials and experience to make that opinion. I have attached my brief, 2 page Curriculum Vitae in this fax/letter. If necessary, I will forward my full 57 page CV. I have studied bald eagles in Michigan for 23 years and am a member of the Northern States Bald Eagle Recovery Team (U.S. Fish & Wildlife Service). I have published over 50 peer-reviewed scientific papers on bald eagles and have received over 100 research grants of over $4.6 million primarily on eagle research. I have given over 200 papers, many invited, at local, state, regional, national, and international scientific meetings, with most on the bald eagle. I have served as an expert witness in Clare County on bald eagle nesting requirements. Additional information is on my CV.

Our data on nesting attempts for bald eagles in Michigan comprises 47 breeding seasons, 1961 to 2007. Eagles at the Shakey River breeding area have been in this location since 1974. As with many territories which have been occupied for such a long time, we sometimes observe a decline in the success of the breeding area over time. This pair has been sporadic in producing nestling eagles since the mid-1990s. The location of this nest is along the river between the Shakey Lakes and the Menominee River. The nest is equidistant between these two large water bodies. I have examined the reproduction of the eagles in the year after the 1996-97, 1998-99, 2000-01, and 2002-2003 winters. There is no clear effect of these draw-downs on the ability of the eagles to produce young. Because the ability of eagles to reproduce can be affected by many different stressors, it would be in my expert opinion that the drawn downs are not causing any impact to this pair of eagles. If wild rice is increasing and waterfowl utilize the rice in the fall, it may actually enhance this location for eagles. In addition, if there are no impacts to the fishery in these lakes from the draw-down, have a smaller water body may make it easier for eagles to fish in the spring.

DEPARTMENT OF FORESTRY AND NATURAL RESOURCES
College of Agriculture, Forestry & Life Sciences 261 Lehotsky Hall Box 340317 Clemson, South Carolina 29634-0317
864.656.3302 FAX 864.656.3304

CLEMSON
UNIVERSITY

Therefore, there would be a very small likelihood that the small drawdown of the Shakey Lakes complex that is suggested, will impact the ability of this pair of eagles to successfully produce young.

If you have any questions or need any further assistance. please email me at wbowerm@clemson.edu or call me at my office, 864-656-6192.

Sincerely,

William W. Bowerman, Ph.D.
Associate Professor

DEPARTMENT OF FORESTRY AND NATURAL RESOURCES
College of Agriculture, Forestry & Life Sciences 261 Lehotsky Hall Box 340317 Clemson South Carolina 29634-0317
864.656.3302 FAX 864.656.3304

Department of Forestry & Natural Resources
Clemson University, G-121 Lehotsky Hall
Clemson, South Carolina 29670 USA

Telephone: (864) 656-6192
Fax: (864) 656-5332
Email: wbowerm@clemson.edu

Curriculum Vitae (Abbreviated)
William W. Bowerman, Ph.D.

Education:

B.A. Biology, *Western Michigan University*, 1985

M.A. Biology, *Northern Michigan University*, 1991, Thesis: *Factors Affecting Bald Eagle Reproduction in Upper Michigan*, Advisor: Dr. William Robinson

Ph.D. Fisheries & Wildlife - Environmental Toxicology (Dual Degree), Specialization Certificate: Ecology & Evolutionary Biology, *Michigan State University*, 1993, Dissertation: *Regulation of Bald Eagle (Haliaeetus leucocephalus) Productivity in the Great Lakes Basin: An Ecological and Toxicological Approach*, Advisor: Dr. John Giesy

Experience:

Clemson University, Associate Professor, Wildlife Ecology/Toxicology, 2004-
Clemson University, Assistant Professor, Wildlife Ecology/Toxicology, 1999-2004
Lake Superior State University, Director, Gale Gleason Environmental Institute, 1996-1999
Eagle Environmental, Inc., President and Chief Scientist, 1994-1996
Michigan State University, Research Associate 1993-94

External Activities:

Member, International Joint Commission's Great Lakes Science Advisory Board, 1996-Present
Member, Northern States Bald Eagle Recovery Team, US Fish & Wildlife Service, 1995-Present

Professional Memberships:

The Wildlife Society
Society for Environmental Toxicology and Chemistry
Sigma Xi
Raptor Research Foundation
World Working Group on Birds of Prey and Owls
Ecological Society of America
American Ornithologists' Union
Association of Field Ornithologists
Wilson Ornithological Society
Cooper Ornithological Society
Society for Conservation Biology
African Society for Toxicological Sciences
International Association of Great Lakes Research
American College of Forensic Examiners
Wildlife Disease Association

Professional Certifications:

Certified Senior Ecologist, Ecological Society of America, 2004
Diplomat & Board Certified Forensic Examiner, American College of Forensic Examiners, 1996

Grants:

Since 1986, Dr. Bowerman has received over 100 grants totaling >$4.6 million.

Presentations:

Dr. Bowerman has presented 223 papers at local, national, and international scientific meetings, symposia, and conferences including 86 invited presentations and 127 general presentations.

Publications: Dr. Bowerman has published 57 peer-reviewed works: 14 book chapters and 43 journal articles. Currently 10 journal articles have been submitted for publication. He has been a co-editor of 1 Book, 1 Journal Issue, and 2 Peer-reviewed Reports.

Selected Papers:

Bowerman, W.W., D.A. Best, J.P. Giesy, M.C. Shieldcastle, M.W. Meyer, S. Postupalsky, and J.G. Sikarskie. 2003. Associations between regional differences in PCBs and DDE in blood of nestling bald eagles and reproductive productivity. Environmental Toxicology and Chemistry 22:371-376.

Bowerman, W.W., C.J. Mehne, D.A. Best, K.R. Refsal, S. Lombardini, and W.C. Bridges. 2002. Testing the effects of ACTH on nestling bald eagle corticosterone levels. Bull. Environ. Contam. Toxicol. 68:355-360.

Grubb, T.G., W.L. Robinson, and W.W. Bowerman. 2002. Effects of watercraft on bald eagles nesting in Voyageurs National Park, Minnesota. Wildl. Soc. Bull. 30:156-161.

Bowerman, W.W., D.A. Best, T.G. Grubb, J.G. Sikarskie, and J.P. Giesy. 2000. Assessment of environmental endocrine disruptors in bald eagles of the Great Lakes. Chemosphere 41:1569-1574.

Bowerman, W.W., J.E. Stickle, J.G. Sikarskie, and J.P. Giesy. 2000. Hematology and blood biochemistries in nestling bald eagles from field studies. Chemosphere 41:1575-1579.

Bowerman, W.W., D.A. Best, T.G. Grubb, G.M. Zimmerman, and J.P. Giesy. 1998. Trends of contaminants and effects for bald eagles of the Great Lakes Basin. Environmental Monitoring and Assessment 53(1):197-212.

Bowerman, W.W., J.P. Giesy, D.A. Best, and V.J. Kramer. 1995. A review of factors affecting productivity of bald eagles in the Great Lakes region: Implications for recovery. Environ Health Perspect.103 (Suppl 4):51-59.

Bowerman, W.W., E.D. Evans, J.P. Giesy, and S. Postupalsky. 1994. Using feathers to assess risk of mercury and selenium to bald eagle reproduction in the Great Lakes region. Arch. Environ. Contamn. Toxicol. 27:294-298.

Bowerman, W.W., T.J. Kubiak, J.B. Holt, D.E. Evans, R.J. Eckstein, and C.R. Sindelar. 1994. Observed abnormalities in mandibles of nestling bald eagles. Bull. Environ. Contam. Toxicol. 53:450-457.

Bowerman, W.W., T.G. Grubb, J.P. Giesy, A.J. Bath, and G.A. Dawson. 1993. Population composition and perching habitat of wintering bald eagles in northcentral Michigan. Canadian Field Naturalist 107: 273-278.

Awards:

Bald Eagle Research Award. The Eagle Foundation, 1987
Regional Forester's Honor Award, For Heroic Action, Eastern Region, US Forest Service, 1989
Outstanding Young Alumni Award, Northern Michigan University, 1992

Research Interests:

- Avian Population Ecology
- Wildlife Toxicology
- Wildlife Habitat Requirements
- Endangered Species and Factors Limiting Their Populations
- Wildlife as Ecosystem Monitors of Contaminants
- Avian Migration Studies using Telemetry
- Hydroelectric Projects and Wildlife Interactions
- Human Recreation and Wildlife Interactions

UNIVERSITY of WISCONSIN
UWMILWAUKEE

Great Lakes WATER Institute
Wisconsin Aquatic Technology & Environmental Research

600 East Greenfield Avenue
Milwaukee, WI
53204-2944
414 382-1700 *phone*
414 382-1705 *fax*
www.glwi.uwm.edu

Dr. Ronald E. Kinnunen
Michigan State University
Sea Grant Extension
Marquette, Michigan

Dear Ron,

After reviewing the information you provided, it is unlikely that the Shakey Lakes system has the potential to support a healthy lake sturgeon population.

The state agencies claim of a reported lake sturgeon sighting is possible, and probably the result of a transfer of fish from the Menominee River by fisher-people. However, with the outlet structure that controls the water level in the system, this prevents any natural movement of lake sturgeon into the Shakey Lakes system.

Again, based on the information you provided, the biological and physical characteristics of the Shakey Lakes system are not appropriate for supporting a lake sturgeon population.

It is ironic that the key issue in the argument is aquatic weed control. I have been conducting research on lake sturgeon for more than 25 years and we have found that lake sturgeon avoid habitats with heavy aquatic vegetation.

Sincerely,

Fred P. Binkowski, Senior Scientist

Appendix H

Score the Shore Photographs

Shakey Lakes: Score the Shore

Photographic documentation of the shoreline of Shakey Lakes

Photographs correspond to shoreline sections surveyed on July 29, 2016

Taken by Lindsay Peterson (WRISC)

Section 1

Section 1

Section 2

Section 2

Section 3

Section 3

Section 4

Section 4

Section 4

Section 5

Section 5

Section 5

Section 6

Section 7

Section 7

Section 8

Section 8

Section 9

Section 9

Section 10

Section 10

Section 11

Section 11

Section 11

Section 12

Section 12

Section 12

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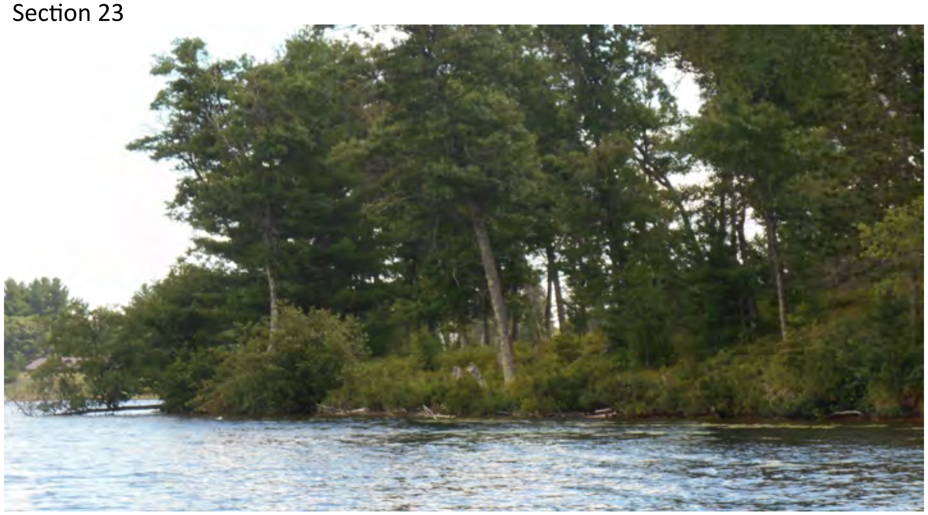
Section 23



Section 23

Section 24

Section 24

Section 24

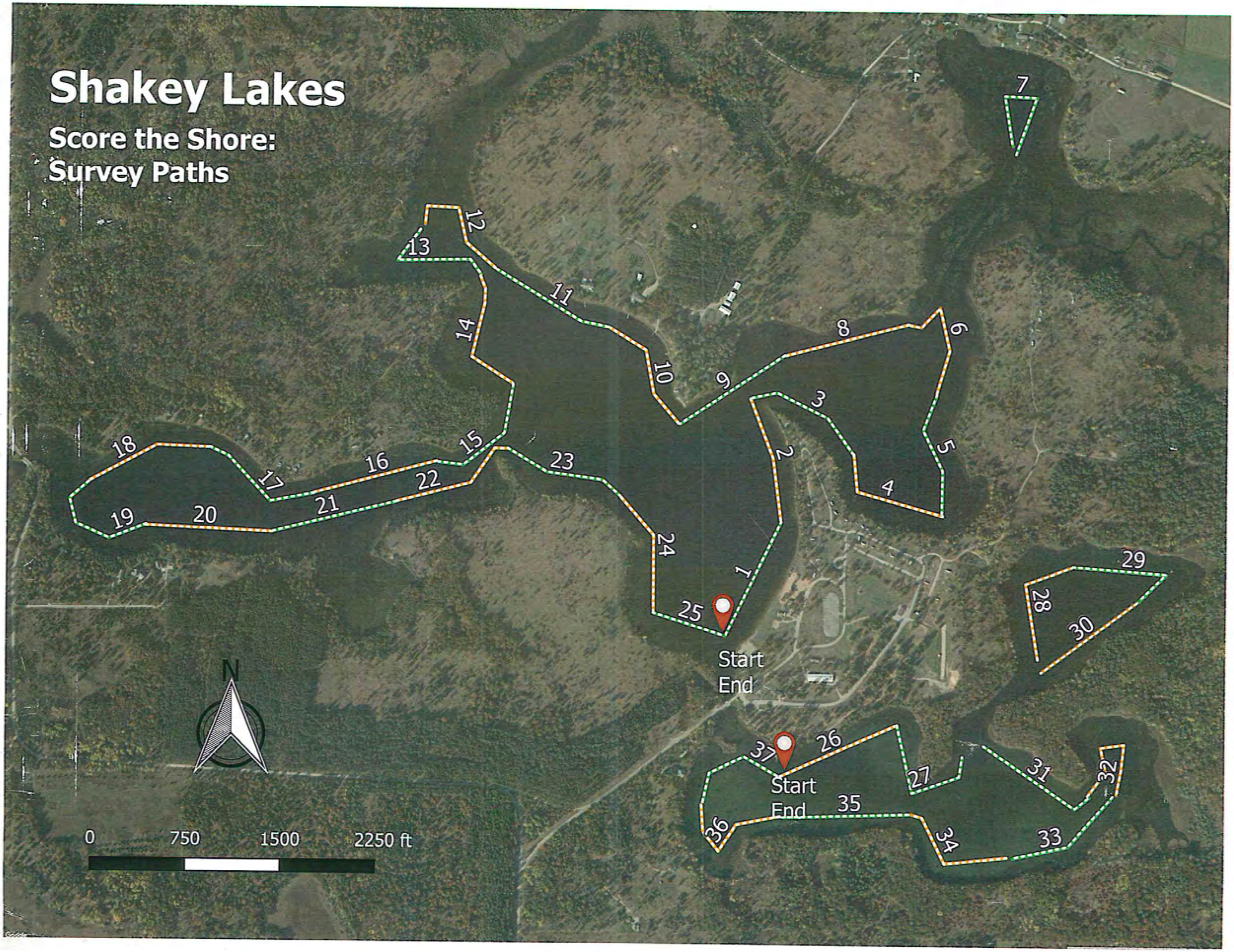
Section 25

Section 25

Section 25

Appendix I

Score the Shore Survey Datasheets


Shakey Lakes
Score the Shore:
Survey Paths
1
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16
17
18
19
20
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24
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28
29
30
31
32
33
34
35
36
37
Start
End
Start
End
N
0
750
1500
2250 ft

SCORE THE SHORE

Data Form

Cooperative Lakes Monitoring Program

Michigan Clean Water Corps

Lake Name: Shakey Lakes County: Menominee

Township: Lake Lake Sampling Site (Field ID) Number: 550197

Volunteer Monitor Name(s): Lindsay Peterson, Charissa Kashain

Date(s) of Survey : 7/29/2016

Lake Level during survey was: X Average/Normal ____ Low ____ High

Does the lake have a legal lake level? ____ Yes ____ No

If yes, indicate level gage reading at time of survey, if possible: ________

Did the lake level impact survey results? If so, how?

____

Total number of 1000' sections surveyed: 37 (-9 sections not surveyed)

(If the final section was substantially shorter than 1000', note its approximate length here: ________________)

Were photographs taken as part of this survey? X Yes ____ No

Development Density		**Overall Shore Score**	
A. Total no. of all buildings & docks	129	A. Add all of the overall section scores:	2,326
B. Total no. of sections:	28	B. Total no. of sections:	28
Divide A by B for the avg. number of structures per 1000 feet	4.6	Divide A by B for the Shore Score for your lake: *(It is a 0-100 scale)*	83

Other comments pertinent to the results of the assessment (plant treatments, restoration projects, deviations from standard procedures, weather)

Every 4 years this chain of lakes is drawn down ~ 40" between the months of Oct - Nov & left low over a winter. This is done as an aquatic plant control method.
Some sections were not surveyed due to time & access limitations. Sections that were visible from boat landing of Baker/Bass were surveyed.

Section #: 1 Lake/County: Shakey Lakes/Menominee Co Date: 7/29/16

GPS/Landmark at Start of Section: ______

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 2

Docks/Boatlifts: 0

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 1

% Emergent/Floating Vegetation X None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) ___ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? ___ No (0) X Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: X None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) ___ Minor (-1) X Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** -4

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) X >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

X None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) ___ >75% (4)

Average Unmowed Vegetation Belt Depth:

X None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 1 x 6.2 + 31.3 = 38 **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): -4 x 9.1 + 36.4 = 0 **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = 100 **Erosion Control Final Score**

Add the Scores Above = 138

Divide the Score Above by 3 = 46 **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #1

Park, boat landing, & swimming beach
Campground extends along point.

Section #: 2 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

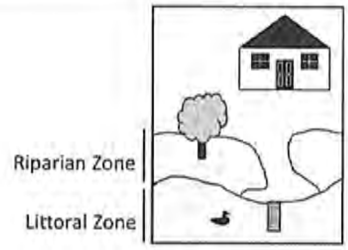
GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Small Docks (1-2 boat slips): 7

Large Docks (>2 boat slips): ________



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Score:** 4

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) _X_ 10-25% (2) ___ 25-75% (3) ___ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

_____ Unable to see

Is aquatic plant management evident/known? ___ No (0) _X_ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) _X_ Few: 1-5 (1) ___ Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) ___ Minor (-1) _X_ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Score:** 2

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

_____ None (0) _____ <10% (-1) _____ 10-25% (-2) _X_ 25-75% (-3) _____ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

_____ None (0) _____ <10% (1) _____ 10-25% (2) _____ 25-75% (3) _✓_ >75% (4)

Average Unmowed Vegetation Belt Depth:

_____ None (0) _X_ < 10 ft. (1) _____ 10-40 ft. (2) _____ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Score:** 0

Vertical Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) _____ Seawall _____ Boulders /Rock Walls

_____ Other - describe:

Sloped Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) _____ Concrete _____ Rock/Riprap

_____ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________ **Total Section Score:** [ ]

☐ **Comments or Concerns**: *Check box if there are comments on the back of this sheet.*

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 4 x 6.2 + 31.3 = 56 **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 2 x 9.1 + 36.4 = 55 **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = 100 **Erosion Control Final Score**

Add the Scores Above = 211

Divide the Score Above by 3 = 70 **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #2

Campground continues

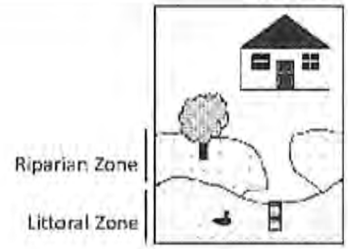
Section #: 3 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ______________________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 8

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? ___ No (0) X Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) X Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) ___ Minor (-1) X Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 3

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) ___ <10% (-1) X 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) X < 10 ft. (1) ___ 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______________________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 8 x 6.2 + 31.3 = **81** **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 3 x 9.1 + 36.4 = **64** **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = **100** **Erosion Control Final Score**

Add the Scores Above = **245**

Divide the Score Above by 3 = **82** **OVERALL SECTION SCORE**

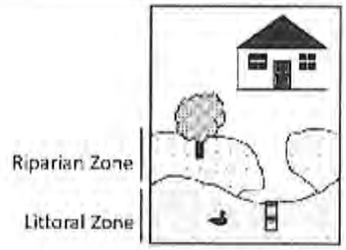
Comments or Concerns for this Section:

Section #3

Section #: 4 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________

PASS 1 (Boat is 100 yards from shore):



Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 13

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 7

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? ___ No (0) X Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) X Few: 1-5 (1) ___ Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) X Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 2

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) ___ <10% (-1) ___ 10-25% (-2) X 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) X < 10 ft. (1) ___ 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 7 x 6.2 + 31.3 = 75 **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 2 x 9.1 + 36.4 = 55 **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = 100 **Erosion Control Final Score**

Add the Scores Above = 230

Divide the Score Above by 3 = 77 **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #4

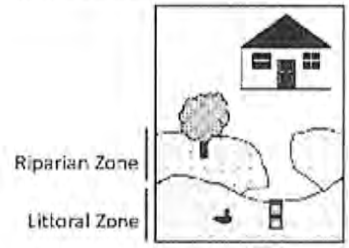
Section #: 5 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 9

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

___ Unable to see

Is aquatic plant management evident/known? _X_ No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) _X_ Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) _X_ Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 7

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

_X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) _X_ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 9 x 6.2 + 31.3 = [87] **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 7 x 9.1 + 36.4 = [100] **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = [100] **Erosion Control Final Score**

Add the Scores Above = [287]

Divide the Score Above by 3 = [96] **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #5

Section #: 6 Lake/County: Shakey Lakes / Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ______

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 9

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

___ Unable to see

Is aquatic plant management evident/known? _X_ No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) _X_ Few: 1-5 (1) ___ Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): _X_ None observed (0) ___ Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 7

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

_X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) _X_ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 9 x 6.2 + 31.3 = | 87 | **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 7 x 9.1 + 36.4 = | 100 | **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = | 100 | **Erosion Control Final Score**

Add the Scores Above = | 287 |

Divide the Score Above by 3 = | 96 | **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #6

Section #: 7 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 18

Docks/Boatlifts: 12

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 8

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? ___ No (0) X Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) X Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) X Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 2

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) ___ <10% (-1) ___ 10-25% (-2) X 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) X 25-75% (3) ___ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) X 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 8 x 6.2 + 31.3 = 81 **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 2 x 9.1 + 36.4 = 55 **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = 100 **Erosion Control Final Score**

Add the Scores Above = 236

Divide the Score Above by 3 = 79 **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #7

Very weedy, slough-like near the inlet of the Shakey river, shallow.

Section #: 8 Lake/County: Shakey Lakes/Menominee Co Date: 7/29/16

GPS/Landmark at Start of Section: ______

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 10

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? X No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) X Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) X Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 7

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) X > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ~~X~~ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 10 x 6.2 + 31.3 = 93 **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 7 x 9.1 + 36.4 = 100 **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = 100 **Erosion Control Final Score**

Add the Scores Above = 293

Divide the Score Above by 3 = 98 **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #8

Section #: 9 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ______

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 7

Docks/Boatlifts: 2

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 6

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) X 25-75% (3) ___ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? ___ No (0) X Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) X Few: 1-5 (1) ___ Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) X Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 1

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) ___ <10% (-1) ___ 10-25% (-2) X 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) X 25-75% (3) ___ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) X < 10 ft. (1) ___ 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** -2

Vertical Artificial: ___ None (0) X <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall X Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: ___ None (0) X <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete X Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 6 x 6.2 + 31.3 = 69 **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 1 x 9.1 + 36.4 = 46 **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): -2 x 11.1 + 100 = 78 **Erosion Control Final Score**

Add the Scores Above = 193

Divide the Score Above by 3 = 64 **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #9

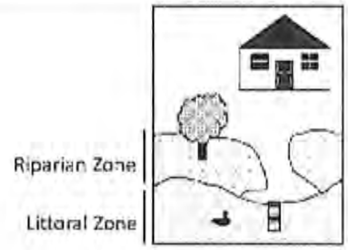
Section #: 10 Lake/County: Shakey Lakes/Menominee Co Date: 7/29/16

GPS/Landmark at Start of Section: ______________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 10

Docks/Boatlifts: 9



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 1

% Emergent/Floating Vegetation ___ None (0) _X_ <10% (1) ___ 10-25% (2) ___ 25-75% (3) ___ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) _X_ 25-75% (3) ___ >75% (4)

___ Unable to see

Is aquatic plant management evident/known? ___ No (0) _X_ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: _X_ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) ___ Minor (-1) _X_ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** -4

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) _X_ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

_X_ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) ___ >75% (4)

Average Unmowed Vegetation Belt Depth:

_X_ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** -2

Vertical Artificial: ___ None (0) ___ <10% (-1) _X_ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall _X_ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 1 x 6.2 + 31.3 = 38 **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): -4 x 9.1 + 36.4 = 0 **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): -2 x 11.1 + 100 = 78 **Erosion Control Final Score**

Add the Scores Above = [illegible] 116

Divide the Score Above by 3 = 39 **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #10

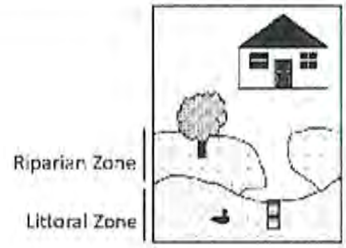
Section #: 11 Lake/County: Shakey Lakes/Menominee Co Date: 7/29/16

GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 1

Docks/Boatlifts: 1



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 5

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) _X_ 25-75% (3) ___ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) _X_ 25-75% (3) ___ >75% (4)

_____ Unable to see

Is aquatic plant management evident/known? ___ No (0) _X_ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) _X_ Few: 1-5 (1) ___ Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) _X_ Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 6

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

_____ None (0) _X_ <10% (-1) _____ 10-25% (-2) _____ 25-75% (-3) _____ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

_____ None (0) _____ <10% (1) _____ 10-25% (2) _____ 25-75% (3) _X_ >75% (4)

Average Unmowed Vegetation Belt Depth:

_____ None (0) _____ < 10 ft. (1) _____ 10-40 ft. (2) _X_ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) _____ Seawall _____ Boulders /Rock Walls

_____ Other - describe:

Sloped Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) _____ Concrete _____ Rock/Riprap

_____ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 5 x 6.2 + 31.3 =		62	**Littoral Zone Final Score**
If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =			
Riparian Zone Raw Score (from other side): 6 x 9.1 + 36.4 =		91	**Riparian Zone Final Score**
Erosion Control Raw Score (from other side): 0 x 11.1 + 100 =		100	**Erosion Control Final Score**
Add the Scores Above =		253	
Divide the Score Above by 3 =		84	**OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #11

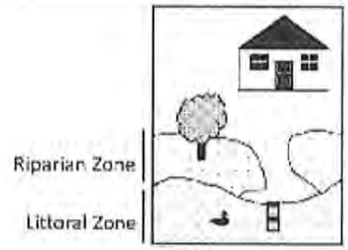
Section #: 12 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 10

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? X No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) X Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) X Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 7

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) X > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 10 x 6.2 + 31.3 = **93** **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 7 x 9.1 + 36.4 = **100** **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = **100** **Erosion Control Final Score**

Add the Scores Above = **293**

Divide the Score Above by 3 = **98** **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

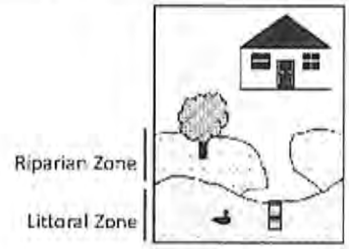
Section #: 13 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 9

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

___ Unable to see

Is aquatic plant management evident/known? _X_ No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) _X_ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) ___ Minor (-1) _X_ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 7

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

_X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) _X_ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 9 x 6.2 + 31.3 = [87] **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 7 x 9.1 + 36.4 = [100] **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = [100] **Erosion Control Final Score**

Add the Scores Above = [287]

Divide the Score Above by 3 = [96] **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #13

Section #: 14 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ______________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 10

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? X No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) X Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) X Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 7

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) X > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______________________

Go to back for Final Scoring and Comments

Swamp thistle found in section.

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 10 x 6.2 + 31.3 = [93] **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 7 x 9.1 + 36.4 = [100] **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = [100] **Erosion Control Final Score**

Add the Scores Above = [293]

Divide the Score Above by 3 = [98] **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #14

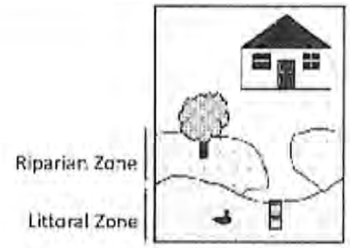
Section #: 15 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 7

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) X 10-25% (2) ___ 25-75% (3) ___ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? X No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) X Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) ___ Minor (-1) X Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 7

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) X > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: 0 None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: 0 None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

0 None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 7 x 6.2 + 31.3 = 75 **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 7 x 9.1 + 36.4 = 100 **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = 100 **Erosion Control Final Score**

Add the Scores Above = 275

Divide the Score Above by 3 = 92 **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

- Section #15

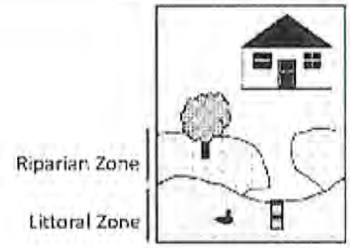
Section #: 16 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 3

Docks/Boatlifts: 1



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 9

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

___ Unable to see

Is aquatic plant management evident/known? ___ No (0) _X_ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) _X_ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) _X_ Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 6

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) _X_ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) _X_ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** -1

Vertical Artificial: ___ None (0) _X_ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) _X_ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 9 x 6.2 + 31.3 = 87 **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 6 x 9.1 + 36.4 = 91 **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): -1 x 11.1 + 100 = 89 **Erosion Control Final Score**

Add the Scores Above = 267

Divide the Score Above by 3 = 89 **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #16

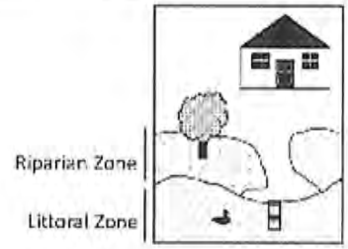
Section #: 17 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 9

Docks/Boatlifts: 4



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 7

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) _X_ 10-25% (2) ___ 25-75% (3) ___ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

___ Unable to see

Is aquatic plant management evident/known? ___ No (0) _X_ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) _X_ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) _X_ Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 4

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) ___ <10% (-1) _X_ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) _X_ 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** -1

Vertical Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: ___ None (0) _X_ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete _X_ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 7 x 6.2 + 31.3 = [75] **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 4 x 9.1 + 36.4 = [73] **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): -1 x 11.1 + 100 = [89] **Erosion Control Final Score**

Add the Scores Above = [237]

Divide the Score Above by 3 = [79] **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #17

Section #: 18 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 5

Docks/Boatlifts: 3

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 9

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

___ Unable to see

Is aquatic plant management evident/known? ___ No (0) _X_ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) _X_ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) _X_ Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 1

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) ___ <10% (-1) ___ 10-25% (-2) _X_ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) _X_ 25-75% (3) ___ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) _X_ < 10 ft. (1) ___ 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** -2

Vertical Artificial: ___ None (0) _X_ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall _X_ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: ___ None (0) _X_ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete _X_ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 9	x 6.2 + 31.3 =	87	**Littoral Zone Final Score**
If "Unable to see" submerged vegetation use this:	x 8.3 + 41.5 =		
Riparian Zone Raw Score (from other side): 1	x 9.1 + 36.4 =	46	**Riparian Zone Final Score**
Erosion Control Raw Score (from other side): -2	x 11.1 + 100 =	78	**Erosion Control Final Score**
	Add the Scores Above =	211	
	Divide the Score Above by 3 =	70	**OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section # 18

Section #: 19 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 5

Docks/Boatlifts: 5

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 8

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) X 25-75% (3) ___ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? ___ No (0) X Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) X Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) X Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 2

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) ___ <10% (-1) ___ 10-25% (-2) X 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) X 25-75% (3) ___ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) X 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** -2

Vertical Artificial: ___ None (0) X <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) X Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: ___ None (0) X <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete X Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 8	x 6.2 + 31.3 =	81	**Littoral Zone Final Score**
If "Unable to see" submerged vegetation use this:	x 8.3 + 41.5 =		
Riparian Zone Raw Score (from other side): 2	x 9.1 + 36.4 =	55	**Riparian Zone Final Score**
Erosion Control Raw Score (from other side): -2	x 11.1 + 100 =	78	**Erosion Control Final Score**
	Add the Scores Above =	214	
	Divide the Score Above by 3 =	71	**OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #19

Section #: 20 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 2

Docks/Boatlifts: 2

Riparian Zone

Littoral Zone

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 8

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) X 25-75% (3) ___ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? ___ No (0) X Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) X Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) X Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 4

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) ___ <10% (-1) X 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) X 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** -2

Vertical Artificial: ___ None (0) ~~X~~ <10% (-1) X 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) X Seawall X Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________

Go to back for Final Scoring and Comments

~~Tansee~~ found on stretch
Tansy

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 8 x 6.2 + 31.3 = 81 **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 4 x 9.1 + 36.4 = 73 **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): -2 x 11.1 + 100 = 78 **Erosion Control Final Score**

Add the Scores Above = 232

Divide the Score Above by 3 = 77 **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #20

Section #: 21 Lake/County: Shaky Lakes/ Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 10

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

___ Unable to see

Is aquatic plant management evident/known? _X_ No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) _X_ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) _X_ Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 7

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

_X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) _X_ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 10	x 6.2 + 31.3 =	93	**Littoral Zone Final Score**
If "Unable to see" submerged vegetation use this:	x 8.3 + 41.5 =		
Riparian Zone Raw Score (from other side): 7	x 9.1 + 36.4 =	100	**Riparian Zone Final Score**
Erosion Control Raw Score (from other side): 0	x 11.1 + 100 =	100	**Erosion Control Final Score**
	Add the Scores Above =	293	
	Divide the Score Above by 3 =	98	**OVERALL SECTION SCORE**

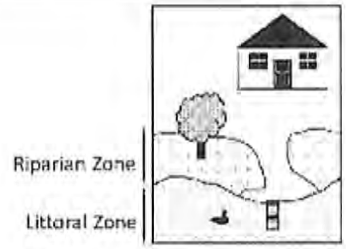
Comments or Concerns for this Section:

Section #21

Section #: 22 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ______

PASS 1 (Boat is 100 yards from shore):



Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 10

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

___ Unable to see

Is aquatic plant management evident/known? X No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) X Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) X Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 7

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) X > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 10 x 6.2 + 31.3 = [93] **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 7 x 9.1 + 36.4 = [100] **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = [100] **Erosion Control Final Score**

Add the Scores Above = [293]

Divide the Score Above by 3 = [98] **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #22

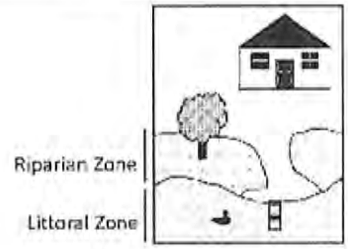
Section #: 23 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ______

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 7

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) _X_ 10-25% (2) ___ 25-75% (3) ___ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

___ Unable to see

Is aquatic plant management evident/known? _X_ No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) _X_ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) ___ Minor (-1) _X_ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 7

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

_X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) _X_ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 7 x 6.2 + 31.3 = [75] **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 7 x 9.1 + 36.4 = [100] **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = [100] **Erosion Control Final Score**

Add the Scores Above = [275]

Divide the Score Above by 3 = [92] **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #23

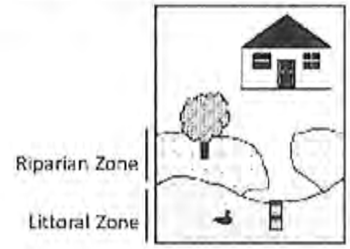
Section #: 24 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ______

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 10

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

___ Unable to see

Is aquatic plant management evident/known? _X_ No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) _✓_ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) _X_ Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 6

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

_X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) _X_ 10-40 ft. (2) _[scribbled out]_ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 10 x 6.2 + 31.3 = *If "Unable to see" submerged vegetation use this:* x 8.3 + 41.5 =	93	**Littoral Zone Final Score**
Riparian Zone Raw Score (from other side): 6 x 9.1 + 36.4 =	91	**Riparian Zone Final Score**
Erosion Control Raw Score (from other side): 0 x 11.1 + 100 =	100	**Erosion Control Final Score**
Add the Scores Above =	284	
Divide the Score Above by 3 =	95	**OVERALL SECTION SCORE**

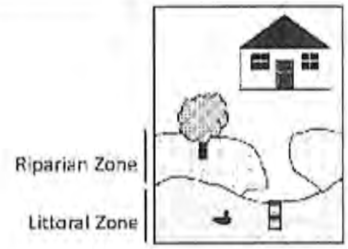
Comments or Concerns for this Section:

Section #24

Section #: 25 Lake/County: Shakey Lakes / Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________

PASS 1 (Boat is 100 yards from shore):



Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 3

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 10

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

___ Unable to see

Is aquatic plant management evident/known? _X_ No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) ___ Several: 6-15 (2) _X_ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) _X_ Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 5

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) _X_ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) _X_ >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) _X_ 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: _X_ None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

_X_ None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 10 x 6.2 + 31.3 =
If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 = **93** **Littoral Zone Final Score**

Riparian Zone Raw Score (from other side): 5 x 9.1 + 36.4 = **82** **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = **100** **Erosion Control Final Score**

Add the Scores Above = **275**

Divide the Score Above by 3 = **92** **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #25

Section #: 35 Lake/County: Shakey Lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ____________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 0

Docks/Boatlifts: 0

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 4

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) X 25-75% (3) ___ >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) ___ >75% (4)

X Unable to see

Is aquatic plant management evident/known? X No (0) ___ Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) ___ Few: 1-5 (1) X Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) X Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 7

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) X > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ____________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 4 x 6.2 + 31.3 = [75] **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 7 x 9.1 + 36.4 = [100] **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = [100] **Erosion Control Final Score**

Add the Scores Above = [275]

Divide the Score Above by 3 = [92] **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #35

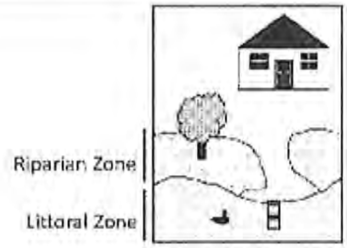
Section #: 36 Lake/County: Shakey lakes/Menominee Co. Date: 7/29/16

GPS/Landmark at Start of Section: ______

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 1

Docks/Boatlifts: 1



PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 3

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) ___ >75% (4)

X Unable to see

Is aquatic plant management evident/known? ___ No (0) X Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) X Few: 1-5 (1) ___ Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): ___ None observed (0) X Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 6

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) X <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) ___ 10-40 ft. (2) X > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** 0

Vertical Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall ___ Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: X None (0) ___ <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) ___ Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 3 x 6.2 + 31.3 = [66] **Littoral Zone Final Score**

If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =

Riparian Zone Raw Score (from other side): 6 x 9.1 + 36.4 = [91] **Riparian Zone Final Score**

Erosion Control Raw Score (from other side): 0 x 11.1 + 100 = [100] **Erosion Control Final Score**

Add the Scores Above = [257]

Divide the Score Above by 3 = [86] **OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #36

Section #: 37 Lake/County: Shaky Lakes/Menominee Co Date: 7/29/16

GPS/Landmark at Start of Section: ______________________

PASS 1 (Boat is 100 yards from shore):

Number of: Homes/Major Buildings: 2

Docks/Boatlifts: 1

PASS 2 (Boat is 20-30 yards from shore):

Littoral (Aquatic) Zone Characteristics and Shoreline Erosion: **Littoral Zone Raw Score:** 4

% Emergent/Floating Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

% Submerged Vegetation ___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) ___ >75% (4)

X Unable to see

Is aquatic plant management evident/known? ___ No (0) X Minor (at docks, swim areas; -1) ___ Major (-2)

Amount of Downed Trees/Woody Debris: ___ None (0) X Few: 1-5 (1) ___ Several: 6-15 (2) ___ Many: 16+ (3)

Erosion along shoreline (check one): X None observed (0) ___ Minor (-1) ___ Moderate (-2) ___ Severe (-3)

PASS 3 (Boat back out to 100 yards from shore):

Riparian (Land Near Shore) Zone Characteristics: **Riparian Zone Raw Score:** 3

% Maintained Lawn, Maintained/Artificial Beach, or Impervious (% of total section length):

___ None (0) ___ <10% (-1) ___ 10-25% (-2) X 25-75% (-3) ___ >75% (-4)

% Unmowed Vegetation Belt (any vegetation other than lawn; % of total section length):

___ None (0) ___ <10% (1) ___ 10-25% (2) ___ 25-75% (3) X >75% (4)

Average Unmowed Vegetation Belt Depth:

___ None (0) ___ < 10 ft. (1) X 10-40 ft. (2) ___ > 40 ft. (3)

Shoreline Erosion Control Practices: **Erosion Control Raw Score:** -2

Vertical Artificial: ___ None (0) X <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Vertical Structure (check all that apply) ___ Seawall X Boulders /Rock Walls

___ Other - describe:

Sloped Artificial: ___ None (0) X <10% (-1) ___ 10-25% (-2) ___ 25-75% (-3) ___ >75% (-4)

Types of Sloped Artificial (check all that apply) X Concrete ___ Rock/Riprap

___ Other - describe:

Bioengineering (e.g. coir logs, branch bundles):

X None (0) ___ <10% (-0.5) ___ 10-25% (-1) ___ 25-75%(-1.5) ___ >75% (-2)

GPS/Landmark at End of Section: ______________________

Go to back for Final Scoring and Comments

Final Scoring

These equations transform your raw scores into a 0-100 scale. You should round to the nearest whole number. Remember to multiply before you add.

Littoral Zone Raw Score (from other side): 4 x 6.2 + 31.3 =	75	**Littoral Zone Final Score**
If "Unable to see" submerged vegetation use this: x 8.3 + 41.5 =		
Riparian Zone Raw Score (from other side): 3 x 9.1 + 36.4 =	64	**Riparian Zone Final Score**
Erosion Control Raw Score (from other side): -2 x 11.1 + 100 =	78	**Erosion Control Final Score**
Add the Scores Above =	217	
Divide the Score Above by 3 =	72	**OVERALL SECTION SCORE**

Comments or Concerns for this Section:

Section #37

Appendix J

Lake User Survey

LAKE SURVEY: Name of Lake_______________________________

In preparation for lake management planning efforts under the Michigan Invasive Species Grant Program Project #14-1010, Wild Rivers Invasive Species Coalition (WRISC) would like to better understand the issues, concerns, and suggestions you may have regarding your lake.

Please take a few minutes to complete this survey and return it to: WRISC c/o Lindsay Peterson, 420 N Hooper Street, Kingsford, MI 49802 or wriscproject@gmail.com

How long have you lived on or observed the lake? _______ Years

What is your residency status on the lake? Year round Seasonal

What uses do you make of the lake? (Circle all that apply)

Swimming Fishing Boating Water Skiing Viewing Hunting Personal Watercraft

How would you rank the quality of the lake?

Excellent Good Average Poor Bad

In the past **5 years**, what would you say about the quality of the lake?

Increased (has gotten better) No change (stayed the same) Declined (has gotten worse)

What aquatic plant problems exist in the lake? (Select all that apply)

___ There are not enough plants for fish and wildlife

___ Plants are excessive and hinder recreation

___ Plants are not a problem

___ Algae blooms are a problem

___ Plants are not a problem except in certain areas

___ Other plant problems (Please explain):

___ The plants are unsightly

What kinds of plants are causing problems? (Circle all that apply)

Shoreline Plants Underwater Plants Floating Plants Algae

Do aquatic plants interfere with any of the following activities? (Circle all that apply)

Swimming Navigation Offshore boating Fishing Viewing

In your opinion, how much of the lake's vegetation should be controlled?

___None ___Only problem plants ___Only in problem areas ___ As much as permitted ___ All plants

If the lake's vegetation should be reduced, which control method(s) do you favor?

Drawdown Harvesting Herbicides Hand Raking No Preference (use what's best)

Suction Harvesting Biocontrol Other (Please specify):

What do you think are the sources of pollution to the lake? (Circle all that apply)

Agricultural runoff Residential runoff Urban runoff Septic seepage Storm sewers

Other (Please specify):

Modified from: Michigan State University Extension, Aquatic Plant Survey Questionnaire, A Citizen's Guide for the Identification, Mapping, and Management of the Common Rooted Plants of Michigan Lakes, Water Quality Series: WQ55; Brett, M., 2001, Washington State Lake Protection Association (WALPA), Seattle, WA 98104.

Do you fertilize your lawn? Yes No In the 20' next to your shore, what % is mown grass? ____

In thinking about your lake, please rank each issue on the scale of 1 to 5, with 1 being "not concerned/not important" and 5 being "very concerned/very important."
While all of the issues may seem important, please try to distinguish the issues as they pertain to your lake. For example, answering "1" for "Infestation by invasive species" does not necessarily mean you are uninterested in that issue. It could be that your lake does not have a problem with invasive species and you do not foresee it becoming a problem in the near future. It is merely not an important or prominent concern for your lake at this time.

Not Important ← → Most Important

1. Infestation by invasive species (i.e. Eurasian watermilfoil, etc.)	1	2	3	4	5
2. Use of herbicides to control aquatic plants	1	2	3	4	5
3. Use of mechanical and other plant control methods	1	2	3	4	5
4. Native plant enhancement	1	2	3	4	5
5. Nuisance/toxic algal blooms	1	2	3	4	5
6. Quality of fishing on the lake	1	2	3	4	5
7. Nutrient pollution (farm, urban, or stormwater runoff)	1	2	3	4	5
8. Water clarity	1	2	3	4	5
9. Odors	1	2	3	4	5
10. Sedimentation/muck accumulation	1	2	3	4	5
11. Shoreline erosion	1	2	3	4	5
12. Impact of new lakeshore development	1	2	3	4	5
13. Enforcement of shoreline and development regulations	1	2	3	4	5
14. Septic system maintenance	1	2	3	4	5
15. Shoreline restoration	1	2	3	4	5
16. Public access and non-resident lake use	1	2	3	4	5
17. Noise pollution from personal watercraft	1	2	3	4	5
18. Motorcraft impacts on shorelines, wetlands, and waterfowl	1	2	3	4	5
19. Beach and/or boat launch maintenance	1	2	3	4	5
20. Management of lake water level	1	2	3	4	5

Please note your 5 most important concerns from the list above, in priority order:

1. ______________________________________
2. ______________________________________
3. ______________________________________
4. ______________________________________
5. ______________________________________

Please note any other areas of concern not listed or addressed in this survey:

Modified from: Michigan State University Extension, Aquatic Plant Survey Questionnaire, A Citizen's Guide for the Identification, Mapping, and Management of the Common Rooted Plants of Michigan Lakes, Water Quality Series: WQ55; Brett, M., 2001, Washington State Lake Protection Association (WALPA), Seattle, WA 98104.