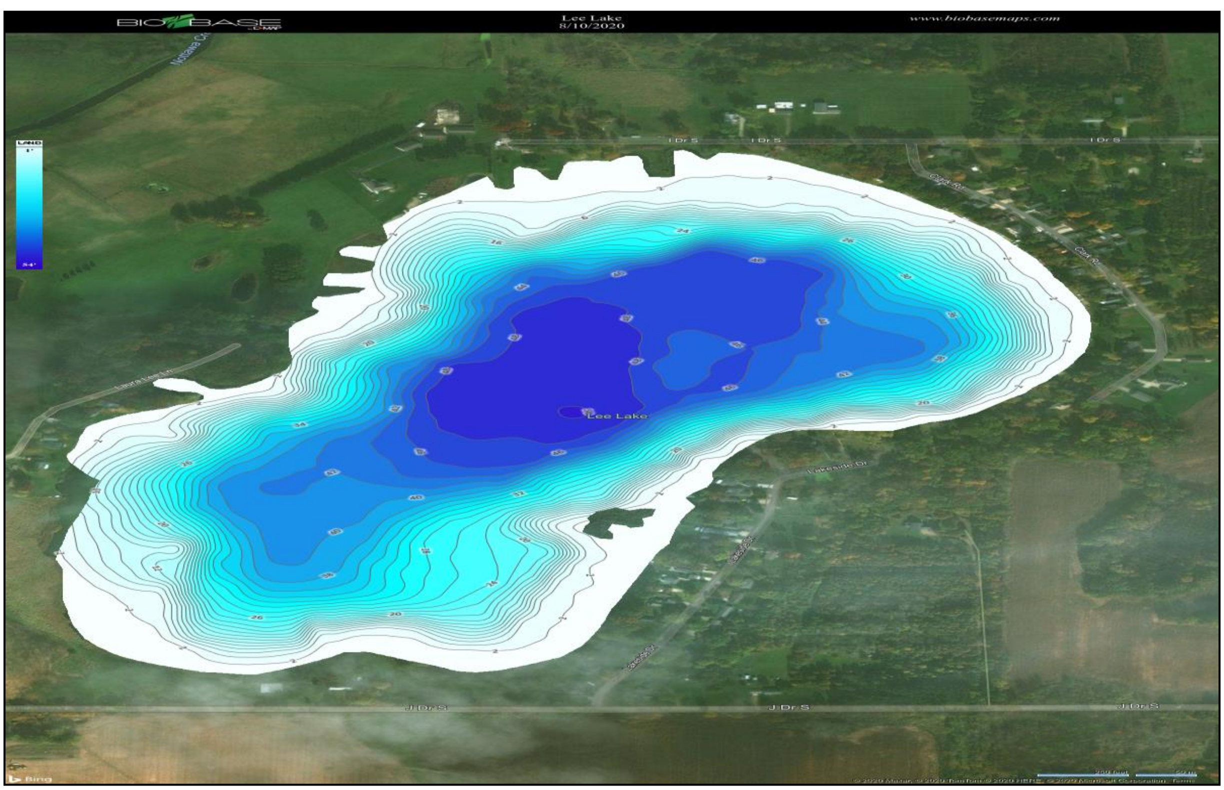
Lee Lake Aquatic Vegetation Survey
Data and Management Recommendations
Report

August, 2020



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AQUATIC VEGATATION AND MANAGEMENT RECOMMENDATIONS IN LEE LAKE CALHOUN COUNTY, MICHIGAN

August, 2020

1.0 EXECUTIVE SUMMARY

This report describes the current exotic and native submersed, floating-leaf, and emergent aquatic plant species within Lee Lake, Calhoun County, Michigan (T. 3S, R. 7W Section 27 of Newton Township). The lake is 131 acres in size and has a great mean depth of nearly 26 feet and a maximum depth of 47 feet. Additionally, there is approximately 2.3 miles of shoreline around the lake. Overall, the water quality of the lake is excellent with ample dissolved oxygen at depth during stratified (summer) months, moderate pH around 8.0-8.5 S.U. and conductivity around 237-270, and low phosphorus concentrations (under 0.020 mg/L). This classifies the lake as mesotrophic which means moderate in nutrients.

Nearly 10.1 acres of Hybrid Watermilfoil (*Myriophyllum sibiricum* var. *spicatum*) and 2.5 acres of invasive *Phragmites australis* were found during an aquatic vegetation survey on August 10, 2020. That acreage is small for the size of the lake but is an immediate concern since much more of the littoral (shallow) zone around the lake could become infested if the milfoil is not managed and the shoreline native vegetation can be dominated by the *Phragmites*. This is a small reduction from 11.3 acres of milfoil found in 2013. A small amount of the invasive emergent, Purple Loosestrife (*Lythrum salicaria*) was also found around the shoreline.

A total of 15 native aquatic plant species were found during the survey and consisted of 11 submersed, 2 floating-leaf, and 2 emergent species. The purpose of this survey was to identify all of the exotic and native aquatic vegetation in and around Lee Lake, provide information on the different aquatic plant management methods available, and then offer professional recommendations for the control of each of the 3 exotic species for the long-term betterment of Lee Lake.

2.0 AQUATIC PLANT SURVEY METHODS

The aquatic plant sampling methods used for lake surveys of plant communities commonly consist of shoreline surveys, visual abundance surveys, transect surveys, AVAS surveys, and GPS Point-Intercept Grid surveys. Bioacoustics monitoring (side-scan sonar imaging) is used to determine biomass density in very large bodies of water (i.e. Chesapeake Bay, US) or in inland lakes. The Michigan Department of Environmental Quality (MDEQ) utilizes an Aquatic Vegetation Assessment Site (AVAS) Survey on most inland lakes prior to and following large-scale aquatic herbicide treatments to assess the changes in aquatic vegetation structure and to record the relative abundance and locations of native aquatic plant species. In addition, various points may be accurately recorded using the GPS Point-Intercept Method highlighted in Section 2.2.

2.1 The Aquatic Vegetation Assessment Site (AVAS) Survey Method

The Aquatic Vegetation Assessment Site (AVAS) Survey Method was developed by the MDEQ to quickly assess the presence and relative abundance of submersed, floating-leaf, and emergent aquatic vegetation within and around the littoral zones of Michigan lakes. With this survey method, the littoral zone areas of the lake are divided into shoreline sections approximately 100-300 feet in length. Aquatic plant samples are collected at each AVAS site, and the species of aquatic plants present and relative abundance of each plant are recorded. In addition to the particular species observed, a relative abundance scale is used to estimate the percent coverage of each species within the AVAS site (Table 1).

If shallow areas are present in the open waters of the lake, then individual AVAS segments can be sampled at those locations to assess the plant communities in offshore locations. For Lee Lake, all sampling locations were recorded with GPS coordinates using a 50-satellite receiver WAAS-enabled GPS unit equipped with side-scan sonar/GPS (Appendix A) that recorded the relative biovolume of all submersed aquatic vegetation. On this map, dark red and orange colored areas indicate dense aquatic vegetation, while yellow and green are much sparser. Blue or black areas (such as the center) indicate deep water that contains no plants. The bio volume is defined as the amount of physical space that an aquatic plant occupies in the water column. In relation to management, it is the most useful variable (more so than density or biomass) because it shows where the aquatic plants are graphically and the relative densities in each area which assists with treatment dosage and plant bed boundaries.

MDEQ Species Abundance Code	*Abundance Meaning Interpretation*	*% Coverage of AVAS Surface Area*
a	**Found**	**< 2**
b	**Sparse**	**2 - 20**
c	**Common**	**21 – 60**
d	**Dense**	**> 60**

Table 1. MDEQ AVAS species relative abundance codes used in AVAS surveys.

2.2 The GPS Aquatic Plant Survey Method

While the MDEQ AVAS protocol considers sampling vegetation using visual observations in areas around the littoral zone, the GPS Survey method is meant to assess vegetation at specific locations of lake (Madsen et *al*. 1994; 1996), or throughout the entire surface area of a lake. This method involves conducting measurements at Global Positioning Systems (GPS)-defined locations. At each GPS Point location, the aquatic vegetation species presence and abundance are estimated. In between the GPS points, any additional species and their relative abundance are also recorded using visual or other techniques. This is especially important to add to the Point Intercept method, since Eurasian Watermilfoil and other invasive plants may be present between GPS points but not necessarily at the pre-selected GPS points. Once the aquatic vegetation communities throughout the lake have been recorded using the GPS points, the data can be placed into a Geographic Information System (GIS) software package to create maps showing the distribution and relative abundance of particular species. The GPS Point Intercept method is particularly useful for monitoring aquatic vegetation communities through time and for identification of nuisance species that could potentially spread to other previously uninhabited areas of the lake. It is also useful in combination with the AVAS method in that it allows for more precise location and coverage of the aquatic vegetation communities within water bodies.

3.0 2020 AVAS /GPS AQUATIC PLANT SURVEY RESULTS

An AVAS/GPS/Side-Scan Sonar survey of Lee Lake aquatic vegetation was conducted on August 10, 2020 to record the relative abundance of native aquatic plant species present and record the current distribution of the exotic invasive aquatic plants within and around Lee Lake.

3.1 Lee Lake Exotic Aquatic Plant Species (August, 2020)

Exotic aquatic plants are not native to a particular site, but are introduced by some biotic (living) or abiotic (non-living) vector. Such vectors include the transfer of aquatic plant seeds and fragments by boats and trailers (especially if the lake has public access sites), waterfowl, or by wind dispersal. In addition, exotic species may be introduced into aquatic systems through the release of aquarium or water garden plants into a water body. An aquatic exotic species may have profound impacts on the aquatic ecosystem. Eurasian Watermilfoil (*Myriophyllum spicatum*; Figure 1) is an exotic aquatic macrophyte first documented in the United States in the 1880's (Reed 1997), although other reports (Couch and Nelson 1985) suggest it was first found in the 1940's. It has since spread to thousands of inland lakes in various states through the use of boats and trailers, waterfowl, seed dispersal, and intentional introduction for fish habitat. It is a major threat to the ecological balance of an aquatic ecosystem through causation of significant declines in favorable native vegetation within lakes (Madsen et *al.* 1991), and may limit light from reaching native aquatic plant species (Newroth 1985; Aiken et *al.* 1979). Additionally, it can alter the macroinvertebrate populations associated with particular native plants of certain structural architecture (Newroth 1985). Since the introduction of it, many nuisance aquatic plant management techniques such as chemical herbicides, mechanical harvesting, and biological control have been implemented. Hybrid Watermilfoil (Figure 2) can grow much more aggressively in dense beds and be resistant to herbicides.

Approximately 20% of the shallow (littoral) zone area of Lee Lake contained Hybrid Watermilfoil at the time of the survey. In addition, approximately 12% of the shoreline contained *Phragmites* and 0.3% of the shoreline was occupied by Purple Loosestrife. This is approximately 10.1 acres of milfoil distributed within Lee Lake (less than the original 11.3 acres). The distribution of Hybrid Watermilfoil was widely scattered around the lake (Figure 3) and is denoted by red polygons. The distribution of Phragmites is denoted by purple polygons (Figure 4).

Figure 1. Eurasian Watermilfoil with seed head and lateral branches.
©Restorative Lake Sciences

Figure 2. Growth habit of hybrid watermilfoil showing rigorous canopy.
©Restorative Lake Sciences

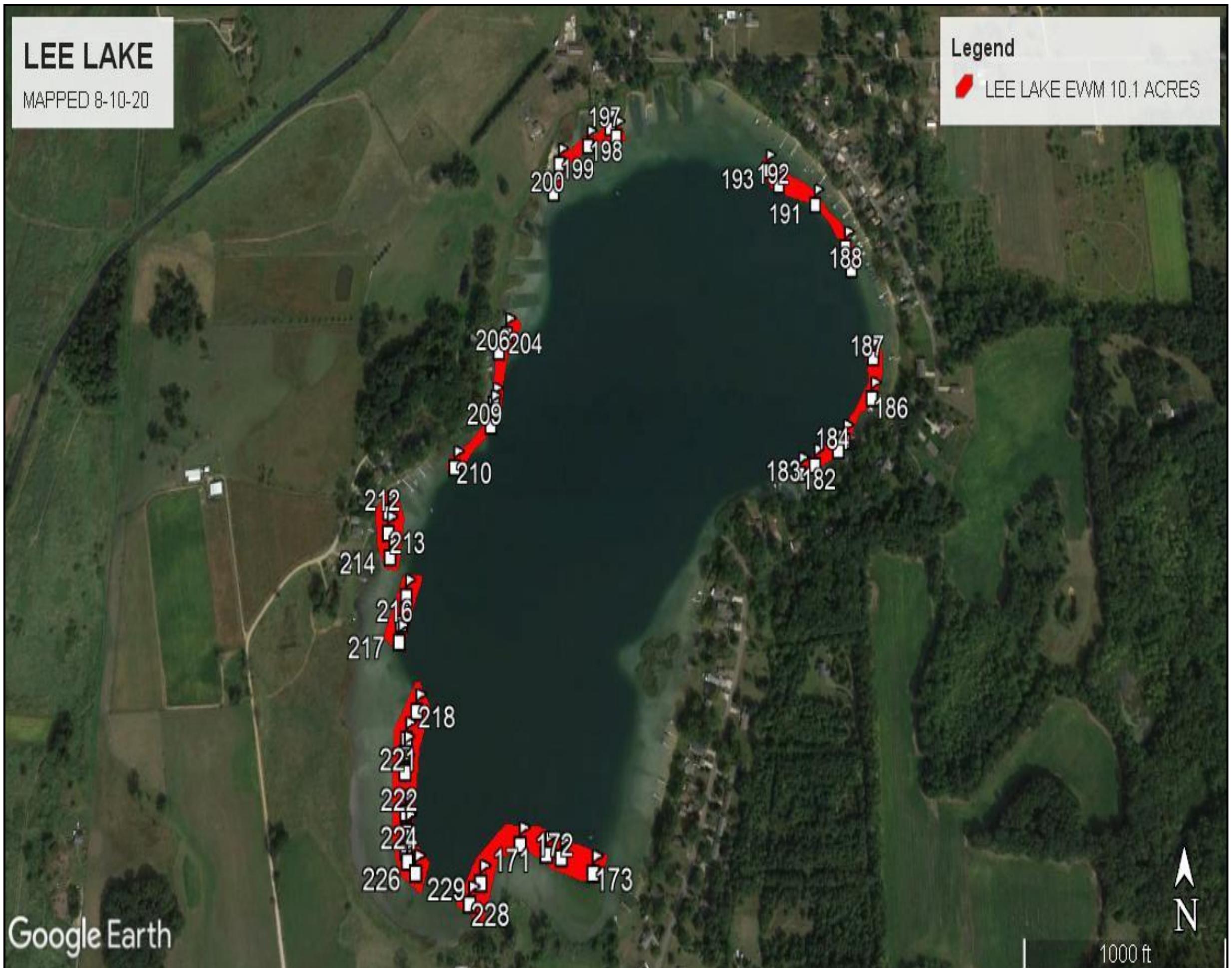

Figure 3. Distribution of Hybrid Watermilfoil in and around Lee Lake (August 10, 2020).

In addition to the exotic Hybrid Watermilfoil, stands of the exotic emergent Giant Common Reed (*Phragmites australis*; Figure 5) was found around the shoreline. *Phragmites* is an imminent threat to the surface area of Lee Lake since it may grow submersed in water depths of 2 or more meters (Herrick and Wolf, 2005), thereby drying up wetland habitat and reducing lake surface area. In addition, large, dense stands of *Phragmites* accumulate sediments, reduce habitat variability, and impede natural water flow (Wang et *al*., 2006). Thus, it is imperative to control *Phragmites* in the tributary areas as well in an effort to preserve the natural hydrology of the Lee Lake ecosystem.

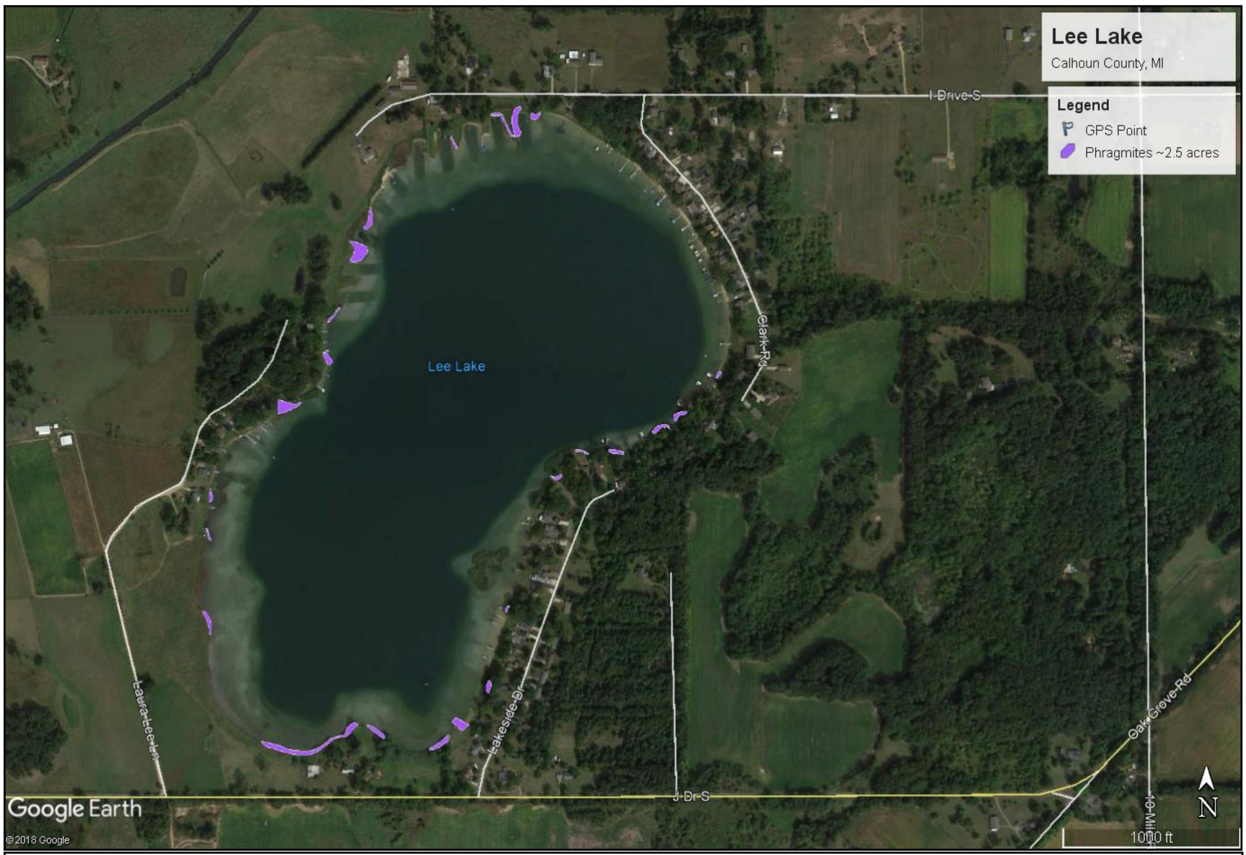

Figure 4. Distribution of invasive emergent Phragmites around Lee Lake (August 10, 2020).

The exotic emergent plant, Purple Loosestrife (*Lythrum salicaria*; Figure 6) was also found around some shoreline areas (at the northernmost region, the easternmost region, and the south shore) and should also be managed. Purple loosestrife is an invasive (i.e. exotic) emergent aquatic plant that inhabits wetlands and shoreline areas. It has showy magenta-colored flowers that bloom in mid-July and terminate in late September. The seeds are highly resistant to tough environmental conditions and may reside in the ground for extended periods of time. It exhibits rigorous growth and may out-compete other favorable native emergents such as cattails (*Typha latifolia*) or native swamp loosestrife (*Decodon verticillatus*) and thus reduce the biological diversity of localized ecosystems. The plant is spreading rapidly across the United States and is converting diverse wetland habitats to monocultures with substantially lower biological diversity. Management options for the plant are provided in the management recommendations section of the report.

Invasive Exotic Aquatic Plant Species in Lee Lake	***Aquatic Plant Common Name***	***Plant Growth Form***	***Aquatic Plant Relative Abundance***
Myriophyllum spicatum	Eurasian Watermilfoil	Submersed	Common
Phragmites australis	Giant Common Reed	Emergent	Sparse/Common
Lythrum salicaria	Purple Loosestrife	Emergent	Sparse

Table 2. Exotic aquatic plant species present within and around Lee Lake (August 10, 2020)

Figure 5. Phragmites
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Figure 6. Purple Loosestrife
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3.2 Lee Lake Native Aquatic Plant Species (August, 2020)

Based on the August 10, 2020 AVAS/GPS/Scan survey, Lee Lake contained 8 native submersed, 2 floating-leaf, and 2 emergent aquatic plant species. The most abundant submersed native aquatic plant species was the submersed macroalga, *Chara vulgaris* (Muskgrass) which occupied nearly 15.0% of the littoral zone area. This plant serves as excellent spawning habitat for fish and keeps sediments on the lake bottom which reduces turbidity. Additionally, *Chara* helps form a dense carpet to reduce the ability of milfoil fragments to root in the lake sediments.

Sago Pondweed (*Stuckenia pectinatus*) was the second most abundant plant that occupied nearly 5.0% of the littoral zone area and resembles thin threads that form along a single stem. This plant can also be a recreational hazard when dense in shallow areas and also produces seeds important for waterfowl.

The third most common plant was the submersed Variable-Leaf Pondweed (*Potamogeton gramineus*) that grows low to the lake bottom and is rarely a nuisance. The leaves are slightly rolled at the margins and it generally grows in shallow waters near shore.

Photos of all of the native plants are shown below in order of decreasing abundance (Figures 7-20).

Aquatic Plant Species in Lee Lake	***Aquatic Plant Common Name***	***Plant Growth Form***	***Relative Abundance***
Chara vulgaris (macro alga)	Muskgrass	Submersed	Common
Stuckenia pectinatus	Sago Pondweed	Submersed	Sparse
Potamogeton gramineus	Variable-Leaf Pondweed	Submersed	Sparse
Potamogeton natans	Floating-Leaf Pondweed	Submersed	Sparse
Potamogeton amplifolius	Large-Leaf Pondweed	Submersed	Sparse
Potamogeton illinoensis	Illinois Pondweed	Submersed	Sparse
Zosterella dubia	Water Stargrass	Submersed	Sparse
Vallisneria americana	Wild Celery	Submersed	Sparse
Utricularia vulgaris	Common Bladderwort	Submersed	Sparse
Najas guadalupensis	Southern Naiad	Submersed	Sparse
Nuphar variegata	Yellow Waterlily	Floating-Leaf	Sparse
Nymphaea odorata	White Waterlily	Floating-Leaf	Sparse
Lemna minor	Duckweed	Floating-Leaf	Sparse
Scirpus sp.	Bulrushes	Emergent	Sparse
Typha latifolia	Cattails	Emergent	Sparse

Table 3. Native aquatic plant species present within Lee Lake (August 10, 2020)

Figure 7. Chara (Muskgrass)

Figure 8. Sago Pondweed
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Figure 9. Variable-Leaf Pondweed
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Figure 10. Large-Leaf Pondweed
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Figure 11. Water Stargrass
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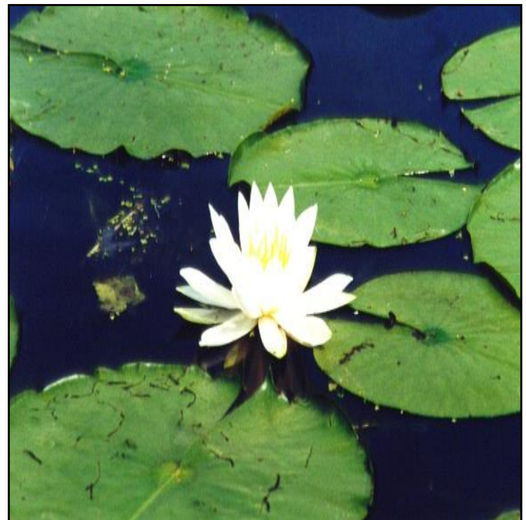

Figure 12. White Waterlily
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Figure 13. Wild Celery
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Figure 14. Illinois Pondweed
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Figure 15. Southern Naiad

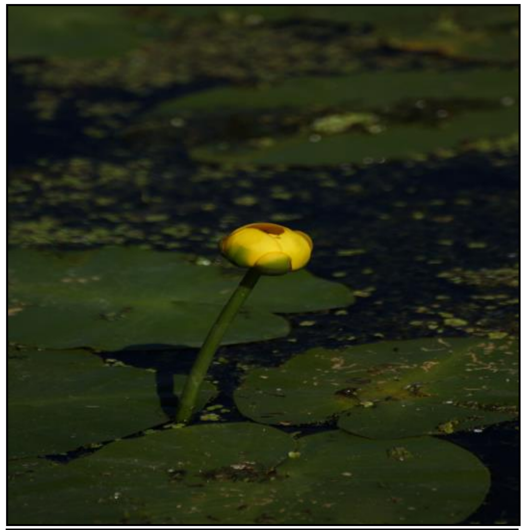

Figure 16. Yellow Waterlily

Figure 17. Cattails

Figure 18. Bulrushes

Figure 19. Bladderwort
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Figure 20. Floating-leaf Pondweed

4.0 AQUATIC PLANT MANAGEMENT OPTIONS FOR LEE LAKE

The management of submersed, floating-leaf, and emergent aquatic plants is necessary in nutrient-enriched aquatic ecosystems due to accelerated growth and distribution. Management options should be environmentally and ecologically sound and financially feasible. Options for control of aquatic plants are limited yet are capable of achieving strong results when used properly. Implementation of more growth of favorable native aquatic plants (especially the submersed pondweeds) in Lee Lake to provide for a healthier fishery is recommended. However, exotic aquatic plant species should be managed with solutions that will yield long-term results.

4.1 Chemical Herbicide Application

The use of aquatic chemical herbicides is regulated by the MDEQ under Part 33 (Aquatic Nuisance) of the Natural Resources and Environmental Protection Act, P.A. 451 of 1994, and requires a permit. The permit contains a list of approved herbicides for a particular body of water, as well as dosage rates, treatment areas, and water use restrictions. Contact and systemic aquatic herbicides are the two primary categories used in aquatic systems.

Contact herbicides cause damage to leaf and stem structures; whereas systemic herbicides are assimilated by the plant roots and are lethal to the entire plant. Wherever possible, it is preferred to use a systemic herbicide for longer-lasting aquatic plant control. There are often restrictions with usage of some systemic herbicides around shoreline areas that contain shallow drinking wells.

Systemic herbicides such as 2, 4-D and Triclopyr are the two primary systemic herbicides used to treat milfoil that grows in less than 35% of a lake. Fluridone (trade name, SONAR®) is a systemic whole-lake herbicide treatment that is applied to the entire lake volume in the spring and is used for extensive infestations. The objective of a fluridone treatment is to selectively control the growth of milfoil in order to allow other native aquatic plants to germinate and create a more diverse aquatic plant community. A whole-lake treatment of fluridone is not recommended for Lee Lake since it contains a low amount of native vegetation and may be better controlled with spot-treatments with granular Triclopyr near shore and 2, 4-D offshore.

The treatment of Phragmites can be conducted either with hand-swiping of the seed plumes with herbicides such as Glyphosate or with hand removal of the seed heads and removal of the underground runners that create new plants.

Algae treatments through the use of algaecides should be limited to filamentous algal blooms and efforts should be taken to reduce the nutrient loads that encourage algal blooms that may require treatments. The current low abundance of green algae in the water of Lee Lake denotes that algal treatments are not needed. All products are applied to the lake in a specialized treatment boat similar to the one in Figure 21.

Figure 21. An airboat used to apply aquatic herbicides.

4.2 Mechanical Harvesting

Mechanical harvesting involves the physical removal of nuisance aquatic vegetation with the use of a mechanical harvesting machine (Figure 22). The mechanical harvester collects numerous loads of aquatic plants as they are cut near the lake bottom. The plants are off-loaded onto a conveyor and then into a dump truck. Harvested plants are then taken to an offsite landfill or farm where they can be used as fertilizer. Mechanical harvesting is preferred over chemical herbicides when primarily native aquatic plants exist, or when excessive amounts of plant biomass need to be removed. Mechanical harvesting is usually not recommended for the removal of Eurasian Watermilfoil since the plant may fragment when cut and re-grow on the lake bottom. Due to the threat of milfoil fragmentation, the use of mechanical harvesting for the removal of the milfoil in Lee Lake is not recommended.
Mechanical harvesting does not require a permit from the Michigan Department of Environmental Quality (MDEQ); however, some counties require a launch site use permit from the Michigan Department of Natural Resources (MDNR) if a public access site is present.

Figure 22. A mechanical harvester.

4.3 Diver Assisted Suction Harvesting (DASH)

Suction harvesting via a Diver Assisted Suction Harvesting (DASH) boat (Figure 23) involves hand removal of individual plants by a SCUBA diver in selected areas of lake bottom with the use of a hand-operated suction hose. Samples are dewatered on land or removed via fabric bags to an offsite location. This method is generally recommended for small (less than 1 acre) spot removal of vegetation since it is costly on a large scale. It may be used in the future to remove small remaining areas of milfoil after large-scale initial treatments have reduced milfoil beds to manageable levels.

Furthermore, this activity may cause re-suspension of sediments (Nayar et *al*., 2007) which may lead to increased turbidity and reduced clarity of the water. This method is a sustainable option for removal of plant beds in beach areas and areas where herbicide treatments may be restricted. The process requires a permit from the MDEQ.

Figure 23. A DASH boat for hand-removal of milfoil or other nuisance vegetation. ©Restorative Lake Sciences, LLC

4.4 Biological Control

Biological control vectors such as the beetles *Galerucella calmariensis* and *G. pusilla* (Figure 24) have been effective on the treatment of shoreline Purple Loosestrife in many locations throughout the Midwest. However, these beetles usually prefer a large stand of purple loosestrife to promote their population. Individual plants or small colonies are better controlled by pulling individual plants out of the soil with a shovel and discarding the plants in a sealed garbage bag. Large stands of Purple Loosestrife may be treated with the land application form of Triclopyr.

Figure 24. The Purple Loosestrife beetle (*Galerucella sp.*). Photo from USGS.

5.0 CONCLUSIONS & RECOMMENDATIONS

The urgent control of the Hybrid Watermilfoil and Phragmites infestation in and around Lee Lake is essential for the long-term preservation of the native aquatic plant communities. Furthermore, the selected methods for the control of it should also protect native aquatic plant species through targeted control. Lee Lake possesses a good fishery, with many species of native aquatic plants that help to support the associated fishery through housing macro invertebrates (fish food) and providing habitat and shelter in the lake. These species are threatened by the dense cover of milfoil in some areas and would rebound after the milfoil is reduced.

The preferred aquatic plant management method(s) must also satisfy the needs of lake residents, by enhancing recreational activities such as boating (navigation) and fishing, increasing the safety of swimming, and protecting the property values of surrounding homes. Thus, management options must complement the socio-economic climate that influences both riparians and individual components of the Lee Lake ecosystem.

Every lake management plan should offer solutions that are ecologically sound, practical, and economically feasible. If donated funds for the suggested management improvements and oversight are limited, it is suggested that the Lee Lake Association form a Special Assessment District (SAD) around the lake to fund the suggested improvements. An SAD may be established through Newton Township pursuant to provisions of P.A. 188 of 1954. The objective of an SAD is to provide an equitable way to disperse costs for lake-wide improvement project(s). The SAD is typically chosen based on established criteria that define “units of benefit” that each individual property derives from the proposed improvements.

The preferred management method for the milfoil problem is to conduct a rigorous 10.1-acre systemic aquatic herbicide treatment in the spring or early summer or continue to remove acres during the summer. Additionally, the use of herbicides such as Imazapyr, Imazamox, and Glyphosate are used for chemical control of *Phragmites* but may not remove the existing biomass. Such control may require biomass removal through mechanical methods.

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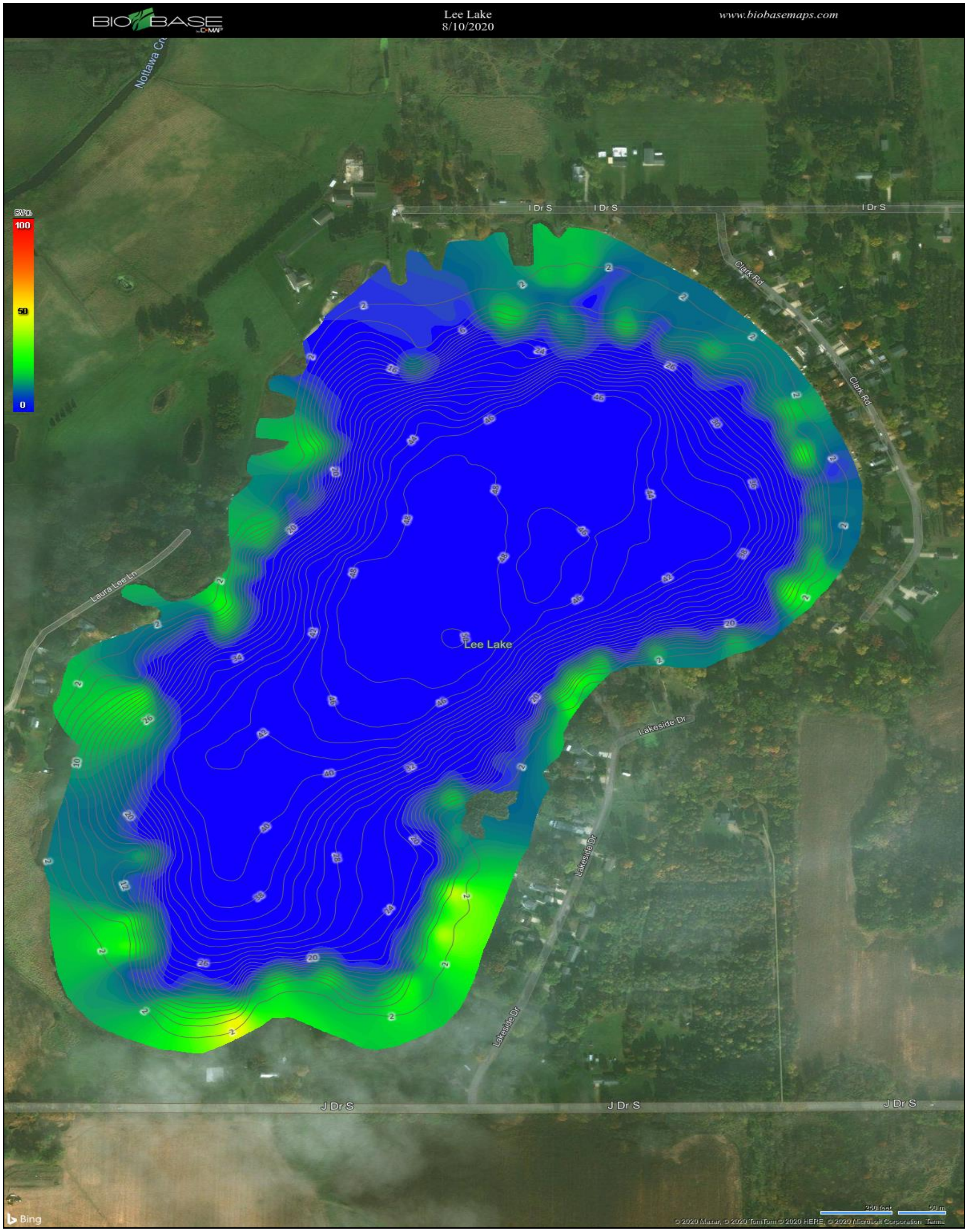
APPENDIX A

2020 BIOBASE SONAR SCAN MAP OF LEE LAKE SHALLOW WEED-INFESTED AREAS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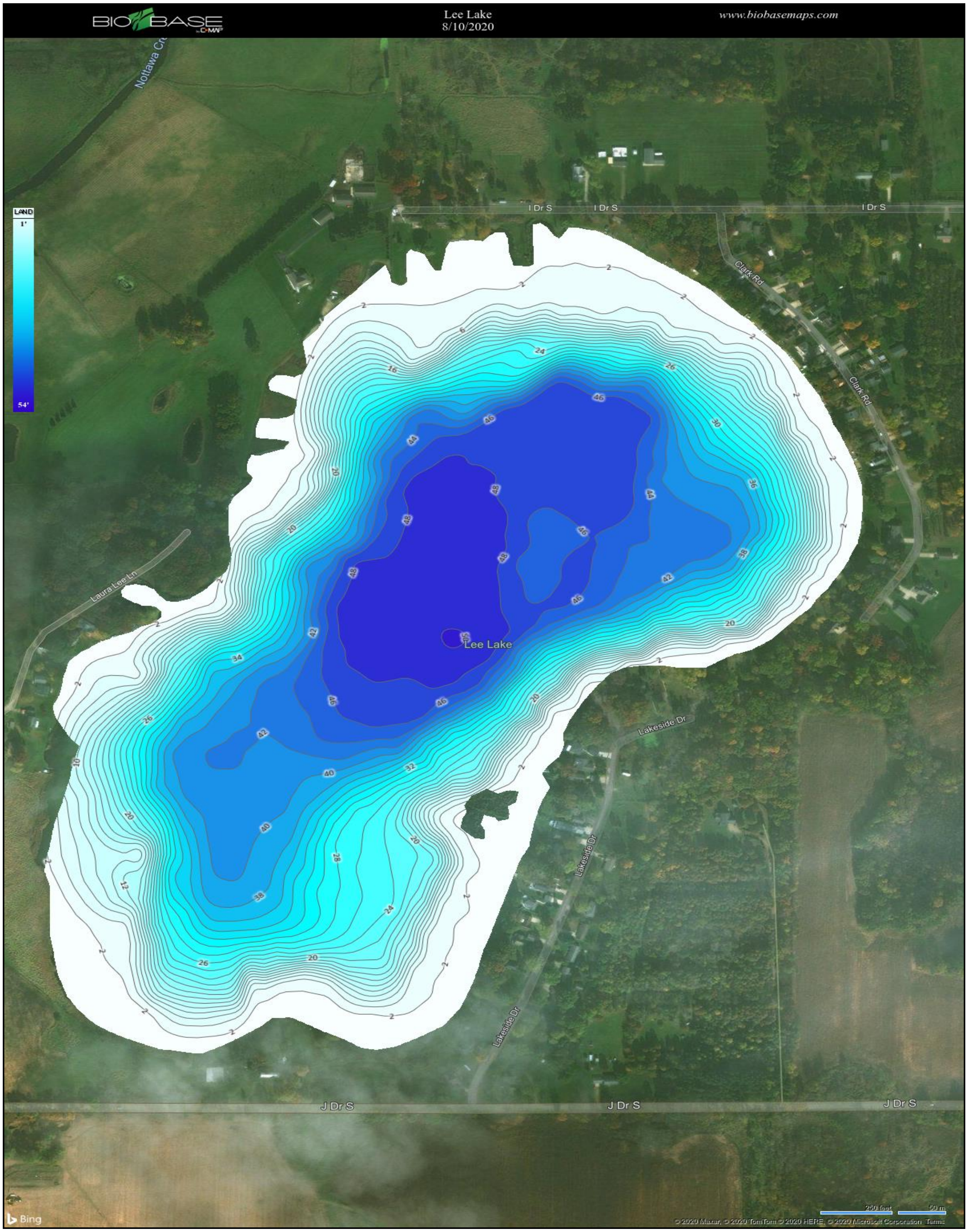
APPENDIX B

2020 BIOBASE SONAR SCAN MAP OF LEE LAKE DEPTH CONTOURS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