PICKEREL LAKE
DAY COUNTY,
SOUTH DAKOTA

AQUATIC PLANT SURVEY
2023

Pickerel Lake Aquatic Plant Survey

Prepared for The Pickerel Lake Conservancy

2023

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EXECUTIVE SUMMARY

An aquatic plant survey was conducted on Pickerel Lake in Day County, South Dakota during 2023. The survey was split into two separate sampling periods to identify the spring and summer plant communities separately. The spring survey was conducted between June 21-23, 2023, and the summer survey was conducted between August 28-30, 2023. In total, 936 points were surveyed at a final resolution of 1 point per half acre. We found 84% of the littoral zone to be occupied with plants from 18 different species, including one invasive plant: curlyleaf pondweed. In addition to the point intercept survey, we also conducted a meandering survey around points where curlyleaf pondweed was identified to better determine its boundaries. We estimated by interpolation model, approximately 110 acres of coverage divided between 24 plots ranging in size from 0.8 to 22.8 acres. The average depth of the curlyleaf pondweed was 9.1 ft. Recommended management options for curlyleaf pondweed is chemical application of diquat in shallow areas where the plant is likely to reach the surface and cause nuisance. There are no known long term control methods but a discussion of some experimental efforts may be useful. Additionally, we searched two public access sites by SCUBA for new AIS infestations one within Pickerel Lake Recreation Area West Unit and the other in the East Unit. The public access searches were revealed no new invasive species. The most common type of vegetation on the lake were coontail, filamentous algae, northern watermilfoil and muskgrass. The first two of these, the most abundant, are common in nutrient rich lakes. The curlyleaf pondweed was well established. Longer term reductions in nutrients, principally phosphorus, may help to reduce some of the nuisance plants, including curlyleaf pondweed, coontail, and filamentous algae. Pickerel Lake is in a part of the state close to Minnesota with a number of other invasive species nearby, including Eurasian watermilfoil and starry stonewort. It is likely only a matter of time before one or both of these show up. Educating lake users to recognize these and continuing with plant surveys annually or as often as budget allows, or at the very least searching near high probability introduction areas such as boat launches, will be critical to finding invasive species early and containing them before they spread and management costs escalate. The lake also has a dense population fo zebra mussels, which will likely continue to increase water clarity and subsequently the extent and depth of plant growth, including AIS.

INTRODUCTION

This report details results of an aquatic plant survey that was conducted by Limnopro Aquatic Science on Pickerel Lake during 2023 at the request of the Pickerel Lake Conservancy.

Aquatic plant surveys are conducted regularly on lakes for a number of reasons, including being able to identify aquatic invasive species early on and develop plans for management. They are also useful to get a sense of the environmental health of a lake given plants play a role in influencing water quality and supporting strong fisheries.

Plants are light limited, and as such, they only grow to a maximum depth generally of 10-20 feet in most lakes. The area of the lake where sunlight penetrates deep enough for plant growth is called the “littoral zone”. A depth of 15 ft is a standard depth contour to demarcate the littoral zone without observational data, and is a good estimate for most lakes.

There are a few different ways that aquatic plant surveys can be accom-

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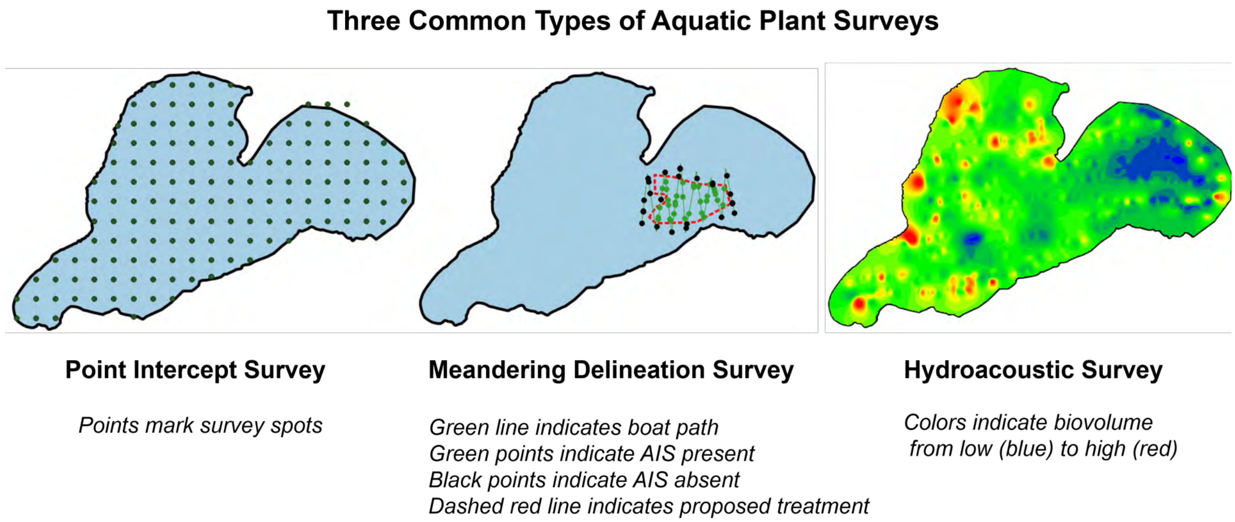

Fig. 1. Example of three types of aquatic plant surveys commonly done in a fictious lake.

plished, and each has different goals and methods. These are point intercept surveys, meandering delineation surveys, and hydroacoustic surveys (Fig. 1).

Point intercept surveys are the most complete and common types and are best for knowing where in the lake different species of vegetation exist as well as the relative densities of each kind. These are also good for finding new invasive plant species, not previously known to exist in a lake. Standard point intercept surveys are conducted a spatial resolution of 1 point per littoral acre, but it is not uncommon for higher resolution surveys to be conducted (e.g., 1 point per half acre or 1 point per quarter acre). The closer the points are together, the more precise the data.

Meandering surveys are an invention of the Minnesota Department of Natural Resources and are their preferred method of having boundaries of invasive species mapped prior to chemical or mechanical treatments in Minnesota. These are not full lake surveys but typically use previous information or knowledge about where an invasive species is on the lake to reconfirm their presence and extent.

Hydroacoustic surveys are derived directly from sonar, cover the entire lake and give an unbiased estimate of both coverage and density of plants, but unlike point intercept surveys, they do not tell you what kind of plants are being recorded. Some of the output from these surveys is spatial information describing biovolume percent and depth to top of the plant canopy. Biovolume percent is a measure of the percentage of the water column depth occupied by plants. The depth to plant canopy is the distance between the surface of the water and the top of the plants in a given area. Both measurements essentially give an indication of where plant growth may be particularly dense.

Aquatic plants play an important role in the functioning of a lake. They reduce wave impacts to shorelines as well as stabilize mud and sand at the bottom of the lake. This is important as it can keep nutrients out of the water that might otherwise lead to algae blooms when wave

Fig. 2. Example of nuisance level surface matting of curlyleaf pondweed on a boat paddle. Photo credit USGS.

disturbed bottom nutrients get stirred into the water and cause algal growth, making the water green and odorous. Aquatic plants also provide habitat and food for other organisms in a lake.

Just because aquatic plants have these sorts of positive environmental functions, it does not follow that more plants equal greater value. It is well known that the highest conservation value for a plant community occurs at (1) intermediate coverage and densities, (2) high species diversity, and (3) high growth form diversity. In other words, not all kinds of plants are the same. The best plant communities have the right kinds in the right amount.

For a variety of reasons, lakes with excessive coverage and densities of plants with low species and functional diversity provide poor environmental conditions and thus have low conservation value.

When lakes are developed and used for recreational purposes, there is an additional goal in plant management that allows for use of a lake by residents in the form of being able to boat, fish, and swim in a given lake. Sometimes conservation values and recreational values conflict with each other. Recreational lakes, such as Pickerel Lake, are managed to support both recreation and conservation.

A complicating factor in managing plant communities is the presence of an invasive plant species. Invasive plants are plants that are from states other than South Dakota or other countries than the USA that, because of their life history characteristics, outcompete native plants for sunlight and nutrients. Often when they are introduced, they cause problems that reduce the recreational value of a lake because they grow densely and close to the surface or reduce native diversity.

Pickerel Lake is known to have curlyleaf pondweed since at least 2019, an invasive plant species that exhibits these characteristics. While curlyleaf pondweed is actively growing it becomes a detriment to lake users when it mats at the surface of the lake and interferes with recreation (Fig. 2).

Curlyleaf pondweed is easy to identify when mature, having a “lasagna noodle” like leaf appearance (Fig. 3). It is South Dakota’s only pondweed with curly leaves

Fig. 3. Curlyleaf pondweed form. Left Shows the characteristic lasagna noodle appearance with round tips while right shows a close up of the toothed leaf margin.

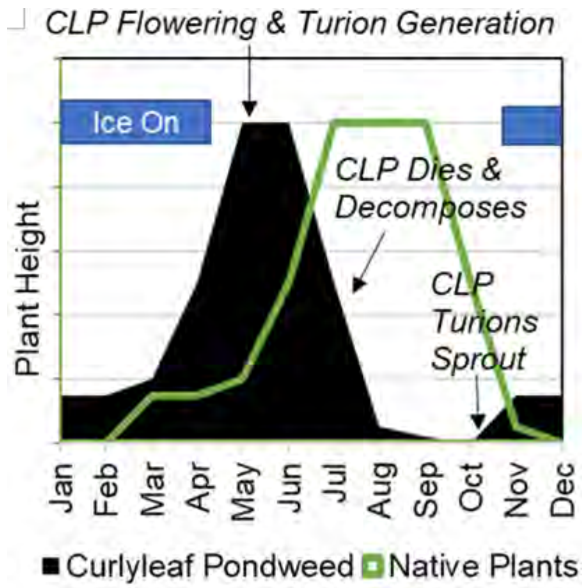

Fig. 4. Curlyleaf pondweed idealized life cycle (black solid area) interposed with "native" plants (hollow green area).

that has serrated, or toothed, leaf margins and a rounded, rather than pointed, tip. It may be difficult to identify when immature because it does not have the characteristic curling and can be mistaken for other similar looking plants.

One life history characteristic that allows curlyleaf pondweed to outcompete native species is its timing for growth and reproduction that differs from most native plants. Curlyleaf pondweed begins growing much earlier in the year than the vast majority of native plants in South Dakota. Because it grows so early, it can shade out native plants, which require early season sunlight to begin their annual growth (Fig. 4). This can, and often does, lead to curlyleaf pondweed becoming a dominant plant in lakes it infests during early spring, particularly until about July 1 in the Midwest.

Even though curlyleaf pondweed begins to disappear from lakes at the beginning of July, it can have impacts for extended periods of the summer after it has died off. As it dies off during the warmest part of the year it releases nutrients, which can stimulate algae growth to make the water turbid or cloudy, or in lakes with zebra mussels, help foster a group of algae that can lead to zebra mussel populations growing. Bacteria that decompose the dead plant use up oxygen in the water, which can lead to localized suffocation of fish and other organisms and release additional nutrients as a chemical reaction occurs at the water-mud interface in the absence of oxygen that releases phosphorus to the lake.

Because these negative impacts often are of higher consequences than the benefits curlyleaf pondweed provides as an early habitat for lake animals, localized herbicide or mechanical treatments are often allowed by regulating agencies when petitioned.

Most native plant species, as well as other invasive species such as Eurasian watermilfoil and starry stonewort, begin growing rapidly after about June 1 when water temperatures exceed 60˚F (Fig. 5). Prior to this, even though they may be

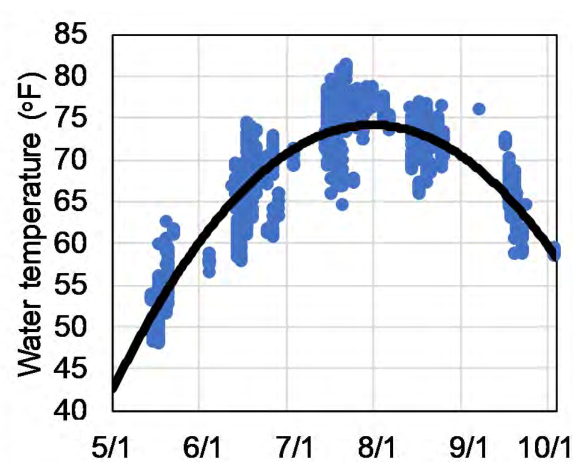

Fig. 5 Average surface water temperatures (black line) based on surface water collections . Data source: Storet National Database.

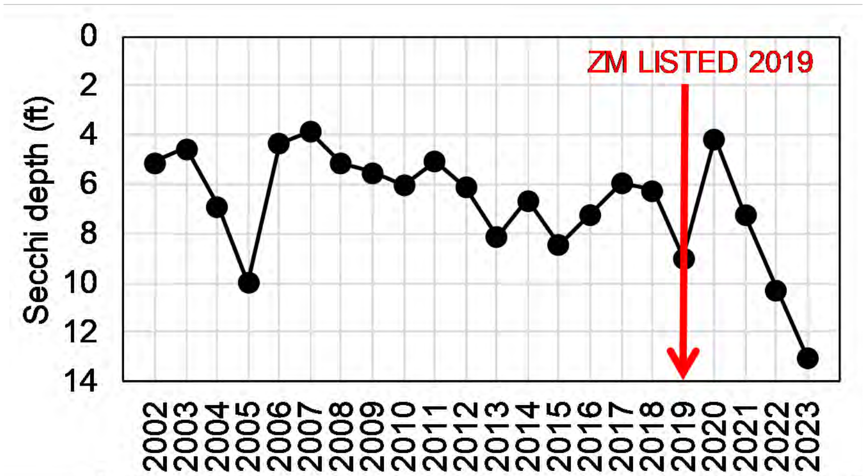

Fig. 6. Water clarity as measured by Secchi depth on Pickerel Lake. Lower values indicate clearer water during months May through October. Zebra mussels were listed in the lake in 2019 and are known to have a clearing effect on lakes

present, they can be difficult to detect. They become easiest to detect during the warmest months of the year from July to early September. Subsequently, a common approach we employ for surveying the plant community is to divide it up into two periods, one that is good for mapping curlyleaf pondweed and the other for natives and other aquatic invasive species of concern.

This plant survey was done in order to determine the degree of curlyleaf pondweed coverage and search for other invasive species as well as determine the nature of the native plant community on the lake.

METHODS

Site Description. Pickerel Lake has a reported surface area of 981 acres with 470 classified as littoral zone using the 15 ft threshold as a demarcation point The maximum and mean depths are 41 and 16 feet respectively.

Water clarity is on the high end for lakes in the region of the state, which provides conditions for higher than average plant coverages and densities as aquatic plants are primarily limited by light (Fig. 6). Zebra mussels are known to have been in the lake at least since 2019, and these animals can have a profound clearing effect on the water as they forage on phytoplankton (i.e.,. floating microscopic algae). Water is clearest in June and declines through the year.

A fisheries survey conducted by South Dakota Game, Fish, and Parks in 2015 indicates the presence of carp in relatively low numbers. Carp are invasive and known to reduce plant abundance and density with their feeding activities, and should be continued to be monitored as larger populations of carp can have negative impacts to the plant community and lake overall.

The only known invasive species at the start of this survey were curlyleaf pondweed and zebra mussels. Both of these were first observed in 2019-2020. Besides these and carp, no other invasive species are known to exist in the lake.

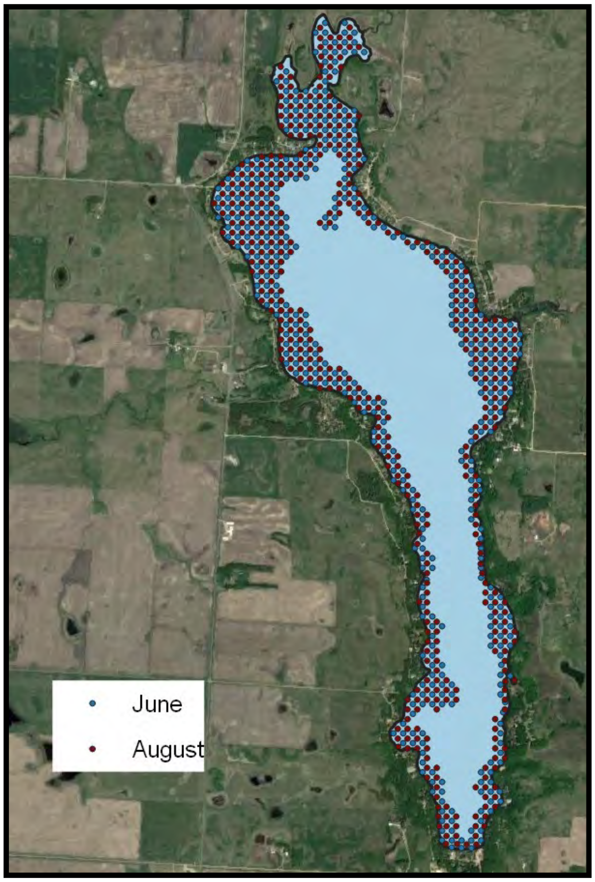

Fig. 7. Sampled points on the Pickerel Lake. Areas less than 15 feet (i.e., the littoral zone) in depth were targeted.

Aquatic Plant Point Intercept Survey. An aquatic plant point intercept survey was done on Pickerel Lake over two separate sampling events. The first event occurred between June 21-23 to coincide with peak curlyleaf pondweed occurrence and the second on August 28-30, 2023 to survey the lake after curlyleaf pondweed had mostly died off for the year. During each survey, point coordinates were loaded to an onboard GPS sonar with a spacing of 1 point per acre arranged such that the final survey resolution with the two events combined was one point per half acre (Fig. 7). A total of 936 points were surveyed combined.

After navigating the boat to each point, a double-sided rake attached to a rope was tossed off the port side of the boat and dragged with four distinct pulling motions over an area of approximately three-meter (10 ft) length. All plants brought to the surface were identified to species and ranked on a density scale from 0 (no plant) to 3 (Fig. 8).

Meandering Delineation Survey. A separate meandering survey was conducted by revisiting mapped points where invasive species were found to determine their boundaries. This was done by revisiting points and using standard methods to *zigzag* around the general area until the plant species was no longer encountered. Any new occurrence was marked and added to the mapping software.

Hydroacoustic Sonar Survey. While navigating through the lake over points, sonar data were collected autonomously to a Lowrance HDS Gen 3 sonar unit as an *.sl2 file. These sonar files were processed by EcoSound, a third-party software service owned by BioBase, a subsidiary of Navico. Some of the output from this service is spatial information describing biovolume percent and depth to top of the plant canopy.

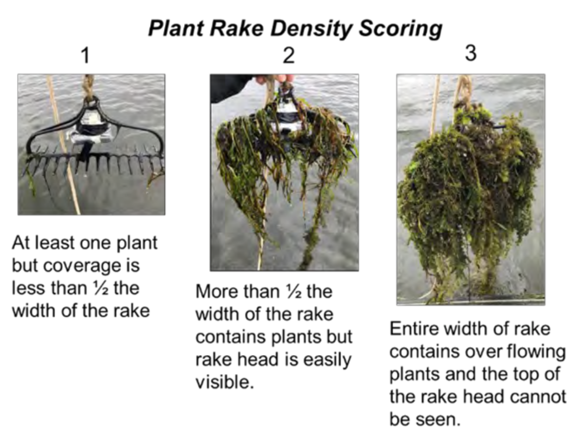

Fig. 8. Aquatic point intercept survey rake density method for density scoring.

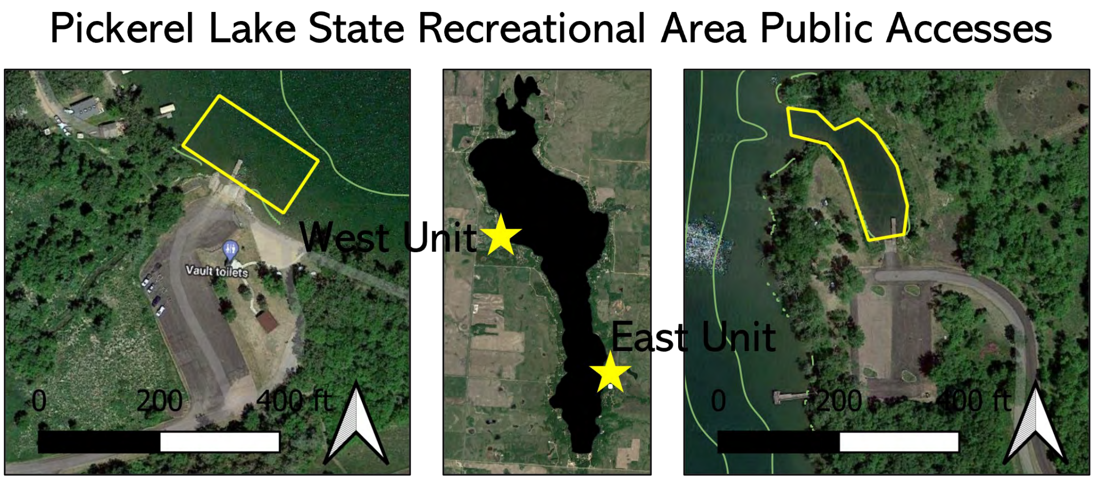

Fig. 9. Areas of approximately 20,000 sq ft where SCUBA dives were completed to look for new infestations of AIS at two public access sites within Pickerel Lake State Recreational Area.

During the later survey, the entire lake was traveled over to get a full lake sonar accounting for the production of full lake depth map, sediment composition, and plant coverage. More information on BioBase processing and data output can be collected at www.biobasemaps.com.

Public Access Invasive Species SCUBA Survey. SCUBA dives were done at two of the most used public access sites, specifically to search for aquatic invasive species not yet accounting for in the lake. Newly introduced aquatic invasive species will often first occur at boat launches. Dive transects were done over an area approximately 200 x 100 ft centered at the boat launch (Fig. 9). All species observed underwater were recorded and reported on. The SCUBA dives took place on 9/15/2023.

***Mapping and Analysis*.** Mapping and geostatistical analyses were performed using a geographic information system (QGIS 3.32). Interpolation methods used a multilevel b-spline interpolation method in QGIS.

Generally, for the remaining plant community we calculated (1) frequency of occurrence for each species, (2) frequency by plant types, (2) the total number of native and non-native species at each point separately, (3) the observed maximum depth of submersed plants., and (4)

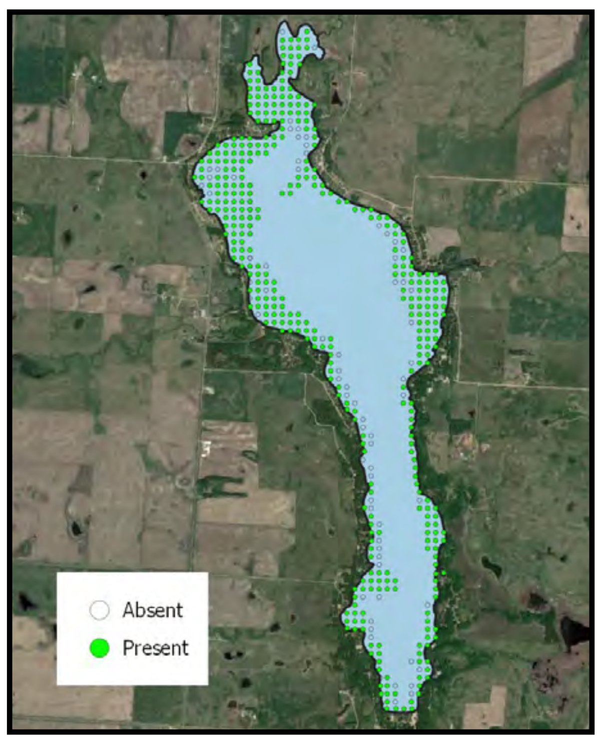

Fig. 10. Presence and absence of plants on the Pickerel Lake.

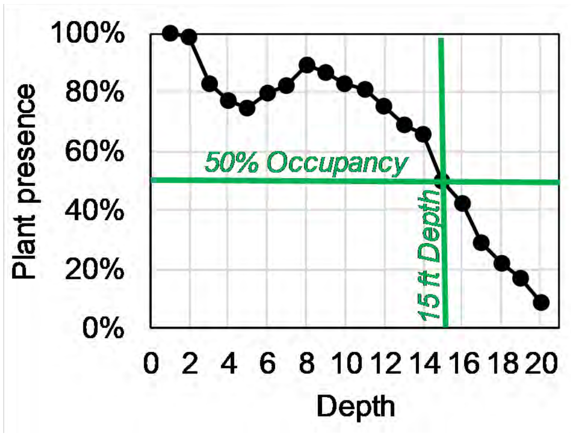

Fig. 11. Percentage of sites at a given depth where at least one plant was found during either sampling period.

in-depth additional assessment of curlyleaf pondweed to aid in future management strategies.

RESULTS

Plants were found at 84% of all sites sampled (Fig. 10). While plants were found up to 20 ft, there was a clear drop-off in plant coverage starting between 14 and 15 ft suggesting a working definition of the weed line in most of the lake at around 14-15 ft. This is the depth at which approximately 50% of sites are plant occupied (Fig. 11).

A total of 18 species (plants or algae) were found on Pickerel Lake and curlyleaf pondweed was the only invasive plant species detected during either survey outing (Fig 12). At any given point during the survey, there was up to seven species but on average two different species per rake.

Five species dominated the plant community, accounting for 85% of all biomass collected. Those vegetation types included coontail, filamentous algae, northern watermilfoil, muskgrass, and water stargrass (Fig. 13).

Coontail accounted for 34% of all biomass collected, and was, by far, the most

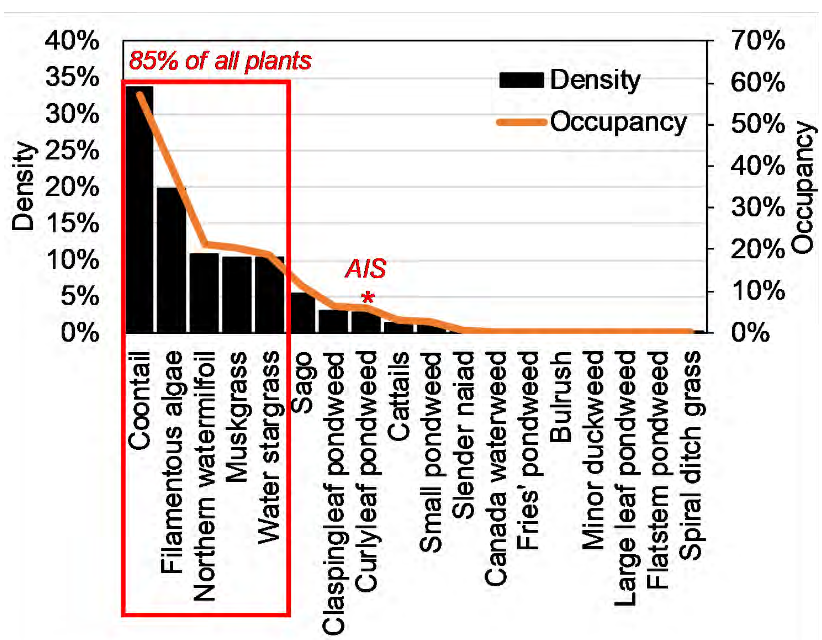

Fig. 12. Types and species of vegetation collected on Pickerel Lake, combined between both surveys. Density (black bars) is the total amount of plant material collected during the two surveys belonging to the listed type while frequency (orange line) indicates the proportion of sites surveyed where at least one individuals of a given species was identified and counted.

Fig. 13. Most commonly sampled vegetation on Pickerel Lake for combined surveys were coontail, filamentous algae, and northern watermilfoil. Filamentous algae is an "algae", while coontail and northern watermilfoil are true plants.

common vegetation type on the lake during both surveys.

Most of the species detected, 12 of the 18, might be classified as rare in that they were collected at less than 10% of the points. This is not unusual as plant communities in lakes tend to have a few dominant species but a higher number of species occurring at only a few locations. This is not to imply that these less common species are not important as often they serve important roles in the lake.

The hydroacoustic survey indicated that there was more vegetation material near the surface during the summer compared with spring. While coverage of plant material was high over the lake, it did not appear particularly dense as canopy depth over most of the lake was relatively low (Fig. 14).

Zebra mussels were abundant in Pickerel Lake, being found attached to rocks or plants at 57% of sites (Fig. 15).

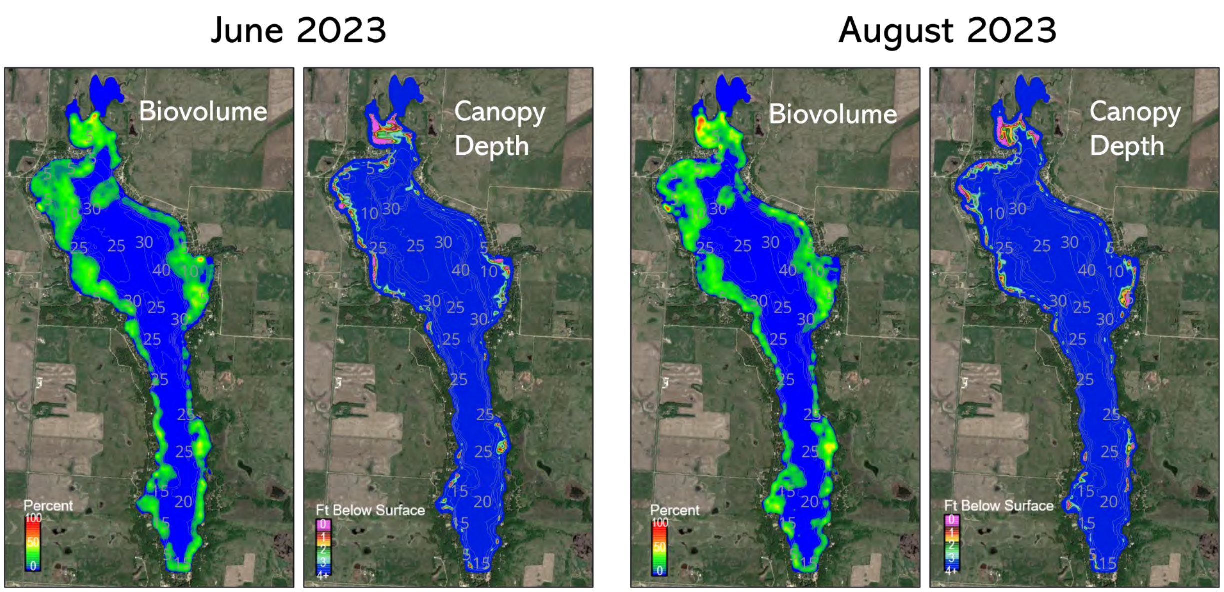

Fig. 14. Biovolume and canopy depth estimated by sonar separately for the early (left) and later (right) surveys. Biovolume is the percent of the water column occupied by plants at a given location while canopy depth is the distance between the top of the plant bed and the surface of the water at a particular point.

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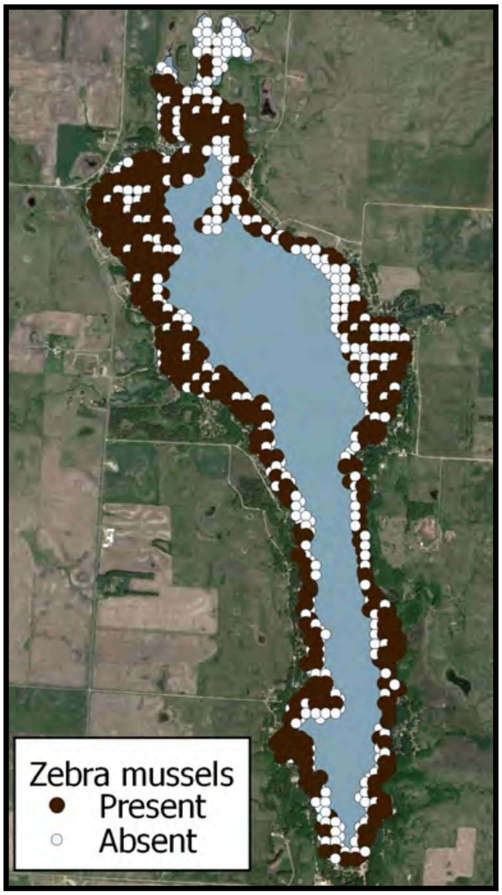


Fig. 15. Sites where plants collected had attached zebra mussels.

counting of the identification of all species detected along with their densities, spatial plots and a pictorial atlas of can be found in the appendix of the report.

DISCUSSION

The aquatic plant survey done on Pickerel Lake in 2023 revealed the following key points: (1) curlyleaf pondweed was the only invasive plant species found in the lake, (2) curlyleaf pondweed appears to be expanding in coverage and management may be appropriate, (3) coontail, muskgrass and filamentous algae are dominant native vegetation, (4) plant coverage but not necessarily density is high, and that (5) zebra mussels will likely continue to increase water clarity and expansion of plants within the littoral zone.

Curlyleaf pondweed was the only invasive plant species found during the two sampling events on Pickerel Lake during 2023. Curlyleaf pondweed, which was first discovered in the lake in 2019, appears to be expanding rapidly in the lake. Based on estimated areal coverage, there is approximately 110 acres (see appendix).

Our current understanding of curlyleaf pondweed is that it is native to the continents of Africa, Asia, Australia, and Europe and was introduced to Minnesota lakes in the 1880's either intentionally or inadvertently along with carp. Likely, the plant spread to South Dakota from one of the many currently infested lakes in Minnesota.

Two of the reasons curlyleaf pondweed is such a successful invader is that (1) its mode of reproduction occurs vegetatively through turions, and (2) the timing of its life cycle allows it to avoid competition for resources with native plants by growing earlier in the year than most other aquatic plants in the Midwest.

Curlyleaf pondweed can reproduce both sexually (flower stalks protrude from the water surface to produce seeds) and vegetatively by creating structures called "turions". Studies indicate that rates of germination for seeds is very low, suggesting that most new growth of curlyleaf pondweed occurs through turions.

Turions grow at the nodes of branches

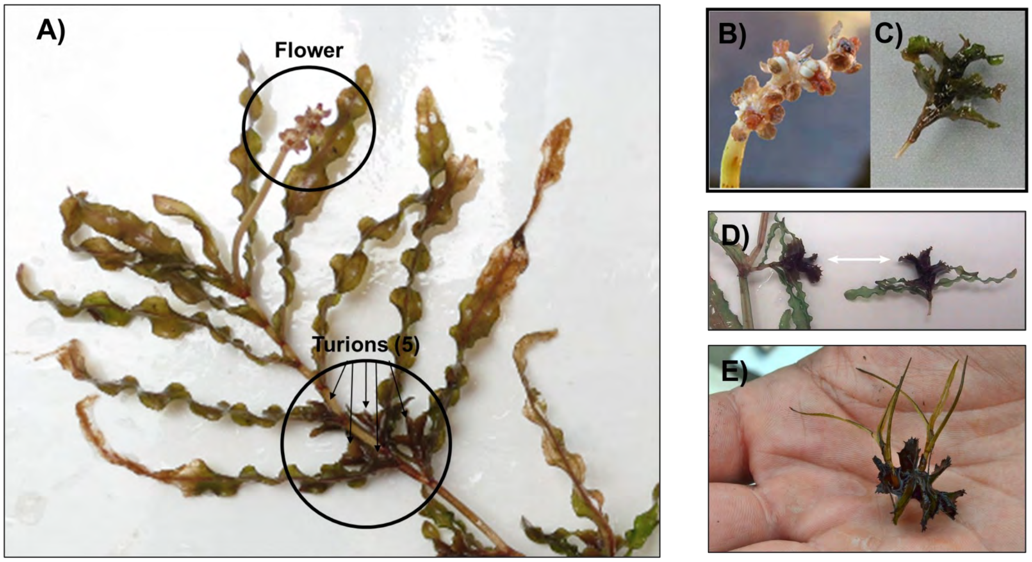


Fig. 16. Curlyleaf pondweed reproductive structures as might be found during June and later showing typical locations of flowers and turions (A), close up of flower (B) and turion (C) , turion growing on plant and detached to float to a new area (D), and (ate season sprouting of turions for next year's growth (E)..

on the curlyleaf pondweed plant (Fig. 16). Turions looks like miniature pine cones, can last for many seasons, and are very hardy against extreme conditions, including being resistant to herbicide treatments. The consequence of this is that even if plants are controlled in a given year, the bank of turions that remain behind means that the next year population growth will continue unabated. This makes long-term control of curlyleaf pondweed very difficult.

The general life history schedule of curlyleaf pondweed in the Midwest occurs starts at ice-out. Curlyleaf pondweed is one of the first plants to grow in the spring after ice-out before most native plants have grown (Table 1).

Options for management include chemical or mechanical removal. Limnopro does not recommend mechanical removal as it can easily spread the plant which grows vegetatively.

Currently two herbicides are commonly used to treat curlyleaf pondweed in the Midwest: endothall and diquat. The cost of diquat is much lower than endothall, and it requires less contact time to be effective. Endothall treatment costs are 4 -12 times that of diquat depending on the concentrations used. Treatment costs can vary, but you should expect to pay

Table 1. General lake events and curlyleaf pondweed life history schedule based on historical surface water readings of water temperature on Pickerel Lake and research literature on curlyleaf pondweed.

Date	Water Temp °F	Lake/CLP Event
4/17	32	Ice Off
4/27	40	CLP Roots and Shoot Develop
5/16	52	CLP Growth Accelerates
5/23	56	CLP Turion Production Begins
6/2	60	Most Native Plants Commence Growth
6/21	67	CLP Flowering/Turion Production Max
7/26	72	Annual High Water Temperature
8/20	69	CLP Turion Germination Begins
10/11	48	CLP Dormancy
11/3	32	Ice On

Watch for these other AIS!

Eurasian Watermilfoil   Starry Stonewort

Fig. 17. Other aquatic invasive species plants not yet known to exist in Pickerel Lake but nearby. Keeping a look out for both Eurasian watermilfoil (left) and starry stonewort (right) can go a long way to keeping the plant from invading and expanding.

between $250—$500 for diquat treatments and $400—$1,000 for endothall treatments.

Whether using diquat or endothall, chemicals currently used on curlyleaf pondweed do not target the entire plant but only the part of the plant the chemical touches. These are known as contact herbicides. As such, the plant can and will grow back the following year; so, annual maintenance should be expected.

The goal for management of curlyleaf pondweed should be not to eradicate the plant but to manage it so that it does not surface mat and create hinderances for recreating on the lake.

One potential experimental method that has been used but without conclusive evidence of effect is a late season curlyleaf pondweed chemical treatment. The general idea is to treat the turions after they have germinated in early fall to kill the newly sprouted plants before they can root and grow the next year to produce a new crop of turions. This, in effect, may be the only way to systematically control the plant for longer term. The issue is that timing is difficult because as water cools into the fall, plants have a harder time responding to chemical.

As a general rule, it is wise to limit the treated area in a lake to not have large harmful effects on nontarget native vegetation. Curlyleaf pondweeds growth cycle allows managers to treat lakes at times when little to no other vegetation is actively growing. This can be done early in the year, typically before June when native vegetation starts growing.

Eurasian watermilfoil and starry stonewort are two other aquatic invasive plant species that are regionally present and worthy of attention. Based on this current survey, there was no evidence for either of these species in Pickerel Lake yet (Fig. 17).

The best chance of getting control of these or any new invasive species is early detection and remediation. Early detection searches for Eurasian watermilfoil and starry stonewort ought to be a priority every year and efforts should be made to educate lake shore property owners to be able to recognize these two species and report any plants that look suspicious to the South Dakota Fish, Game, and Parks and/or Limnopro immediately.

The dominant plant species was coontail, being found at 57% of sites and accounting for 34% of the total vegetation collected. Coontail has the potential to grow to the surface over large areas creating mats along the surface; however, it does not seem at the moment to be causing a substantial problem. Coontail has the capability to grow in turbid waters as it can draw nutrients from the water column in addition to the sediment which differs from other aquatic plants.

If native plants are creating nuisance or preventing homeowners from reaching open water, individual property owners may apply for a permit to treat along their shoreline. Regulations in South Dakota require that the treated area be no more than half of the width of owned shoreline, or no more than 50 feet, whichever is less. Generally, the area is not to exceed 2,500 square feet. If property owners do not wish to use pesticides, the law allows you to maintain a swimming or boat docking area by physical removal of the vegetation.

For homeowners wishing for a chemical control, purchasing and using a product named Hydrothol 191 is a good general purpose herbicide that can control most plants and algae, including coontail and filamentous algae, which are dominant over the lake. If using chemicals, it is very important to read the labels and apply it only as stated.

Algae is best controlled using copper products such as copper sulfate or Cutrine. Given both muskgrass and filamentous algae are abundant and technically algae, copper products would be best suited for their control. Filamentous algae is particularly hard to control given it will grow back rapidly. The state of South Dakota limits the use of copper products on lakes managed primarily for fisheries.

Homeowners should be aware that when using chemicals or after mechanically removing plants, plants will regrow, and may regrow more densely than what was originally there. It is always a possibility that you open up space for more aggressive and disturbance tolerant species. The best advice is that if plant coverage at a property is tolerable, leave it alone.

Some other ways that may help with control of filamentous algae are to use barley straw bales, an aerator, or aquathruster type device. Barley straw bales can be placed under your docks at the beginning of the year and removed at the end of the year. They are known to release natural algicides as they decompose in the presence of oxygen. New bales should be used each year. Aerators and aquathrusters can create water movement and supplemental oxygen to help with decomposition and nutrient reductions in nearshore areas. The long-term solution to reducing filamentous algae is to reduce the amount of nutrients in the lake.

In conclusion, management ought to focus continued monitoring of the plant community and water quality to detect changes quickly to make mitigation easier.

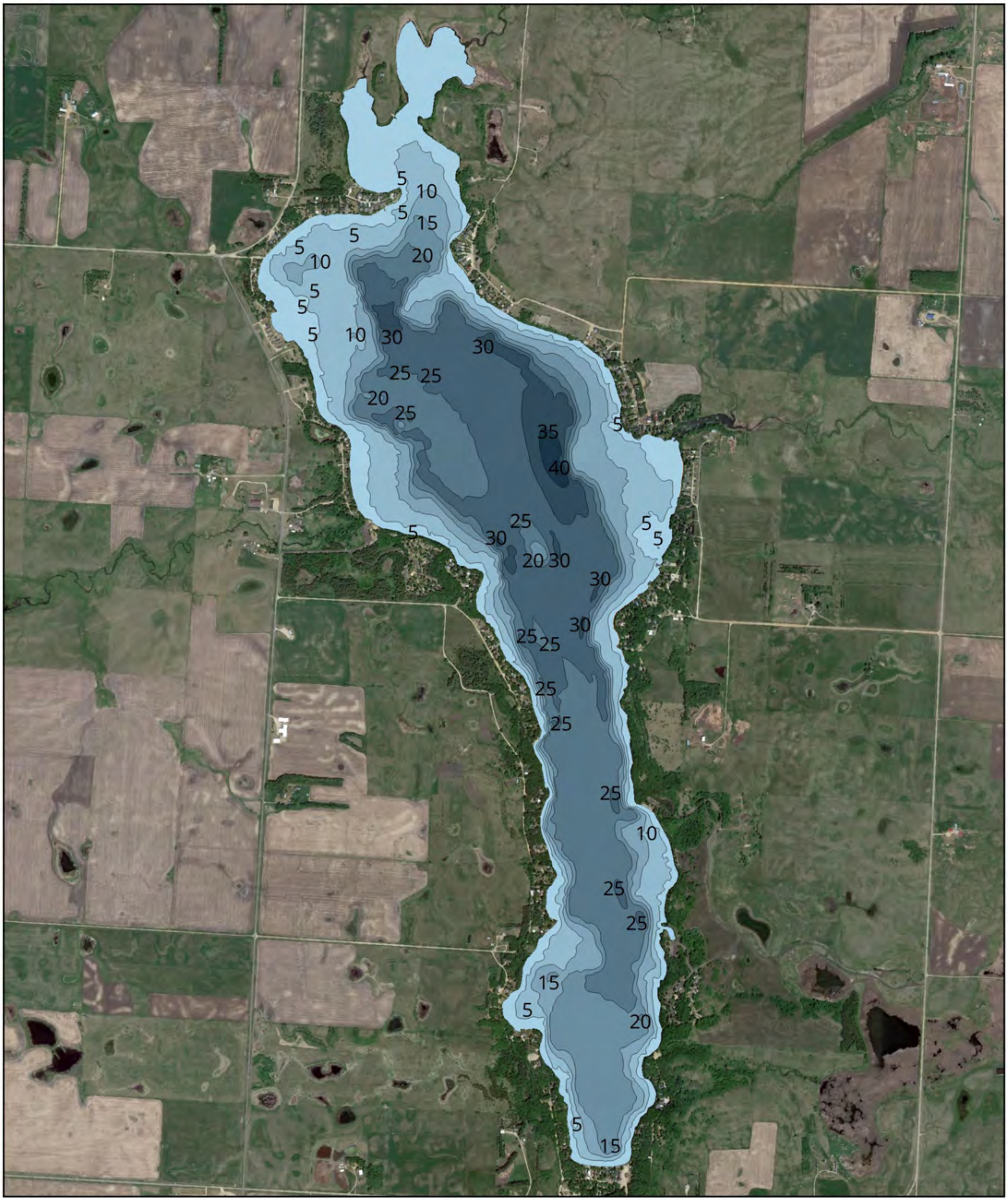
MANAGEMENT RECOMMENDATIONS

1. Chemical control of curlyleaf pondweed in highly used areas with a focus on shallow areas using diquat during May 2024 as budget allows.
2. Consider experimental trials of diquat treatment of newly germinated turions during September 2024 as budget allows.
3. AIS early detection dive search at public boat launch during fall 2024 and annually as budget allows.
4. Point intercept survey in 2025 and every other year as budget allows to search for new AIS.
5. Development of nutrient budget to determine costs, ways, and methods for nutrient reductions to help with nuisance growth of algae on the lake.

Appendix

Plant community summary from aquatic point intercept surveys performed by Limnopro in June and August for Pickerel Lake. Occupancy is defined as the percentage of total sites during the survey that the plant was found at least once, and density is the percentage of rake scores attributed to a given species (i.e., how much of the plant exists given it does exist).

			Combined		June		August	
Common Name	Scientific Name	Habitat	Density	Occupancy	Density	Occupancy	Density	Occupancy
Coontail	*Cerataphyllum demersum*	Submerged	34%	57%	37%	56%	31%	59%
Filamentous algae	Various	Submerged/Floating	20%	40%	18%	34%	22%	45%
Northern watermilfoil	*Myriophyllum sibiricum*	Submerged	11%	21%	5%	9%	16%	33%
Muskgrass	*Chara* spp.	Submerged	10%	20%	15%	28%	6%	13%
Water stargrass	*Heteranthera dubia*	Submerged	10%	19%	8%	15%	13%	23%
Sago	*Stuckenia pectinata*	Submerged	5%	11%	9%	17%	3%	6%
Claspingleaf pondweed	*Potamogeton richardsonii*	Submerged	3%	7%	3%	5%	4%	8%
Curlyleaf pondweed	*Potamogeton crispus*	Submerged	3%	6%	4%	8%	2%	4%
Cattails	*Typha* spp.	Emergent	1%	3%	2%	3%	1%	3%
Small pondweed	*Potamogeton pusillus*	Submerged	1%	3%	0.2%	0.4%	2%	5%
Slender naiad	*Najas flexilis*	Submerged	0.3%	1%	0%	0%	1%	1%
Canada waterweed	*Elodea canadensis*	Submerged	0.1%	0.3%	0.1%	0.2%	0.2%	0.4%
Fries' pondweed	*Potamogeton friesii*	Submerged	0.1%	0.3%	0.3%	1%	0%	0%
Bulrush	*Schoenoplectus* spp.	Emergent	0.1%	0.3%	0.2%	0.4%	0.1%	0.2%
Minor duckweed	*Lemna minor*	Floating	0.1%	0.2%	0%	0%	0.2%	0.4%
Large leaf pondweed	*Potamogeton amplifolius*	Submerged	0.1%	0.2%	0.1%	0.2%	0.1%	0.2%
Flatstem pondweed	*Potamogeton zosterformis*	Submerged	0.1%	0.2%	0.2%	0.4%	0%	0%
Spiral ditch grass	*Ruppia cirhosa*	Submerged	0.1%	0.2%	0%	0%	0.2%	0.4%



0.25 0.5 mi

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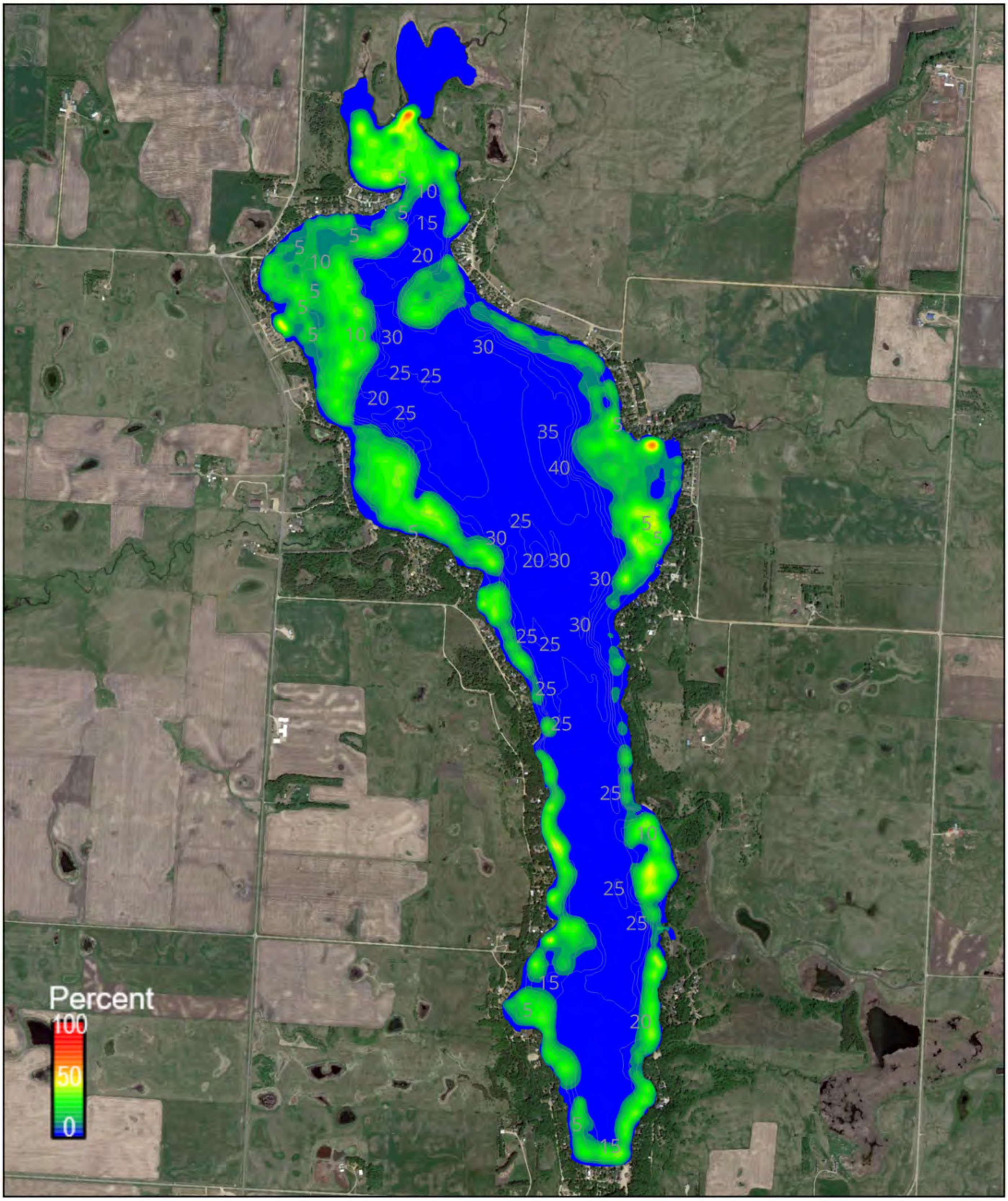
Pickerel Lake
Bathymetry (Depth)
2023



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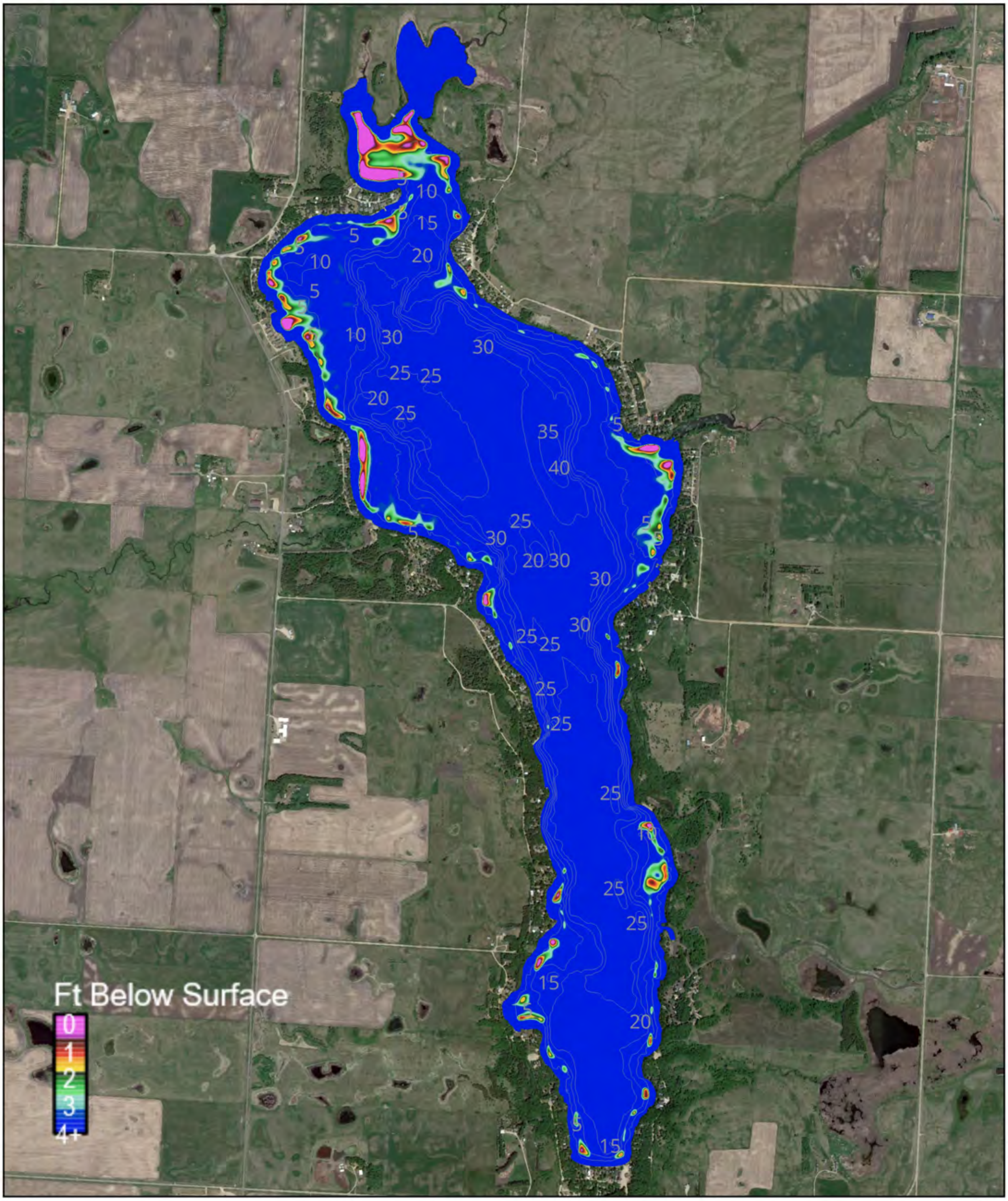
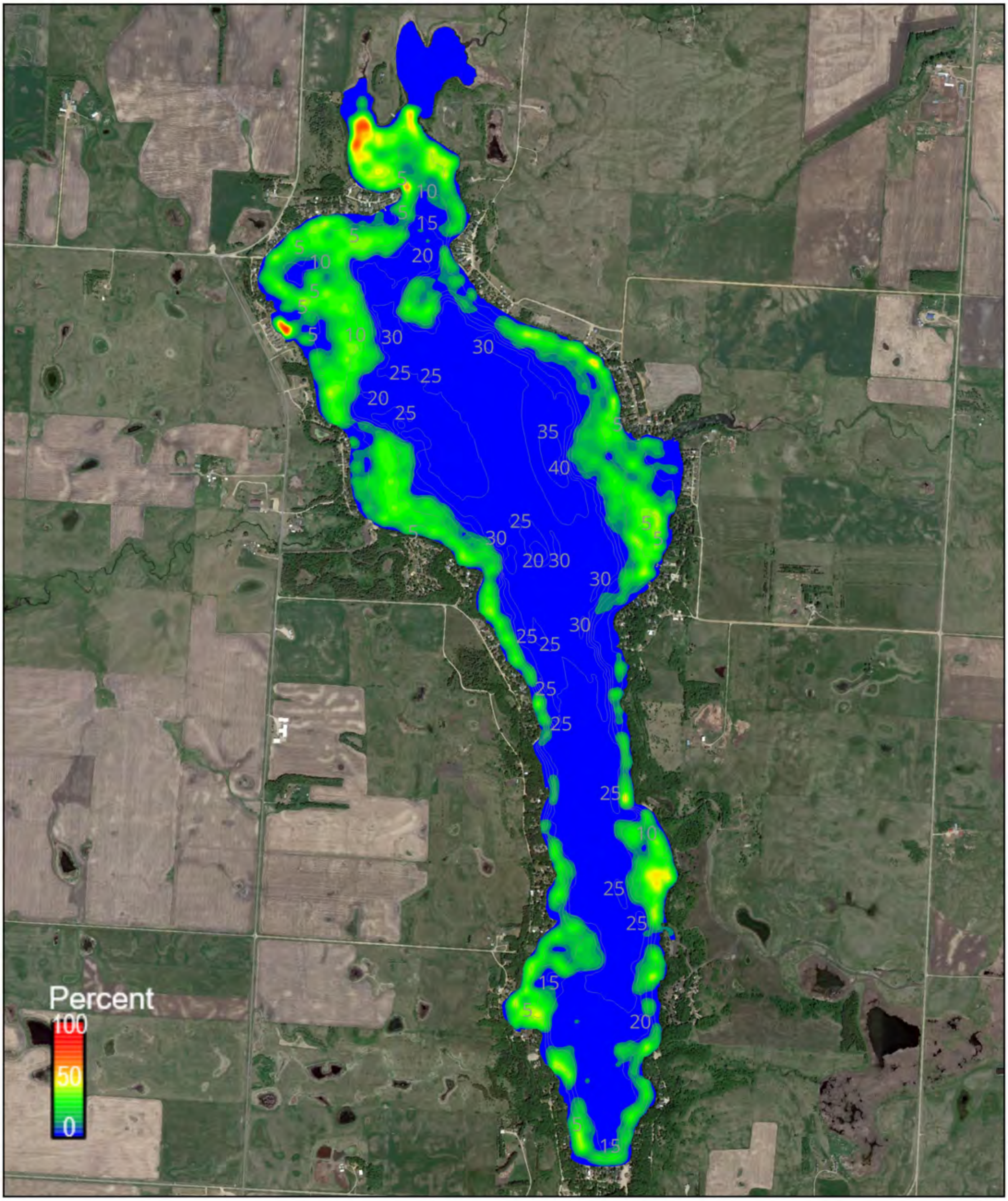
Pickerel Lake
Biovolume
June 2023



Pickerel Lake
Canopy Depth
June 2023



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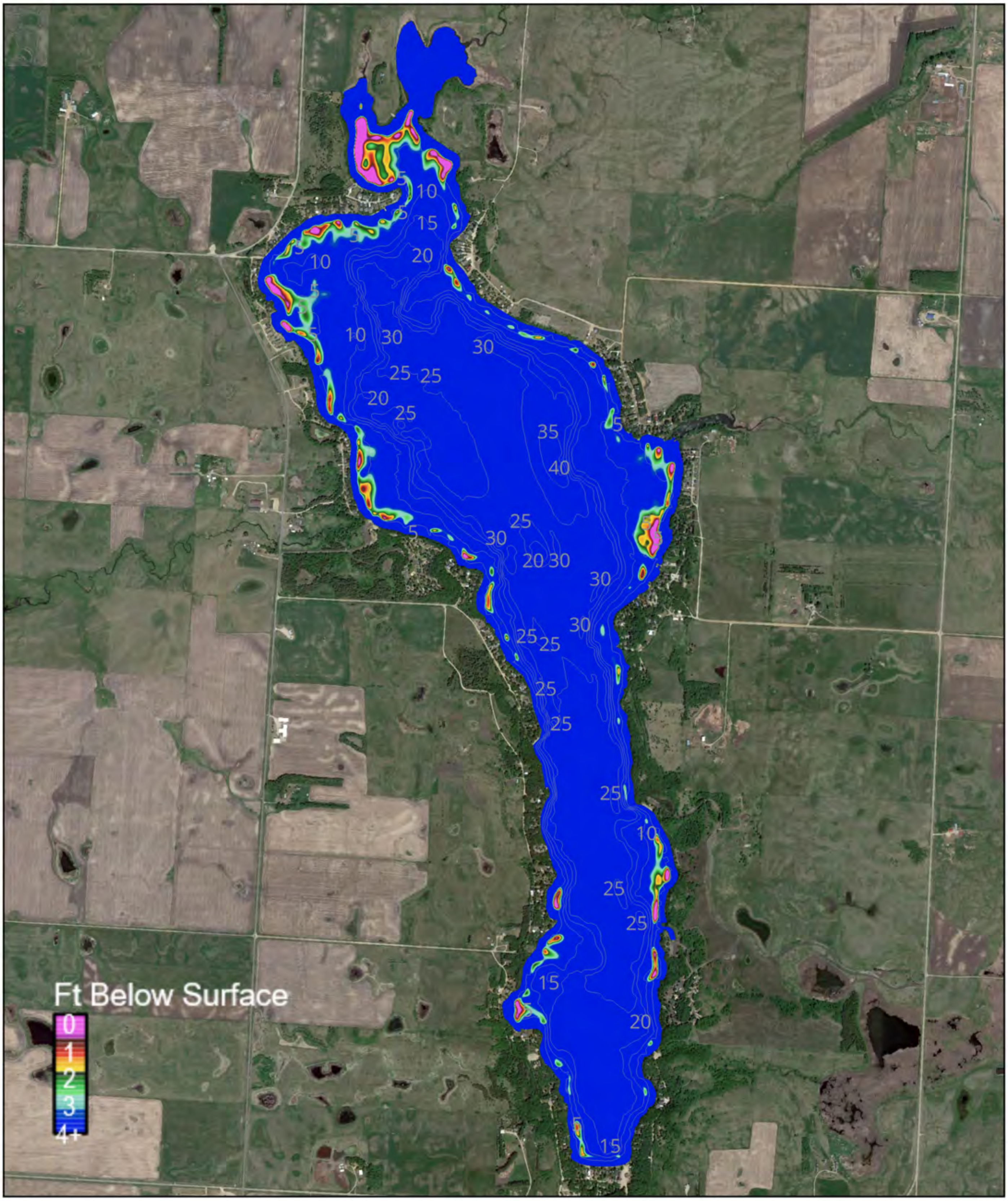
Pickerel Lake
Biovolume
August 2023



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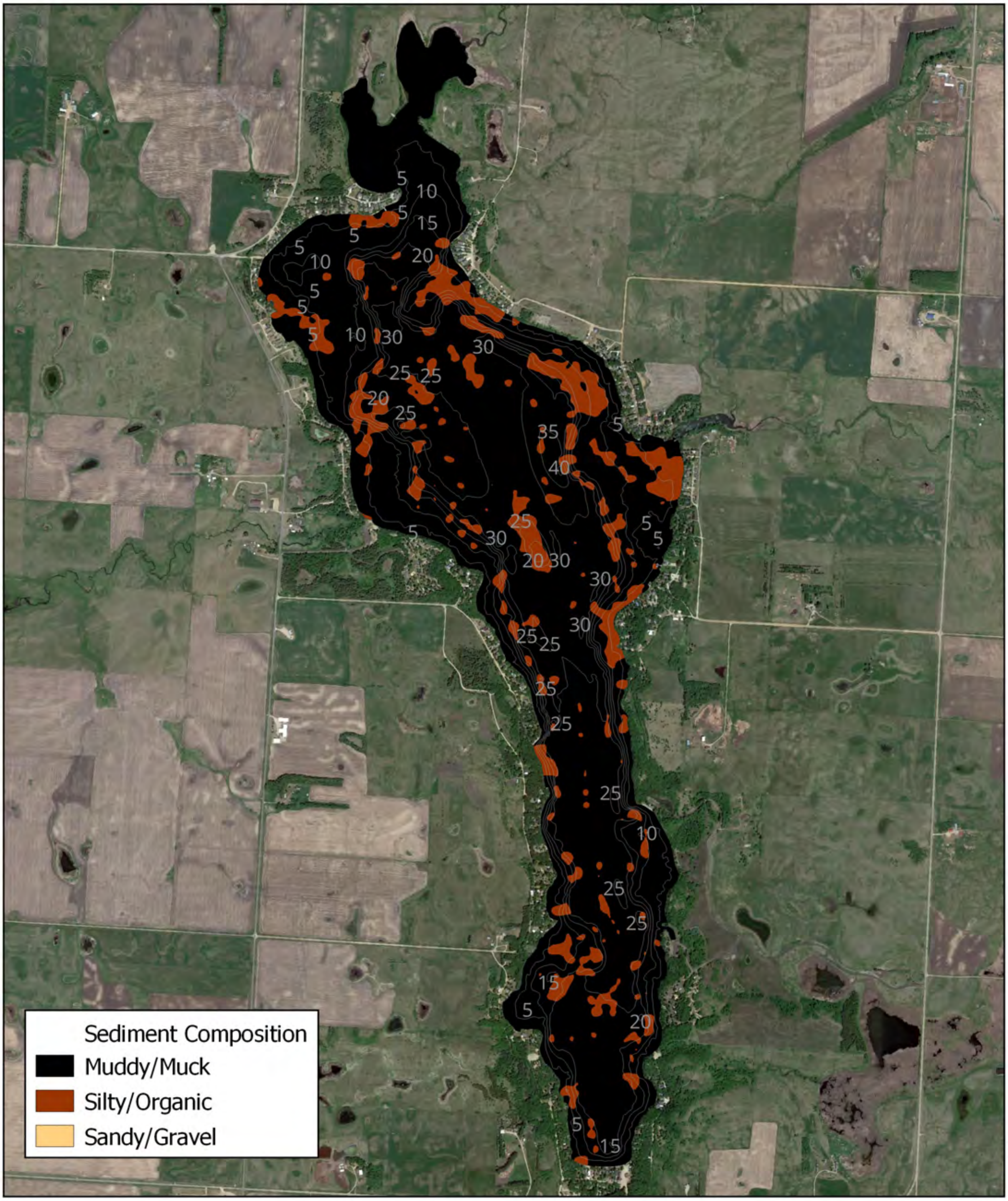
Pickerel Lake
Canopy Depth
August 2023



0.25 0.5 mi

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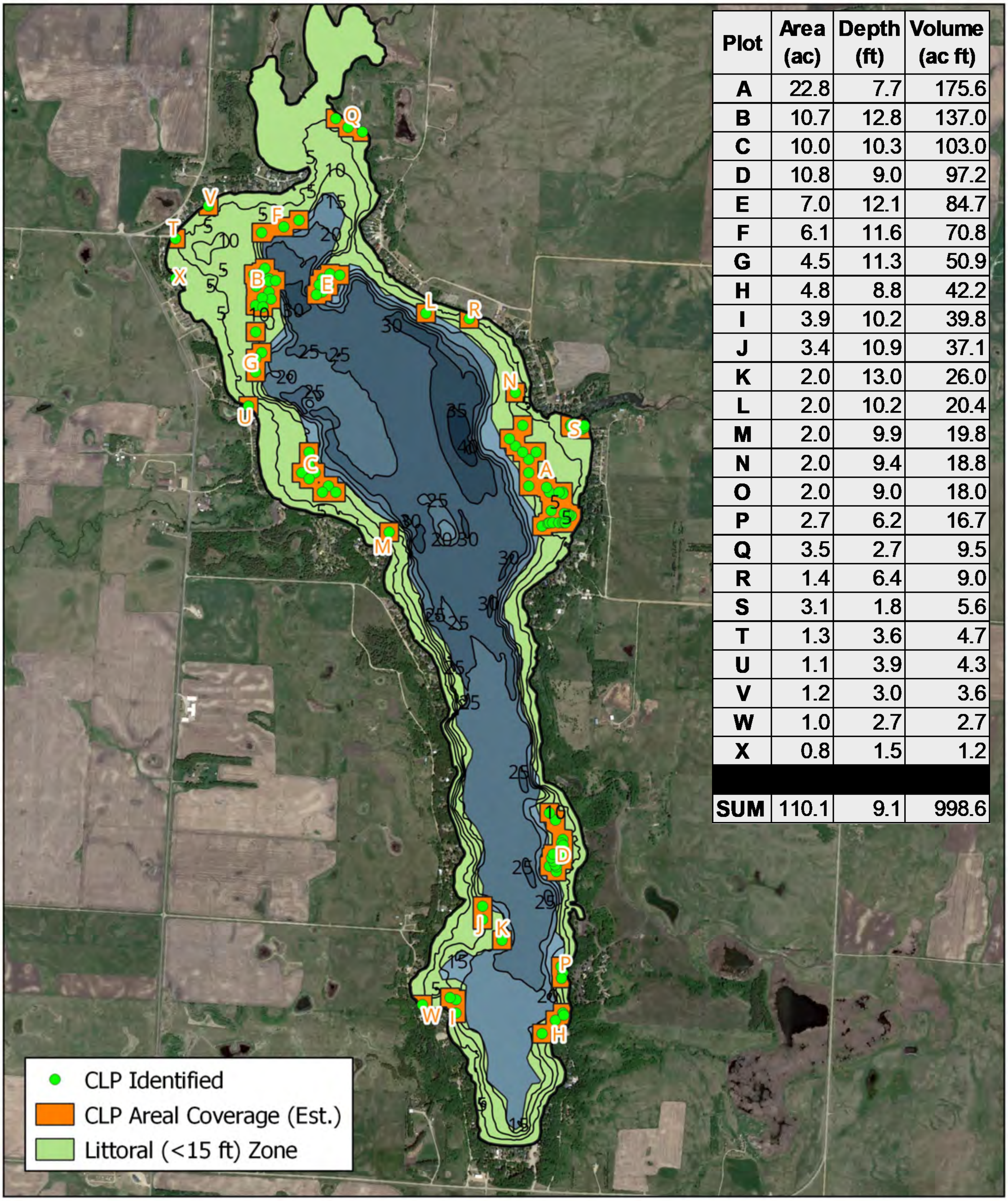
Pickerel Lake
Sediment Composition
2023



Plot	Area (ac)	Depth (ft)	Volume (ac ft)
A	22.8	7.7	175.6
B	10.7	12.8	137.0
C	10.0	10.3	103.0
D	10.8	9.0	97.2
E	7.0	12.1	84.7
F	6.1	11.6	70.8
G	4.5	11.3	50.9
H	4.8	8.8	42.2
I	3.9	10.2	39.8
J	3.4	10.9	37.1
K	2.0	13.0	26.0
L	2.0	10.2	20.4
M	2.0	9.9	19.8
N	2.0	9.4	18.8
O	2.0	9.0	18.0
P	2.7	6.2	16.7
Q	3.5	2.7	9.5
R	1.4	6.4	9.0
S	3.1	1.8	5.6
T	1.3	3.6	4.7
U	1.1	3.9	4.3
V	1.2	3.0	3.6
W	1.0	2.7	2.7
X	0.8	1.5	1.2
SUM	110.1	9.1	998.6

0.25 0.5 mi

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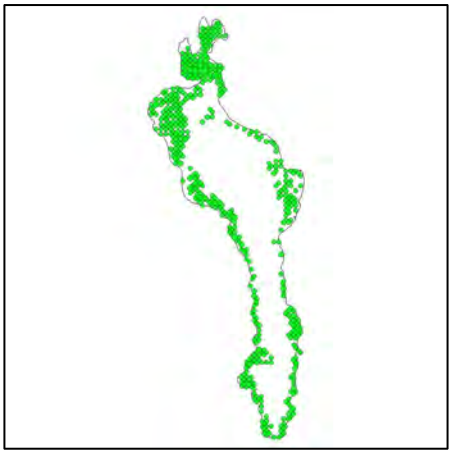
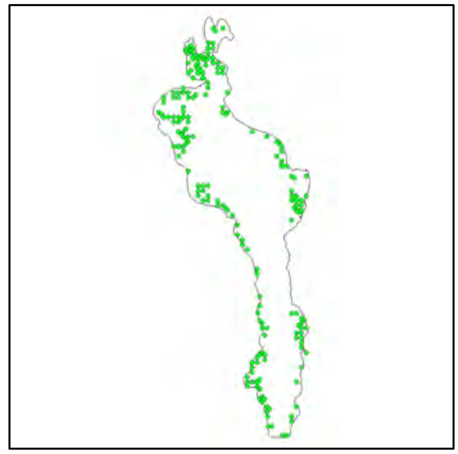
Pickerel Lake
Curlyleaf Pondweed
2023

Coontail

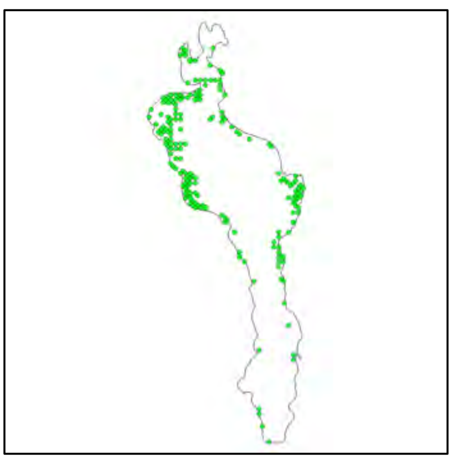


Filamentous algae

Northern watermilfoil

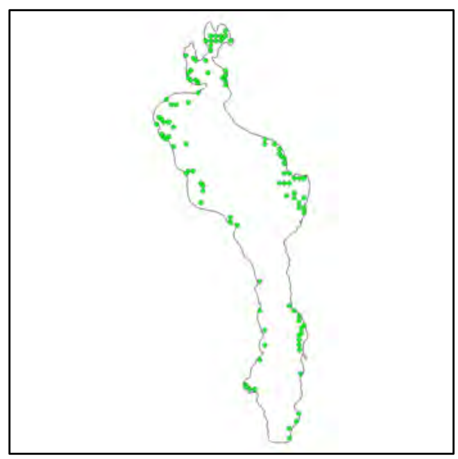


Muskgrass

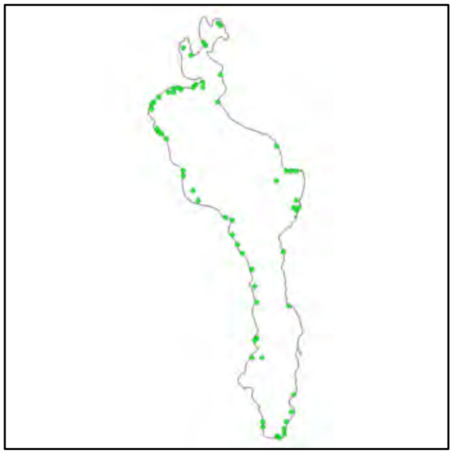


Water stargrass

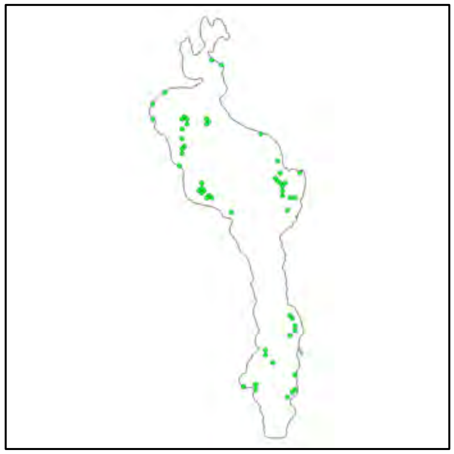
Sago



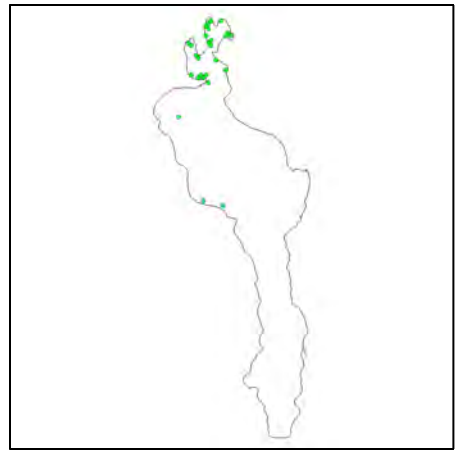
Claspingleaf pondweed



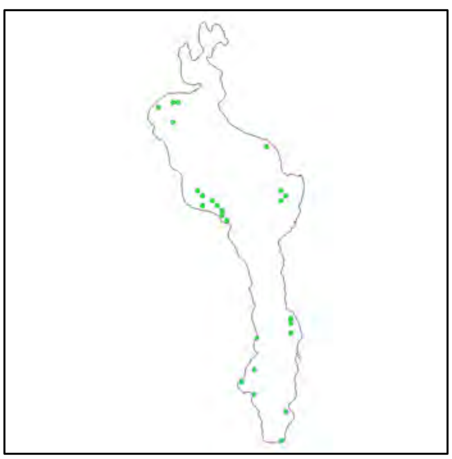
Curlyleaf pondweed



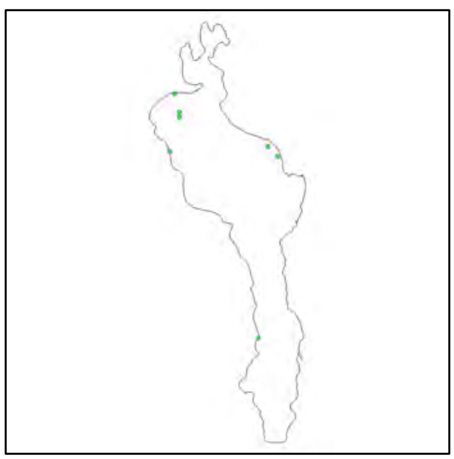
Cattails

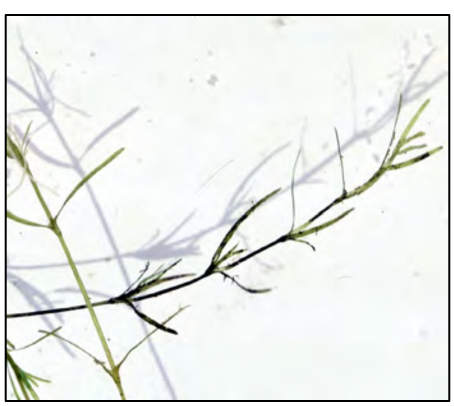


Small pondweed



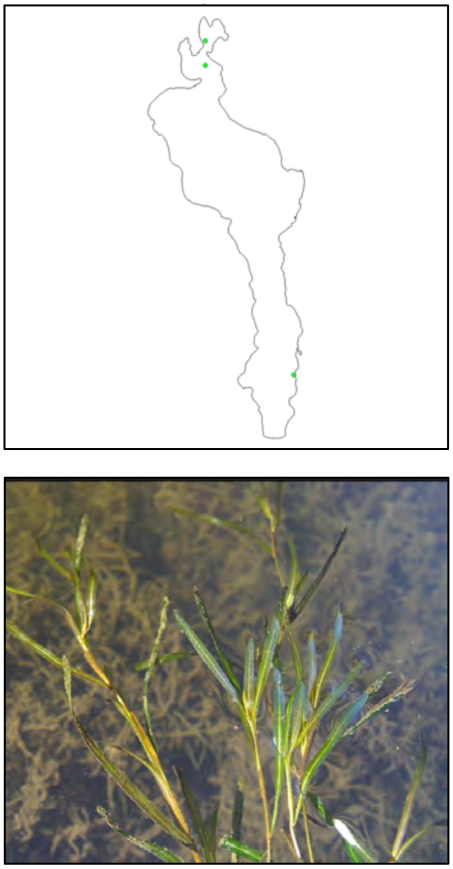
Slender naiad



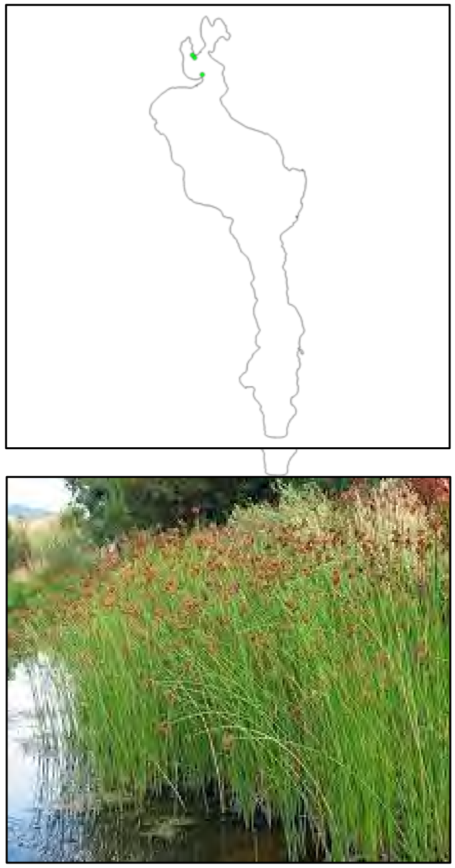


Canada waterweed

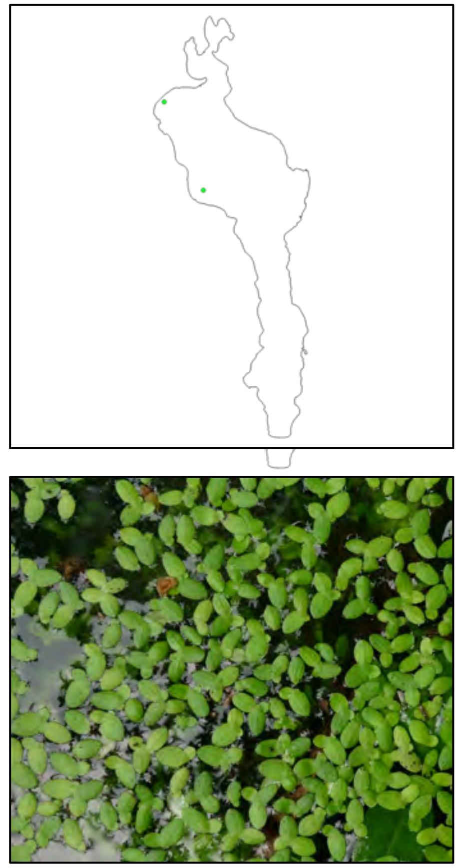
Fries' pondweed



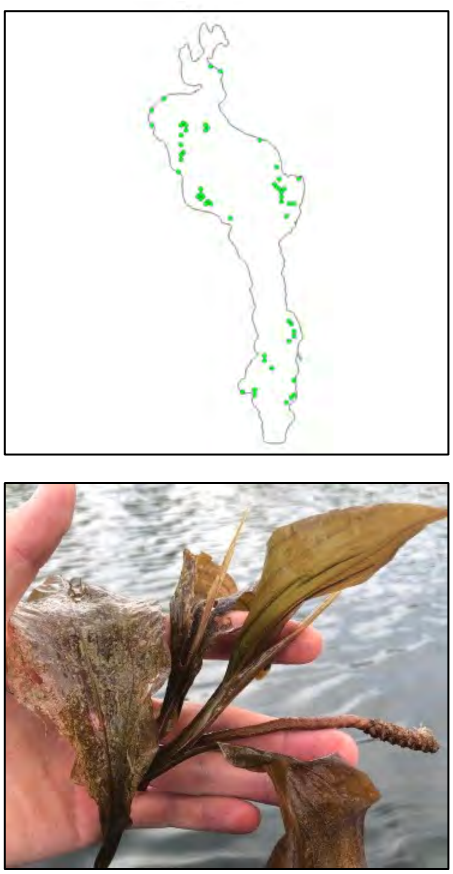
Bulrush



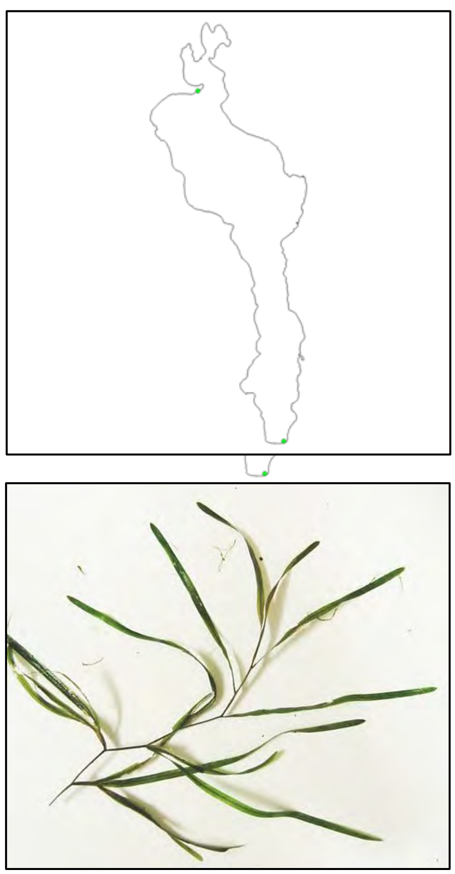
Minor duckweed



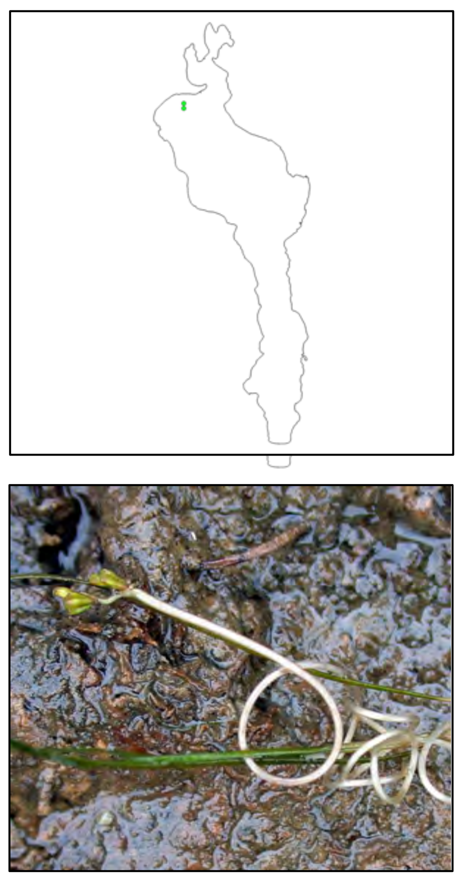
Large leaf pondweed



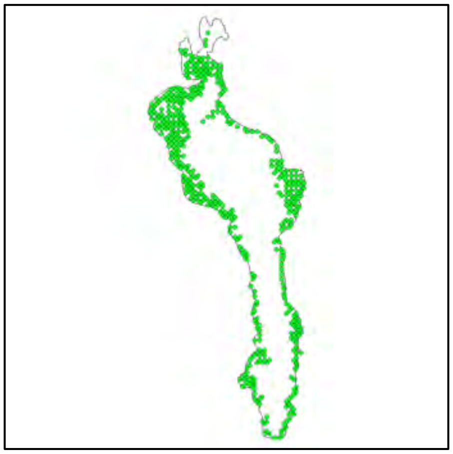
Flatstem pondweed



Spiral ditch grass



Zebra mussels



AIS Survey Report

Lake Name: PICKEREL LAKE

Aquatic Invasive Species Early Detection Survey

Surveyor 1: Dan McEwen
Surveyor 2: NA

Survey Date: 9/15/2023
Survey Time: 11:30 – 15:00 CDT

Environmental Conditions

Fair conditions with no precipitation, air temperature at 73 ºF, 40% relative humidity with 10 mph winds out of the NNE. Water clarity and visibility were excellent (>10 ft).

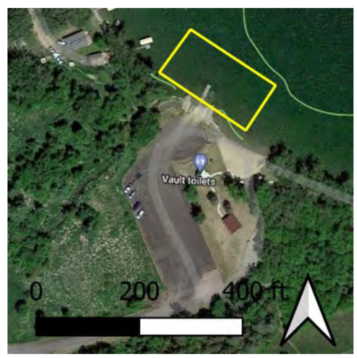
History

Known infestations of curlyleaf pondweed and zebra mussels. No additional known AIS in the lake.

Diagnosis

Starry stonewort: Not detected
Eurasian watermilfoil: Not detected
Curly-leaf pondweed: Present
Brittle naiad: Not detected
Rusty crayfish: Present: Not detected
Banded mystery snails: Not detected
Chinese mystery snails: Not detected
Zebra mussels (Juvenile-Adults): Present

West Unit



East Unit

Outcome Summary

A total of 10 species were collected during the SCUBA dive survey of which only two were invasive and both already known to exist in the lake. The invasive species were curlyleaf pondweed and zebra mussels. A complete list of species, including natives, encountered is shown at right.

Species Observed	West Unit	East Unit
Claspingleaf pondweed	1	1
Coontail	1	1
Curlyleaf pondweed	1	0
Filamentous algae	1	1
Leafy pondweed	0	0
Muskgrass	1	0
Northern watermilfoil	1	1
Sago	1	1
Water stargrass	1	1
Zebra mussels	1	1

Survey Description

An area of approximately 100 x 200 ft at public launch areas within the Pickerel Lake Recreational Unit, one at the West Unit and the other at the East Unit. Each area was surveyed by SCUBA dive transect.