CROSS LAKE
PINE COUNTY, MINNESOTA

AQUATIC PLANT SURVEY
2021

Cross Lake Aquatic Plant Survey

Prepared for Cross Lake Association

2021

LIMNOpro
Lake, River, and Pond Management
www.limnopro.com

1848 3rd Street North
PO Box 721
St. Cloud, MN 56302
Phone: (320) 342-2210
Email: dan@limnopro.com

Prepared by

Daniel C. McEwen, Ph.D., CLP
Limnopro Aquatic Science, Inc.
1848 3rd St. N., PO Box 721, St. Cloud, MN 56302
dan@limnopro.com

Field Surveys by

Ethan Hosey, Christopher Berry, and Dylan Notsch

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CROSS LAKE AQUATIC PLANT SURVEY

Daniel C. McEwen, Ph.D., CLP

Limnopro Aquatic Science, Inc., 1848 3rd St. N., St. Cloud, MN 56303

EXECUTIVE SUMMARY

An aquatic plant survey was conducted on Cross Lake over the course of the open water season in 2021. The survey consisted of two separate sampling events. The first was done in late spring to coincide with peak standing biomass of curlyleaf pondweed, an early season aquatic invasive species (AIS) previously known to infest the lake. The second portion of the survey was done in late summer to determine the normal plant community existing over most of the year, after curlyleaf pondweed died off, and to look for additional AIS. Overall, plant coverage in the lake was low, likely a result of poor water clarity that exists for most of the summer. The plant community consisted of 29 species of plants or macroalgae. Species richness within the lake was high but most of the beneficial species found were rare. The most common native plants found were water celery, waterlilies, coontail, small pondweed, and filamentous algae. We found curlyleaf pondweed at 23 acres, which is 5% of the 507 acre littoral zone. During these surveys we also found 16 acres of Eurasian watermilfoil, another AIS known to infest the lake. Approximately 6 acres of the Eurasian watermilfoil overlapped during part of the year with curlyleaf pondweed. In theory all of the curlyleaf pondweed and Eurasian watermilfoil could be targeted for removal with either chemical or mechanical means as MN DNR will allow up to 15% of the littoral zone to be treated with chemical or up to 50% of it with mechanical harvesting. No additional AIS were detected within Cross Lake during the survey. Management recommendations would be continued monitoring and control of invasive species to prevent the spread and reduce the potential for AIS to cause negative effects on the native plant community, continue to monitor water quality to monitor changes in clarity as it pertains to plant management, and strive for improvements in clarity to increase plant coverage.

INTRODUCTION

Aquatic plants are an important part of the ecological functioning of a lake. They reduce wave impacts to shorelines as well as stabilize sediments, keeping nutrients out of the water column that might otherwise lead to poor water quality. Aquatic plants also provide habitat and food for other organisms in a lake. These benefits are the "conservation value" of plants. The highest conservation value for a plant community occurs at (1) intermediate coverage and densities, (2) highest species diversity, and (3) growth form diversity. meaning mixes of broad-leaf, narrow leaf, canopy forming and lower growth forms.

When lakes are developed and used for recreational purposes such as fishing, swimming, and boating there is an additional goal in plant management that allows for those activities to be enjoyed by users. Sometimes conservation values and recreational values conflict with each other.

Recreational lakes are usually managed to best make a trade-off between recreation and conservation. These lakes will have less coverage and density than those that are not developed, but yet enough to ensure the ecological integrity of the lake.

A way to plan, manage, and goal set for this tradeoff in a practical way was de-

CONTACT Dan McEwen * dan@limnopro.com
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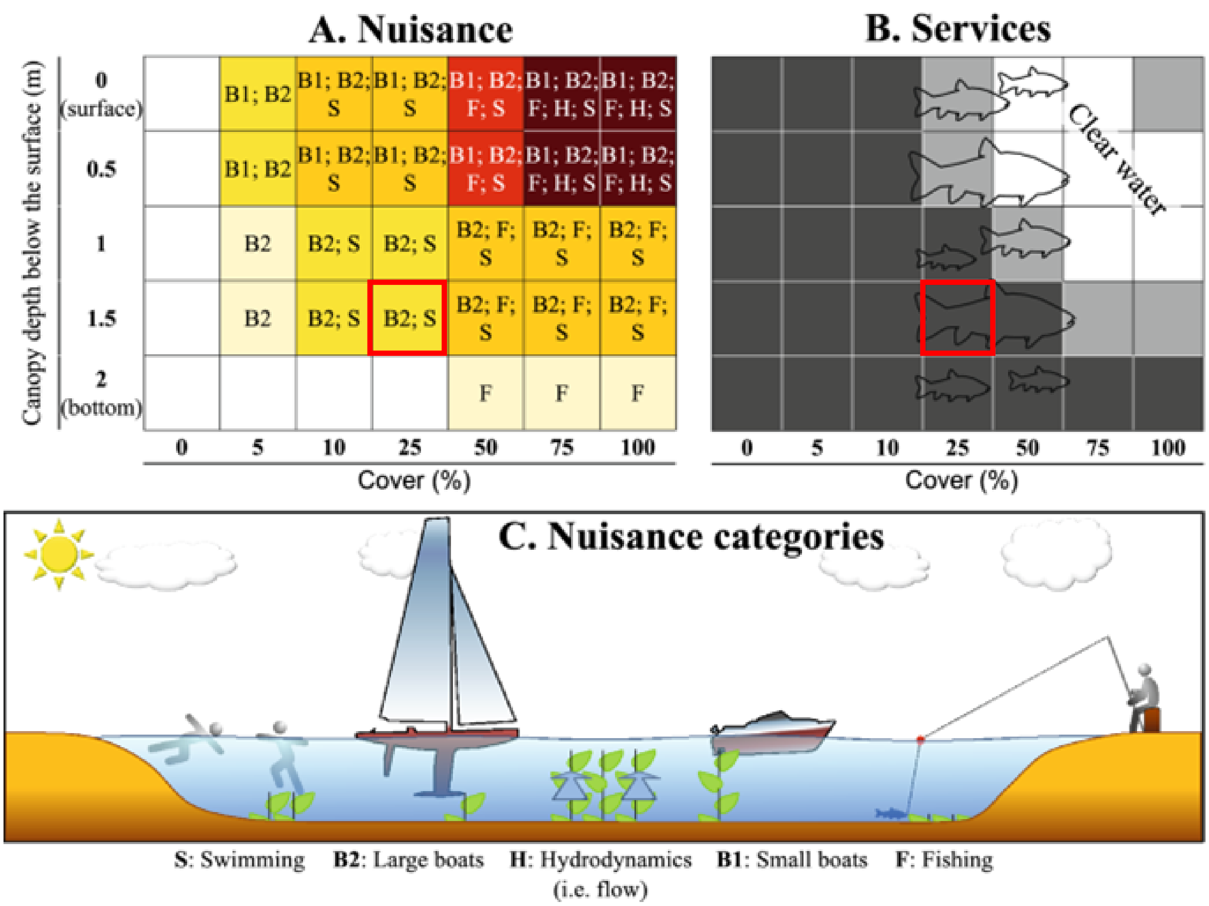


*Fig. 1. **A** Case study (water depth = 2 m) classification of nuisance macrophyte vegetation by plant canopy depth and plant cover depending on ecosystem services provided by the aquatic system. Letters indicate that macrophytes are classified as nuisance for each anthropogenic function: B1 = small recreational boats; B2=large recreational boats; F= fishing; S= swimming; H=hydrodynamics, i.e. water flow in this case. For a graphical representation, see **C**. Darker (red) fills indicate more services are impaired by macrophytes. **B** Probability of maintaining two important ecosystem services (i.e. clear water and fish populations) in shallow aquatic systems considering the total area of the ecosystem. Lighter fills are generally considered more desirable for the stability of the clear water state. The school of fish indicates the plant cover that is suggested as optimal for fish populations. Fish size has no informative meaning. **C** Graphical representation of the ecosystem services impaired by submerged plant growth, as reported in **A**. Red boxes on plots indicate average condition of Cross Lake during 2021 survey.*

tailed in a 2019 scientific paper entitled "*Classifying nuisance submerged vegetation depending on ecosystem services"* published in the Journal Limnology by Michael Verhofstad and Elisabeth Bakker. Their recommendations focus on optimal depth of canopy below the water surface and optimal plant coverage (i.e., the percentage of the lake bottom that grows plants) to support recreation and habitat for organisms in lakes. The results of this survey will show that Cross Lake is well positioned on this framework with localized nuisance only for large boats and swimming, while remaining ideal for healthy fishery (Fig. 1).

A complicating factor in managing plant communities is the presence of invasive plant species. Invasive plants are plants that are not native to Minnesota. Be-

Fig. 2. The most managed aquatic invasive species in Minnesota from left to right include curlyleaf pondweed, Eurasian watermilfoil, and starry stonewort. Top panel shows some identifying characteristics of each species and bottom panel is an example of these AIS growing to the surface where they may cause nuisance for recreational use of lakes. Cross Lake has both curlyleaf pondweed and Eurasian watermilfoil.

cause of their life history characteristics, invasive plants can outcompete native plants for sunlight and nutrients. When they are introduced, they can cause problems that reduce the recreational value of a lake.

Common invasive plant species in Minnesota include curlyleaf pondweed, Eurasian watermilfoil, and starry stonewort (Fig. 2). Any of these can mat at the surface of the lake and interfere with recreation and/or reduce native plant diversity by shading them out.

Cross Lake has known infestations of both curlyleaf pondweed and Eurasian watermilfoil but not starry stonewort. Subsequently, a short introduction of those two species is given here.

The most common invasive plant species in Minnesota is curlyleaf pondweed (hereafter CLP). One life history characteristic that allowed CLP to become a problem in Minnesota is its timing for growth and reproduction that differs from most other plants. Because it grows so early, it can shade out native plants, which require early season sunlight to begin their annual growth (Fig. 3). This can, and often does, lead to CLP becoming a dominant plant in lakes it infests during late spring until about the first week of July in Minnesota.

Most plant species, besides CLP, begin growing rapidly after the beginning of June when water temperatures exceed 60 °F. Prior to this, even though they may be present, the majority of plants can be difficult to detect. They become

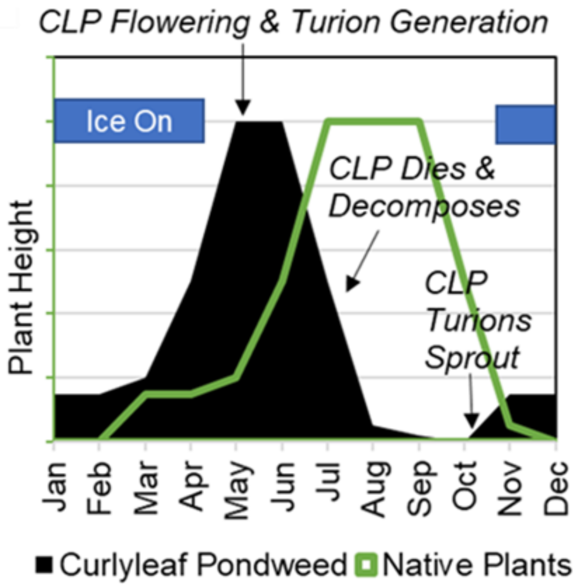


Fig. 3. Curlyleaf pondweed idealized life cycle (black solid area) interposed with "native" plants (hollow green area).

easiest to detect during the warmest part of the year from July to September.

Subsequently, a common approach we employ for surveying the plant community when CLP is suspected to occur is to divide it up into two periods, one that is good for surveying CLP and the other for natives and other aquatic invasive species (AIS) of concern.

The only other AIS plant species known to infest Cross Lake is Eurasian watermilfoil (hereafter EWM). EWM is native to Europe and Asia and was introduced to the eastern United States in the early 1900's and first discovered in Minnesota in 1987 at Lake Minnetonka in central Minnesota. It is most commonly found around Minneapolis-St. Paul metro area as well as surrounding suburban areas but is spreading through greater Minnesota presently.

EWM has a more normal growth schedule than CLP, but does tend to get started a little earlier than most native species. A big difference between EWM and CLP is that rather than dying off in early summer, EWM persists through the growing season so it can cause longer term problems. In lakes with both CLP and EWM this can lead to codominance between the two species with CLP growing to nuisance levels in late spring and early summer and EWM becoming a nuisance during the summer months following CLP die-back.

EWM can be distinguished from the native watermilfoils by counting the leaflet pairs on each leaf. Native milfoils tend to have less than 11 pairs, while EWM has 12-24 leaflet pairs (Fig. 4).

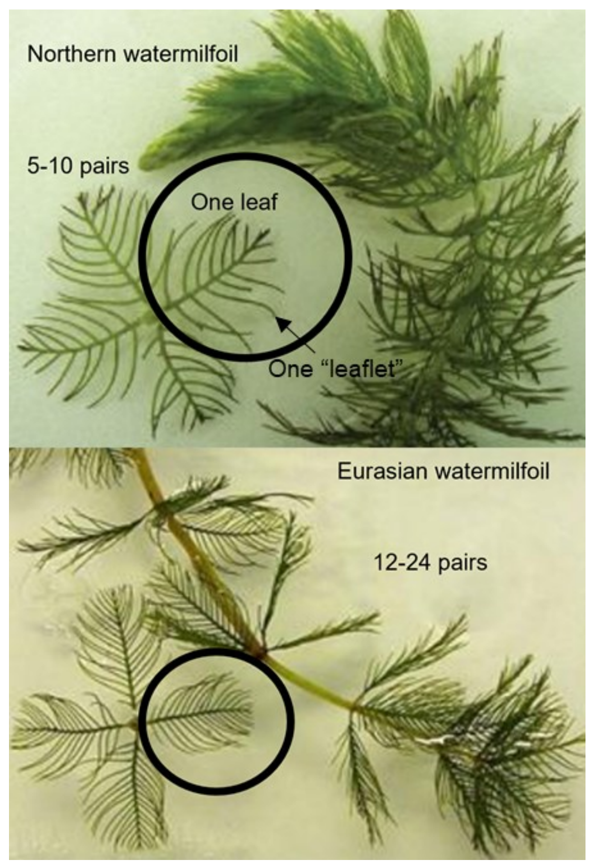


Fig. 4. Northern watermilfoil (top) has rigid leaves when out of the water, and 5-10 leaflet pairs. Eurasian watermilfoil (bottom) has limp leaves when out of the water and 12-24 leaflet pairs.

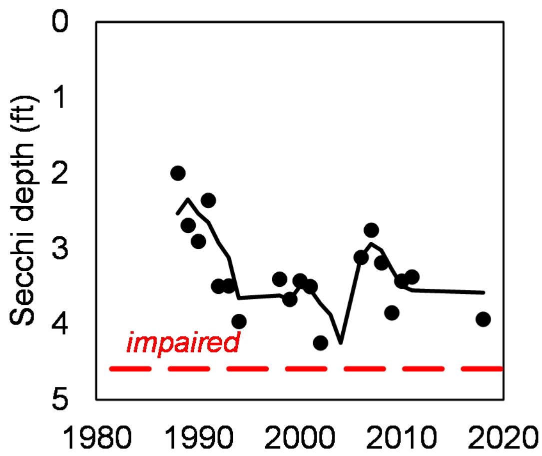


Fig. 5. Historical Secchi Depth data from Cross Lake from MPCA. This lake is in the North Central Hardwood Forest Ecoregion and has an impairment threshold of 4.6 ft. which is indicated by the red dashed line. Any points above the red line would be considered impaired. The solid black line is the three year moving average.

This report describes an aquatic plant survey conducted during the 2021 open water season on Cross Lake (DOW: 58011900) in Pine County in order to determine degree of CLP and EWM infestation and search for other invasive species as well as determine the state of the native plant community on the lake to guide future management activities.

METHODS

Site Description. Cross Lake has a reported surface area of 925 acres with 507 classified as littoral zone and a maximum depth of 30 feet. The littoral zone is the area of the lake where sunlight penetrates deep enough to reach the bottom in sufficient amounts to allow for germination and plant growth. The MN DNR delineates the littoral zone as any part of the lake that is less than 15 feet. While a good approximation, the true littoral zone will differ depending on several different factors. This survey will show the observed littoral zone for Cross Lake is likely around 10 ft.

The Minnesota Pollution Control Agency (MPCA) listed Cross Lake as impaired in 2004 for nutrients and low clarity exceeding standards for lakes in the North Central Hardwood Forests Ecoregion (Fig. 5). The last assessment year was 2019 where it remained on the impaired water's list.

EDDMapS (www.eddmaps.org) indicates the first record of CLP occurred in 1990 and the first record of EWM in 2004. The most recent infested waters list (October 28, 2021) by the MN DNR indicates no other known aquatic invasive species (www.dnr.state.mn.us/invasives/ais/infested). DNR standard fisheries survey reports indicate that invasive common carp have been in Cross Lake since at least 1981.

The presence of carp can directly impact plants in the lake. When carp feed they sift through lake sediments and in the process uproot plants and stir sediment nutrients into the water column promoting algal growth, which creates poor conditions for native plants.

The most recent MN DNR fisheries report (2018) indicates carp may be a problem in the lake. Biomass estimated from that survey is estimated at 3.2 pounds per net, which exceeds the problem threshold estimated in the literature of 3.1 pounds per net.[1] Carp have historically been a problem in Cross Lake, and from 1984-1990, commercial crews removed 440,000 pounds of carp.

1 Bajer et. al (2016). Biological invasion by a benthivorous fish reduced the cover and species richness of aquatic plants in most lakes of a large Norther American ecoregion. Global Change Biology 22:3937-3947

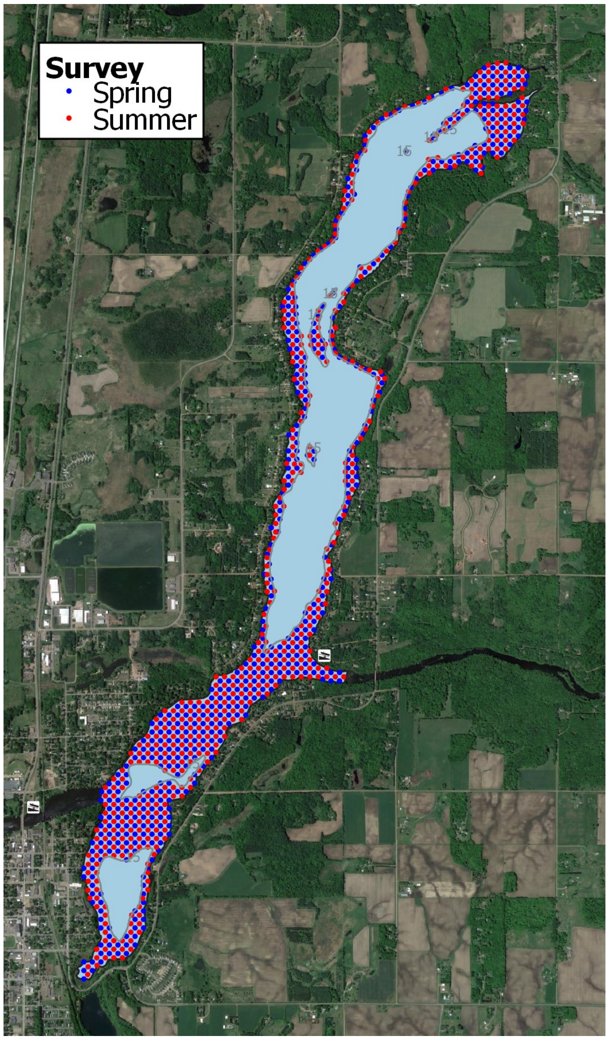


Fig. 6. Sampled points during 2021 on Cross Lake. The spring portion of the survey is represented with blue dots and the summer portion is represented by red dots (right).. Areas without points are greater than 15 ft and not surveyed.

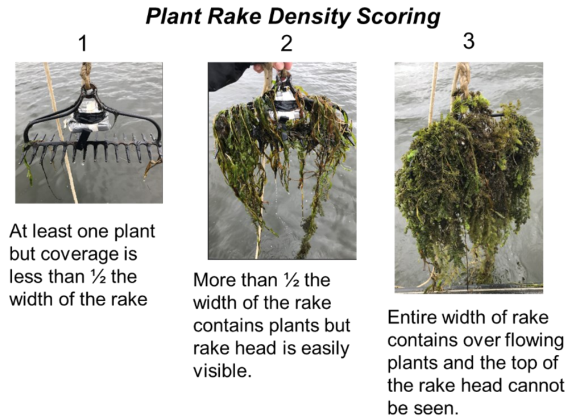


Fig. 7. Aquatic point intercept survey rake density method for density scoring.

Aquatic Plant Point Intercept Survey. The survey was divided into two parts (Fig. 6). The spring part of the survey occurred on June 21, 2021 to determine the degree of CLP infestation during the part of the year is was expected to be the worst. During that sampling event 511 points were loaded to an onboard GPS/sonar unit at a spacing of 1 point per acre.

The summer portion of the survey was conducted on August 17-18, 2021. This was to identify the late summer plant community and search for other AIS, such as EWM, during their peak growth period. During that sampling event, 513 points were loaded to an onboard GPS/sonar unit offset from the June sampling event in order to provide a final resolution of 1 point per 0.5 acres across the entire littoral zone.

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. 7).

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 per-

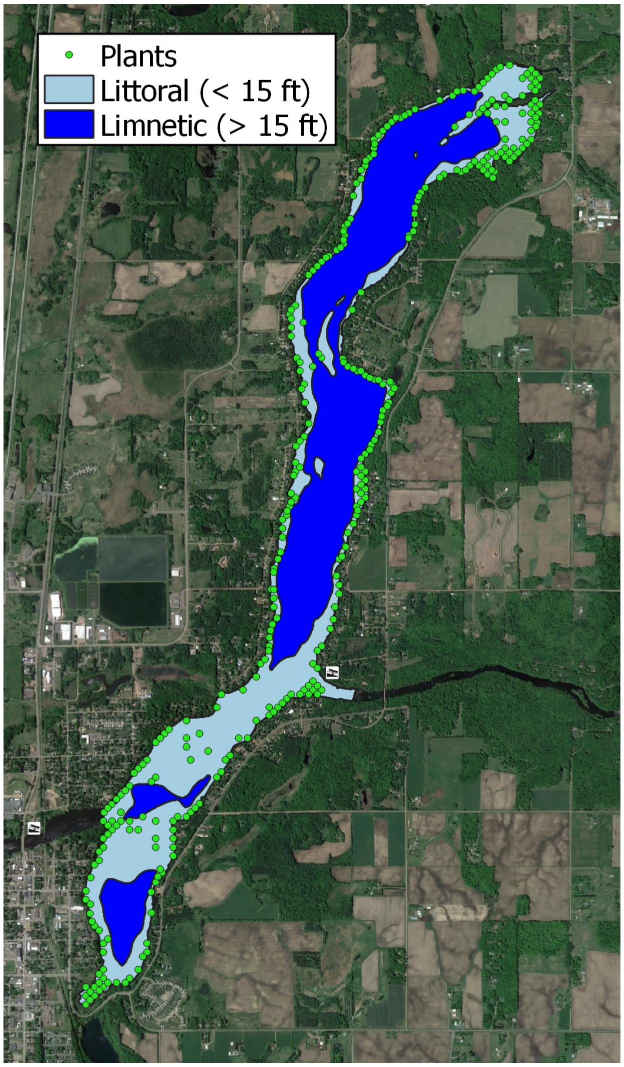


Fig. 8. Plant occupancy on Cross Lake. Green dots represent a sampling point with at least 1 plant. Areas in light blue (i.e., littoral zone) without points were searched but found void of plants. Dark blue (i.e., limnetic zone) was not surveyed

cent" (BV%) and depth to top of the plant canopy. BV% is a measure of the percentage of the water column depth occupied by plants. It is a useful way to show overall plant density, but it is not able to distinguish different species from one another. Plant coverage in conjunction with canopy depth can be used to determine areas of the nuisance growth. More information on BioBase processing and data output can be collected at www.biobasemaps.com.

Additional mapping and geostatistical analyses were performed using a geographic information system (QGIS 3.16). Interpolation methods used a multilevel b-spline interpolation method in QGIS.

Generally, for the plant community we calculated (1) frequency of occurrence for each species, and (2) relative density of each species.

We also listed Conservation Coefficients (CC), which is an index of how well a species can exist in the face of disturbance. CCs range from 0 (most able to withstand disturbance) to 10 (least able to withstand disturbance). The higher CC values indicate they can only exist where habitats are relatively undisturbed. In addition to generating CC's for each plant, we calculated a weighted CC (CC_w) for the entire plant community that can be useful for comparison to future assessments.

Finally, we assigned one of three management categories to each plant species: *Desirable, Undesirable* and *Neutral* based on their desirability to have on the lake relative to their propensity to cause a nuisance. Desirable plants are lower canopy-growers that are less likely (though not impossible) to grow to the surface. Undesirables are plant species that do tend to grow to near the surface and become a problem. Neutral plants are typically surface floating plants that can become a nuisance when exceedingly dense but under less dense conditions can provide positive habitats for animals in lakes. These designations are based on our experience and are subjective.

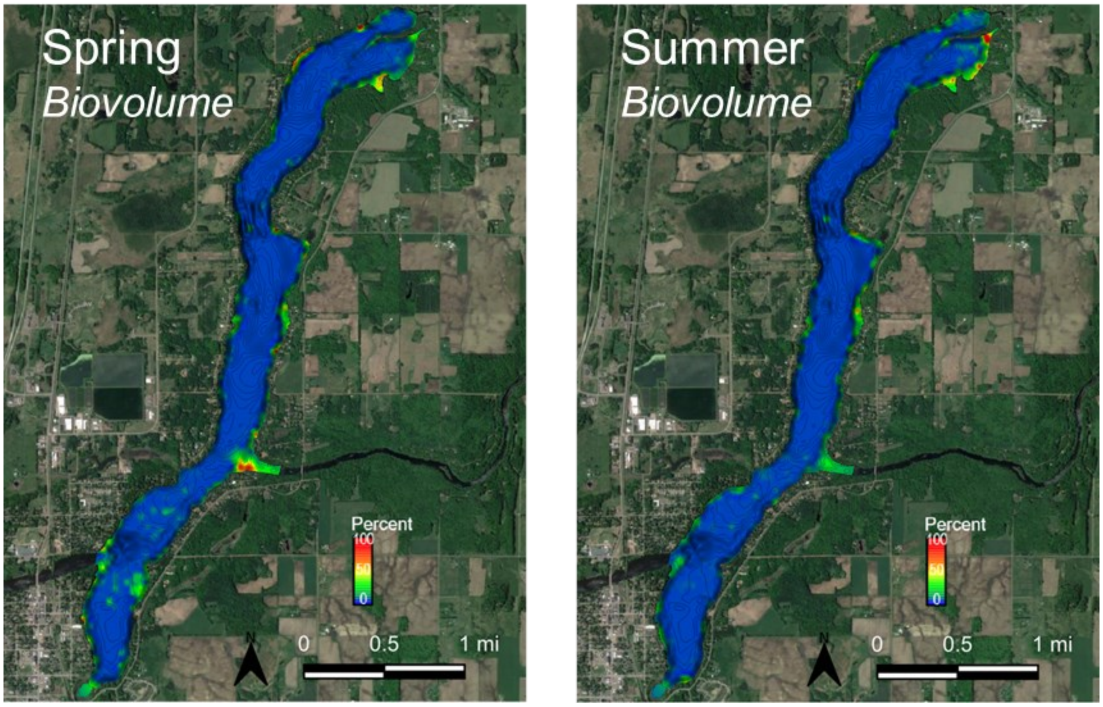


Fig. 9. Biovolume based on sonar collected during June (left) and August (right) surveys. Biovolume is the percentage of the water column occupied by plants. The value ranges from 0% (no plants = dark blue) to 100% (plants grow to the surface = dark red).

RESULTS

Aquatic Plant Point Intercept Survey. Aquatic plants were found at 34% of points sampled over the littoral zone (Fig. 8). Plant coverage did not differ substantially between the spring and summer samples (i.e., 36% vs. 32% respectively).

Hydroacoustic surveys indicated about half of the areas that have plants have plants growing to within 5 ft of the surface, which we would classify as being a nuisance. It appears that the densest plant growth occurs at the far north bay as well as the outlet near and around the public boat launch (Fig. 9).

Although the deepest depth where plants were found was 20 ft, only a small proportion of sites sampled greater than 8 ft were occupied by any plants (Fig. 10). This is likely reflective of the poor water clarity during the summer. While 15 ft is the standard depth for a littoral

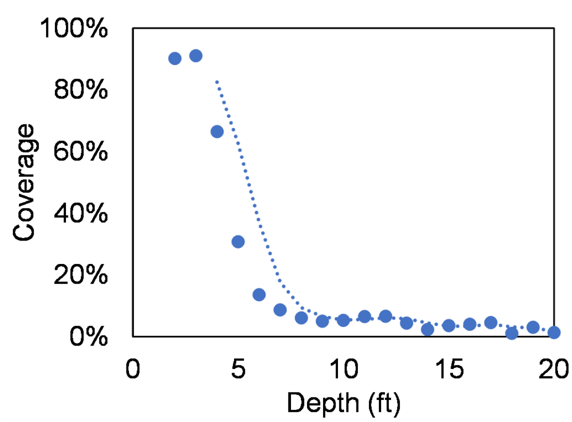


Fig. 10 Percentage of sites at a given depth where hydroacoustic data indicates plant presence. Dashed line represents the three point moving average. Data is from all three point intercept surveys.

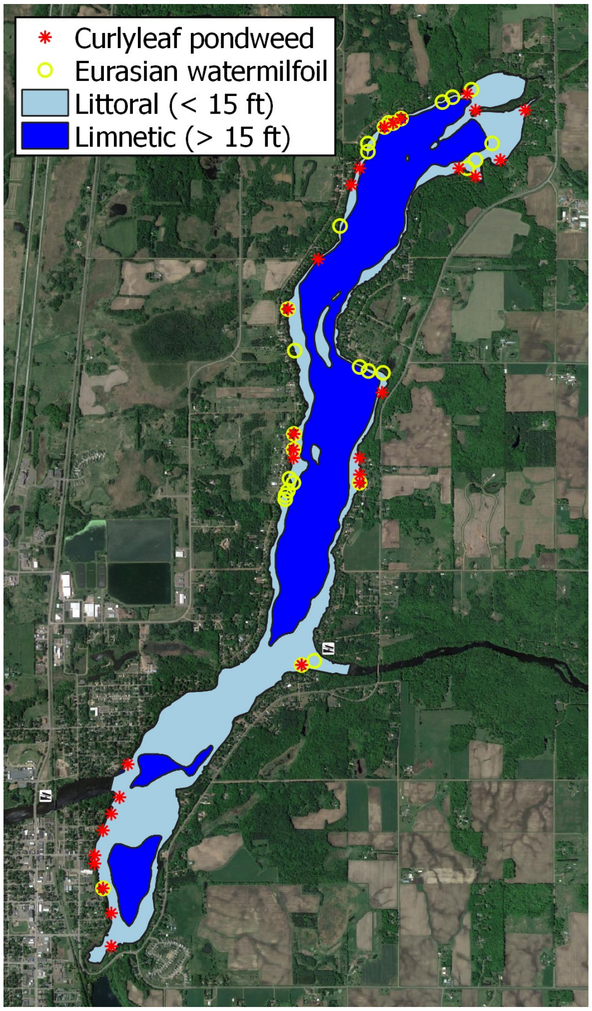


Fig. 11. Locations of aquatic invasive species found in Cross Lake for combined surveys in 2021. Green dots represent a sampling point with at least 1 plant, and hollow circles represent a sample point with no plants.

zone, this year's observed littoral zone was likely closer to between 8 and 10 ft.

A total of 29 species of plants or algae were identified across the two sampling events during 2021. The most common plants in the lake were water celery, waterlilies, coontail and small pondweed along with a matrix of filamentous algae. These five types of vegetation accounted for over 70% of all plants collected. Twenty five of the 29 species were detected at less than 10% of sample sites and as such would be considered rare.

The only aquatic invasive species found during the survey were CLP and EWM (Fig. 11). A total of 23 acres of CLP and 19 acres of EWM were found. Of this acreage, there was overlap of CLP and EWM in 6 acres. Both of these were already known to be in the lake. Nearly all of the CLP found was found during the spring survey. It had mostly died back by the summer survey. EWM was found during both surveys.

Species that could be considered indicative of a non-disturbed habitat or of high quality were present, but rare. Such plants include Fries' pondweed (CC=8), humped bladderwort (CC=8), thread-leaved pondweed (CC=8) and wild rice (CC=8). The weighted conservation coefficient for the entire lake was 4.4.

A full list of plant species identified in Cross Lake, along with their CCs, occurrences and densities are given in the appendix. Spatial density plots for all species and a pictorial atlas of species found is included in the report.

DISCUSSION

The set of surveys on Cross Lake revealed the following key points: (1) native plant growth and coverage is within an ideal range; (2) CLP and EWM are the only invasive species present but combined are restricted to less than 10% of the littoral zone, and (3) water quality as measured by clarity is poor.

On balance, plant growth in Cross Lake is within a range where most recreation can occur unimpeded and where a quality fish community can persist. The nuisance index described in Fig. 1 does suggest that in some areas of the lake there may be some nuisance growth getting in the way of moving large boats around or fishing and swimming but areas are minimal (See Fig. 1). Relative to similar lakes we have been on, plant coverage is on the low side.

Water quality in the lake is poor, which likely is reducing the coverage of plants on the lake. Poor water quality results from both external and internal additions of nutrients, primarily phosphorus. Algae are phosphorus limited, meaning the more phosphorus that gets into the water column, the more algae will grow. Algae reduce the amount of light that can get through the water, so the water becomes cloudy or turbid. This turbidity in turn reduces the amount of light available for plants to grow.

Reducing available phosphorus in the lake during the year can improve water quality and the type of plant community that exists in the lake. External phosphorus runs into the lake from the surrounding land and streams. Internal phosphorus comes from phosphorus that has accumulated through the years in the bottom mud of the lake.

Plants draw up this phosphorus from the mud to build tissue when they grow. When plants die during the year, the phosphorus in their tissue gets released to the water column. Because CLP dies off during warm periods of the year when algae grow, it adds phosphorus to the lake during times that fuel algae growth. While native plants also die and can release phosphorus, most of that happens late in the year when it is too cold for serious algae growth. Controlling CLP may help to improve water quality, which may result in a higher quality native plant community.

Carp can also cause problems for the development of quality plant communities. Carp are well known aggravators of turbid water in lakes. Carp dig around on the lake bottom to feed and in the process remove and destroy native plants. If native plants cannot grow, their root systems cannot stabilize sediments and their shoots can not buffer water movement. Additionally, there are many nutrients in the sediment that get stirred up into the water column when carp feed and subsequently promote algal growth.

The most recent carp survey (2018) indicated 174 pounds of fish per acre, which is near the suggested threshold for causing problems with water quality. If the 2018 estimate is correct, it would mean that a minimum reduction in the amount of 4 pounds per acre would need to take place to improve water quality. Given a littoral zone acreage of 507 acres, this would equate to a removal of 2,028 pounds before improvements in water quality were seen.

One caveat about these estimates is that standard MN DNR gillnet surveys, which is what these estimates are based on, are not the best ways to estimate true carp biomass existing in the lake. The better way to get good estimates of carp biomass is to use either mark recapture techniques or electrofishing. Electrofishing can be the better option due to cost.

After determining carp biomass it can be determined if carp control might improve the lake. Methods of carp control include removal through commercial fishing and/or determining where the fish are reproducing and making those environments either inaccessible or difficult for spawning to occur.

Even though plants may not on average be a nuisance, there may be areas that do present problems. The state of Minnesota allows control of nuisance plants if they interfere with property owner's ability to recreate. Either chemical or mechanical removal of plants may be done under an Aquatic Plant Management (APM) permit. APM permits are applied for by individual property owners to treat a portion of their personal shoreline. These permits allow up to two seasonal chemical treatments of aquatic plants along property owner shorelines if aquatic plants impede the ability of the property owner to use the lake. Generally, the MN DNR will allow you to treat a width of half of the shoreline property you own out to 100 feet lakeward. They will also allow you to carve out a 15-foot width channel to reach the main lake if given permissions.

The only two invasive species detected during the survey were CLP and EWM. Larger offshore areas are allowed for treatment where any AIS exists.

Chemical treatment of offshore areas requires an Invasive Aquatic Plant Management (IAPM) permit, which is approved by the regional MN DNR AIS Specialist within Ecological and Water Resources Division. The MN DNR will permit chemical herbicide treatment up to 15% of the littoral area or mechanical harvesting up to 50% of a waterbody. Given the total amount of acreage for CLP and EWM combined is less than 10%, in theory all of it could be controlled. It is important to note that if any treated areas fall within 150 ft of a homeowner's shoreline a signature from said property owner must be obtained.

Some understanding of the different types of chemical that are used to treat both CLP and EWM is important. The types of chemicals allowed to treat CLP are known as "contact" herbicides. They affect only the part of the plant they come in contact with (e.g., leaves) meaning that underground structures are left behind and plants will grow back annually. *Contact* herbicides are not designed for long term control but rather to provide relief to recreational users. The types of chemicals allowed to treat EWM include both "contact" herbicides and "systematic" herbicides. *Systematic* herbicides are designed to kill the entire plant. In fact, we have had success in near eradicating EWM in some lakes with it.

Given the difference in how these types of herbicides work, we suggest that if CLP is treated, it is only treated if it exists in areas likely to impede the general public from being able to boat, swim, fish, or otherwise recreate. One way to select such areas objectively might rely on high lake usage based on where docks are most dense along the shore (see appendix dock density map). CLP will grow back then next year in the same areas. On the other hand, targeting EWM to attempt to keep it from growing back does make sense.

Finally, other AIS that are present in and problematic in Minnesota lakes but were not found in Cross Lake should be continued to be monitored for. The most common problem AIS not within Cross

Lake are zebra mussels and starry stonewort. The best chance of control for either of these species is early detection and remediation. Early detection searches for these species ought to be a priority every year and efforts should be made to educate frequent lake users to be able to recognize these species and report any plants that look suspicious to the MN DNR and/or Limnopro immediately.

MANAGEMENT RECOMMENDATIONS

1. CLP chemical herbicide treatment if it persists in areas that it impedes with recreation.
2. EWM chemical herbicide treatment at maximum labeled rate of 2,4-D as budget allows.
3. Enrollment to lake water quality monitoring program to collect total phosphorus, chlorophyll a, and Secchi depth readings once per month during open water season.
4. Develop a lake diagnostic and management plan to summarize existing data and information on the lake and determine gaps of knowledge that can help toward increasing plant coverage.
5.. Carp survey using trap nets, seine nets, or electrofishing to determine carp biomass.
6. Nutrient budget to quantify sources and sinks of phosphorus to the lake for identifying management opportunities for reducing nutrients.
7. AIS Early Detection Survey at the public boat launch during late summer to look for first indication of Eurasian watermilfoil, starry stonewort, and other AIS.
8. Annual hydroacoustic survey for monitoring of biovolume, canopy depth, and coverage.

CONTACTS

Dan McEwen
Principal Scientist
Limnopro Aquatic Science, Inc.
dan@limnopro.com
(320) 342-2210

Wendy Crowell
Aquatic Invasive Species Coordinator
Minnesota DNR
wendy.crowell@state.mn.us
(651) 259-5085

Richard Rezanka
IAPM Permitting
Minnesota DNR
richard.rezanka@state.mn.us
(218) 328-8821

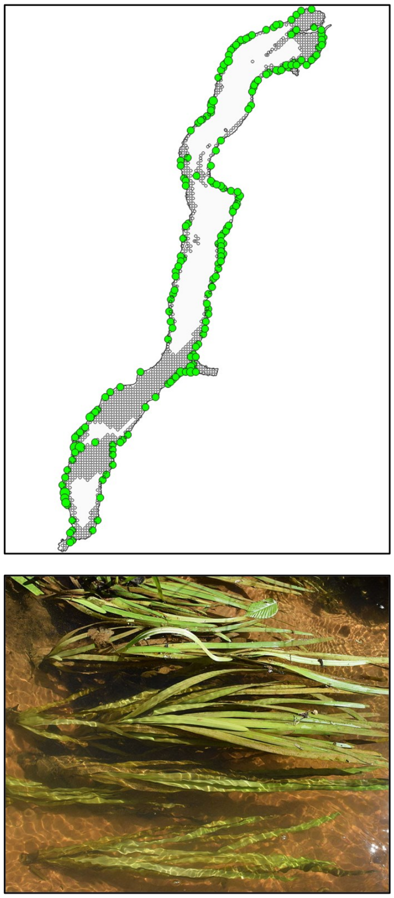
Audrey Posterick
APM Permitting
Minnesota DNR
audrey.kuchinski@state.mn.us
(651) 259-5085

Appendix

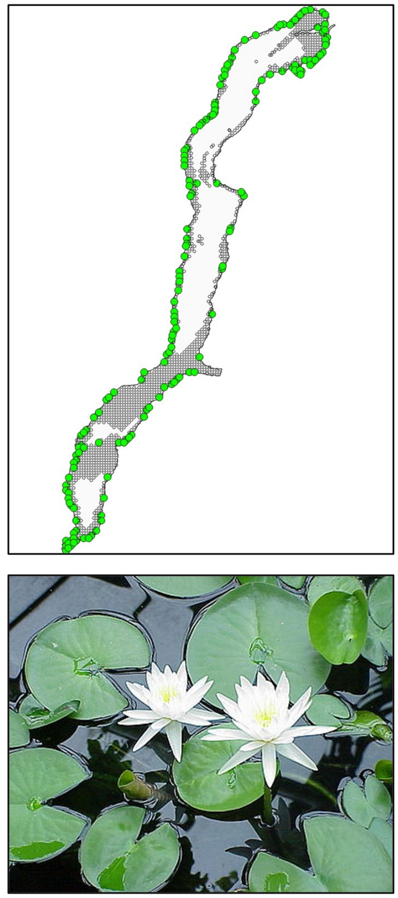
Summary of plant survey data on Cross Lake in Pine County, MN. CC is the conservation coefficient (higher numbers indicate a more sensitive species to disturbance). MC is management category and our judgement of species that have qualities for lakes that are desirable (D), undesirable (U), or neutral (N). Density is an estimate, based on rake densities, of the proportion of mass for a given species during the survey. Occupancy is the proportion of sites sampled that had at least one instance of the species.

				Combined		Spring		Summer	
CC	**MC**	**Common Name**	**Scientific Name**	**Density**	**Occupancy**	**Density**	**Occupancy**	**Density**	**Occupancy**
6	D	Water celery	*Vallisneria americana*	19.6%	19.3%	14.7%	16.8%	25.3%	21.8%
6	N	American white waterlily	*Nymphaea odorata*	15.6%	16.5%	12.0%	13.7%	19.9%	19.3%
1	U	Filamentous algae	Various	14.5%	15.2%	10.9%	12.5%	18.7%	17.9%
2	U	Coontail	*Ceratophyllum demersum*	12.2%	12.6%	12.1%	13.7%	12.2%	11.5%
7	D	Small pondweed	*Potamogeton pusillus*	9.2%	9.8%	13.0%	14.9%	4.8%	4.7%
4	D	Canadian waterweed	*Elodea canadensis*	7.9%	8.2%	7.2%	8.2%	8.8%	8.2%
0	U	Curlyleaf pondweed	*Potamogeton crispus*	2.9%	3.0%	5.1%	5.9%	0.2%	0.2%
0	U	Eurasian watermilfoil	*Myriophyllum spicatum*	2.7%	2.8%	3.9%	4.5%	1.2%	1.2%
6	D	Water stargrass	*Heteranthera dubia*	2.2%	2.3%	1.9%	2.2%	2.6%	2.5%
5	D	Claspingleaf pondweed	*Potamogeton richardsonii*	2.0%	2.1%	2.2%	2.5%	1.8%	1.8%
6	D	Flat-stemmed pondweed	*Potamogeton zosteriformis*	1.8%	2.0%	3.2%	3.7%	0.2%	0.2%
8	D	Fries' pondweed	*Potamogeton friesii*	1.2%	1.3%	2.2%	2.5%	0.0%	0.0%
6	D	Leafy pondweed	*Potamogeton foliosus*	0.9%	1.0%	1.7%	2.0%	0.0%	0.0%
9	D	Humped bladderwort	*Utricularia gibba*	0.9%	1.0%	1.7%	2.0%	0.0%	0.0%
5	D	Flexuous naiad	*Najas flexilis*	0.8%	0.9%	0.3%	0.4%	1.4%	1.4%
5	N	Greater duckweed	*Spirodela polyrrhiza*	0.8%	0.9%	1.4%	1.6%	0.2%	0.2%
1	N	Cattail	*Typha* spp.	0.8%	0.9%	1.4%	1.6%	0.0%	0.0%
8	D	Thread-leaved pondweed	*Stuckenia filiformis*	0.7%	0.8%	1.2%	1.4%	0.0%	0.0%
6	N	Spatterdock	*Nuphar variegata*	0.6%	0.7%	0.2%	0.2%	0.8%	0.8%
5	N	Duckweed	*Lemna* spp.	0.5%	0.5%	0.5%	0.6%	0.0%	0.0%
NA	D	Aquatic Mosses	Various	0.5%	0.5%	0.3%	0.4%	0.6%	0.6%
5	N	Spotted watermeal	*Wolffia borealis*	0.3%	0.3%	0.3%	0.4%	0.2%	0.2%
8	N	Wild rice	*Zizania palustris*	0.3%	0.3%	1.5%	1.8%	0.0%	0.0%
7	D	Muskgrass	*Chara* spp.	0.2%	0.2%	0.0%	0.0%	0.4%	0.4%
7	D	Northern watermilfoil	*Myriophyllum sibiricum*	0.2%	0.2%	0.0%	0.0%	0.4%	0.4%
7	U	White waterscrowfoot	*Ranunculus aquatilis*	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
3	D	Sago	*Stuckenia pectinata*	0.2%	0.2%	0.3%	0.4%	0.0%	0.0%
7	D	Nuttall's elodea	*Elodea nuttallii*	0.1%	0.1%	0.2%	0.2%	0.0%	0.0%
6	N	Arum-leaved arrowhead	*Sagittaria cuneata*	0.1%	0.1%	0.2%	0.2%	0.0%	0.0%

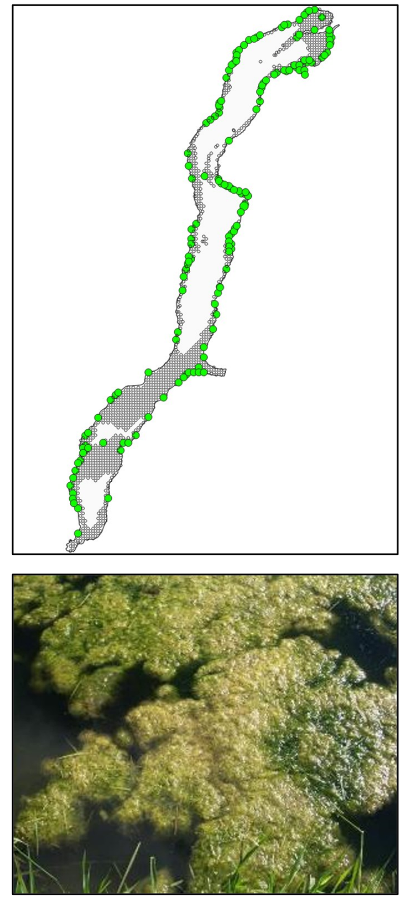
Water Celery



American White Waterlily

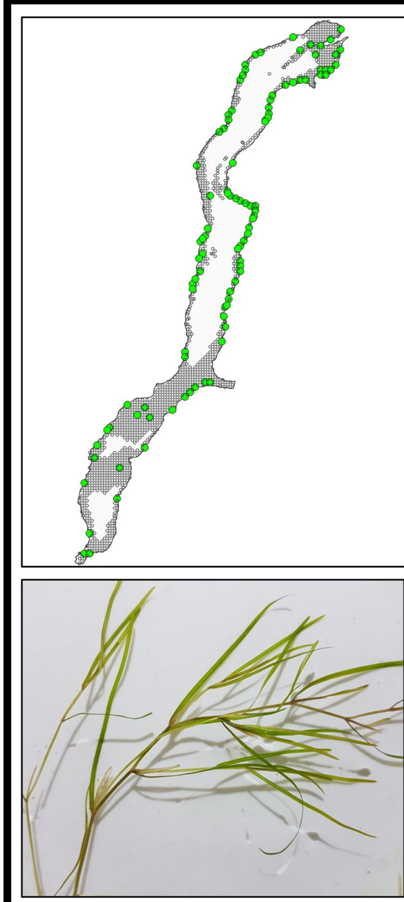


Filamentous Algae

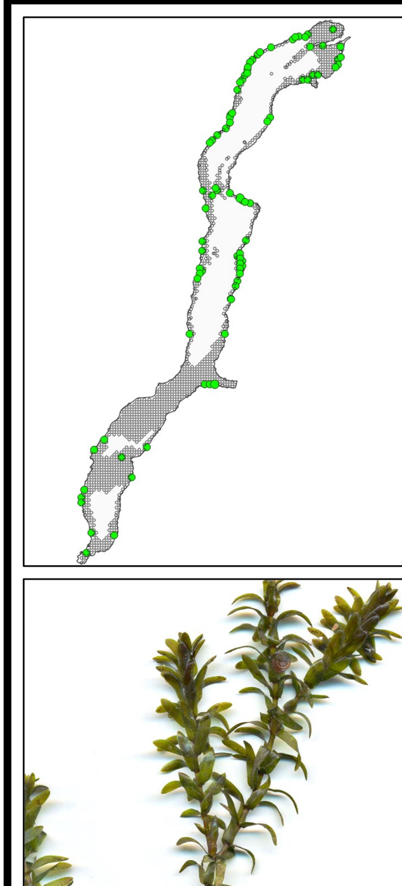


Coontail

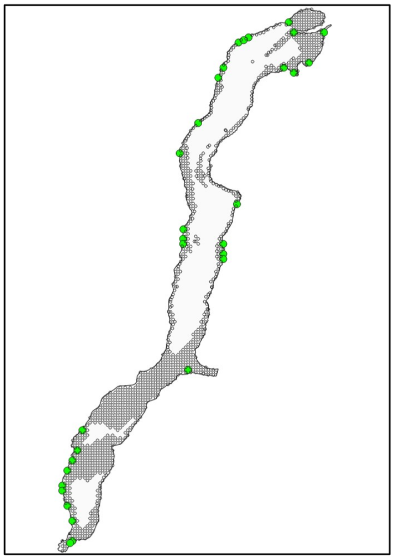
Small Pondweed



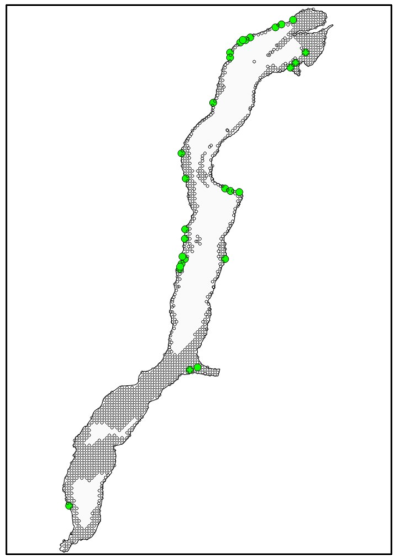
Canadian Elodea



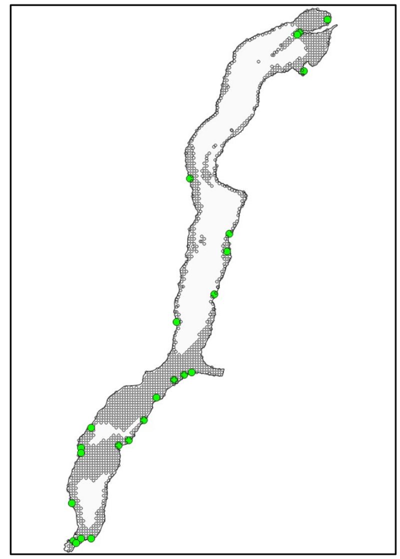
Curlyleaf Pondweed



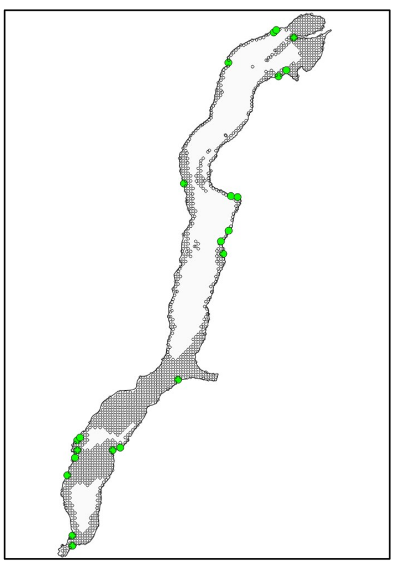
Eurasian Watermilfoil



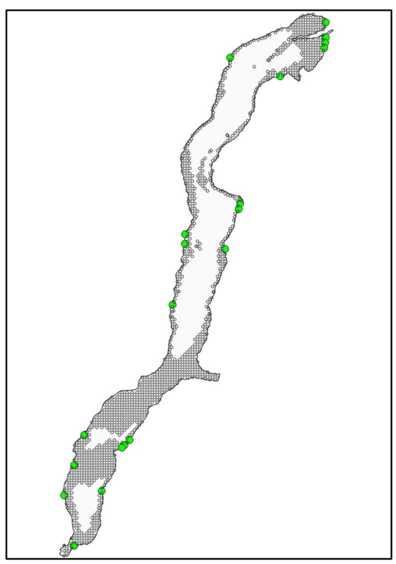
Water Stargrass



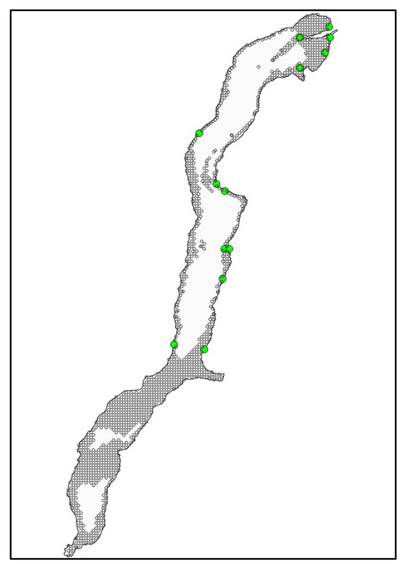
Clasping-leaf Pondweed



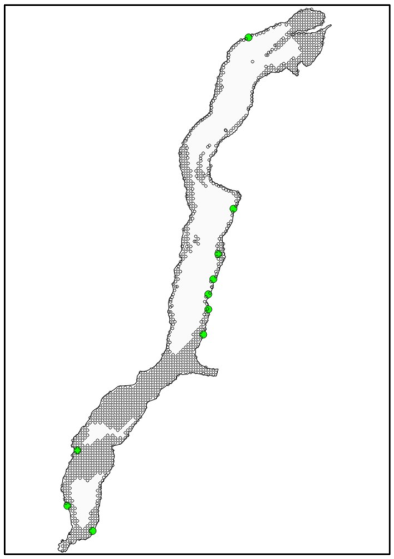
Flat-stem Pondweed



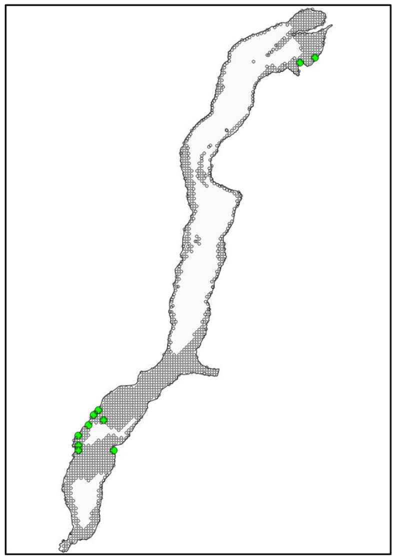
Frie's Pondweed



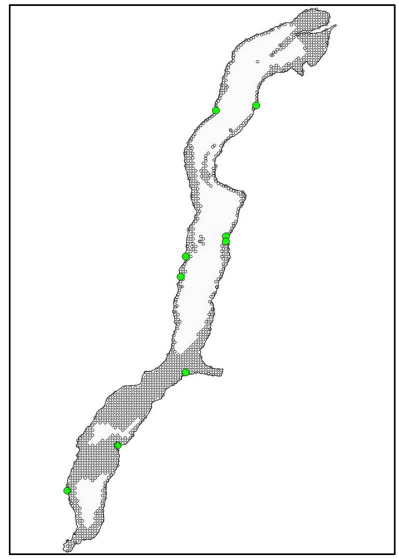
Leafy Pondweed



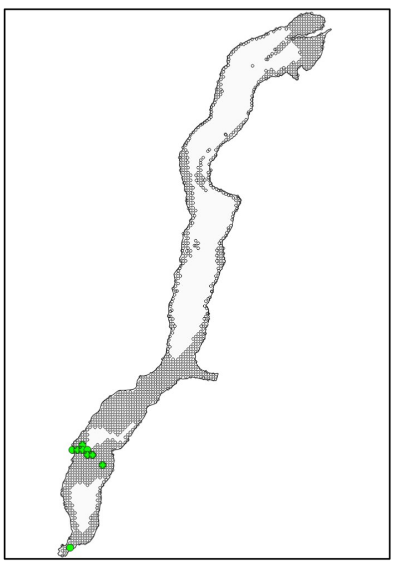
Humped Bladderwort



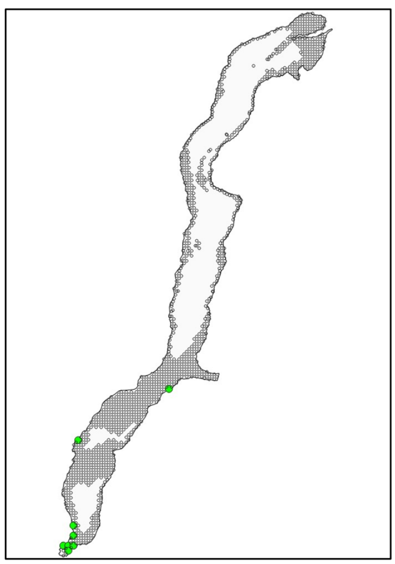
Flexuous Naiad



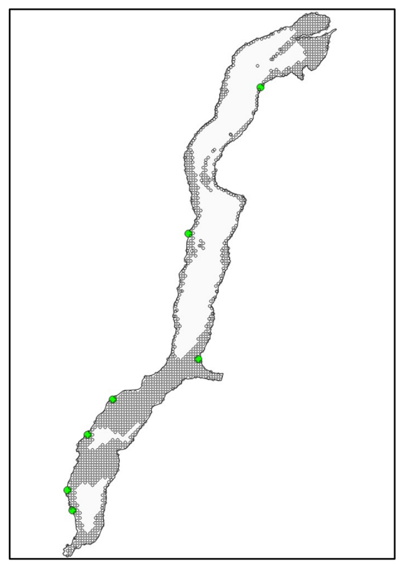
Greater Duckweed



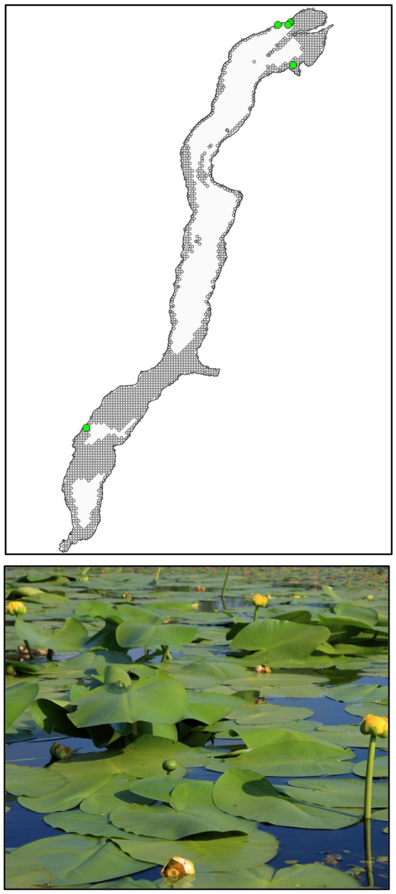
Cattail



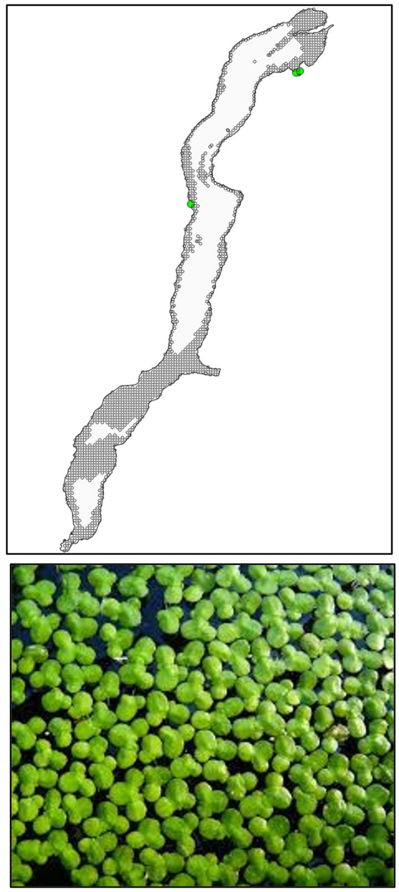
Thread-leaved Pondweed



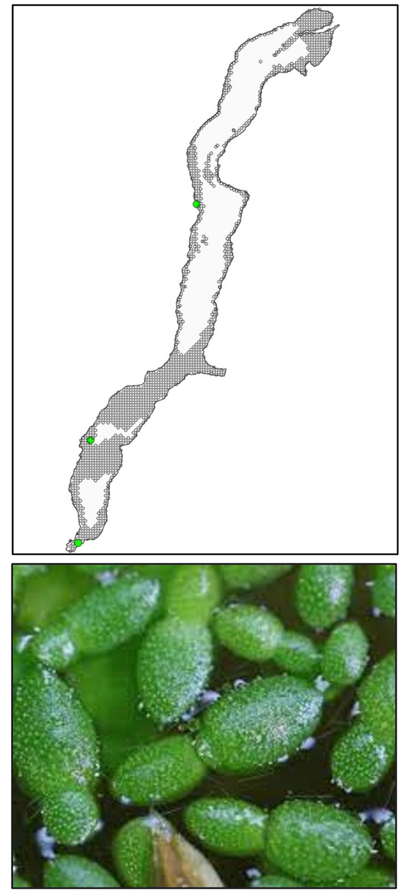
Spatterdock



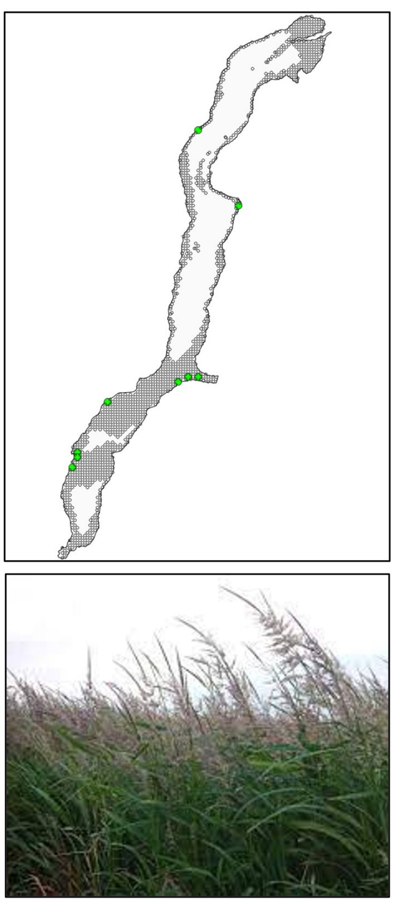
Duckweed



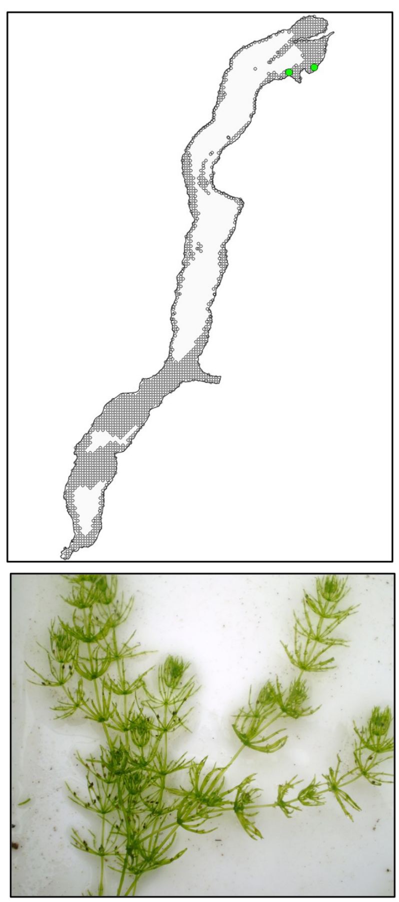
Watermeal



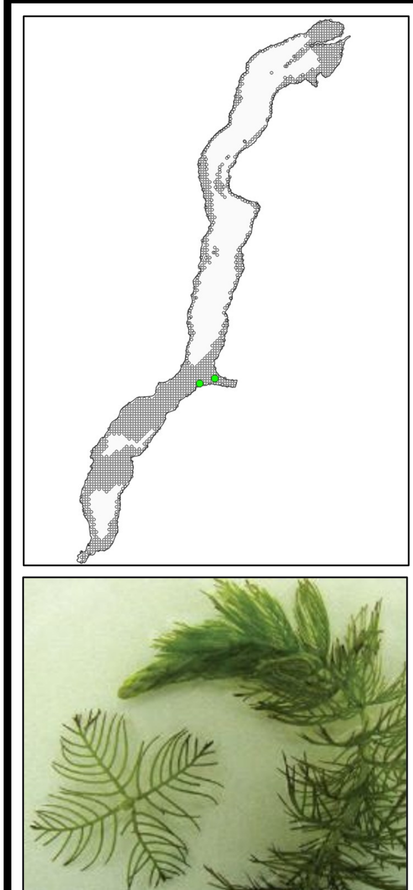
Wild Rice



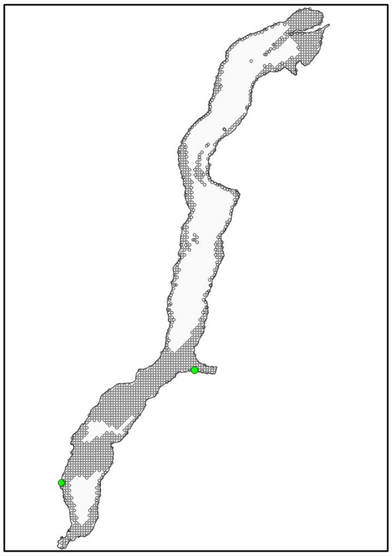
Muskgrass



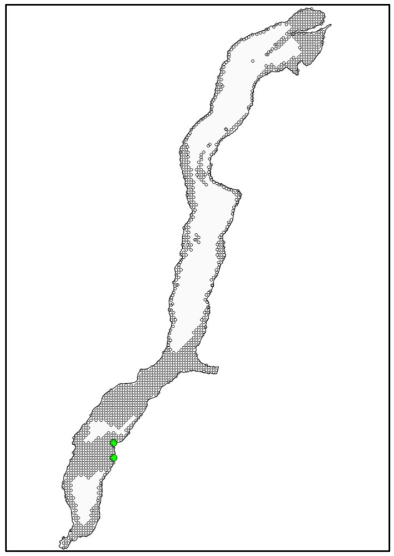
Northern Watermilfoil



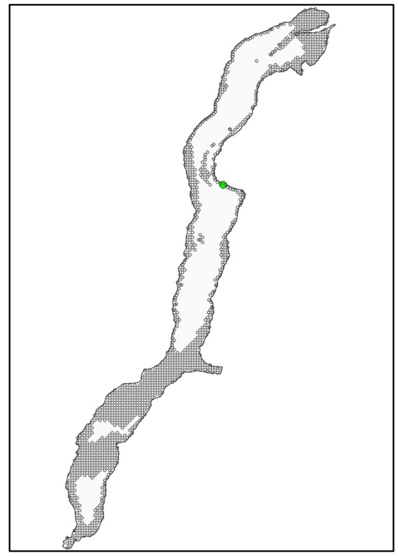
White Watercrowfoot



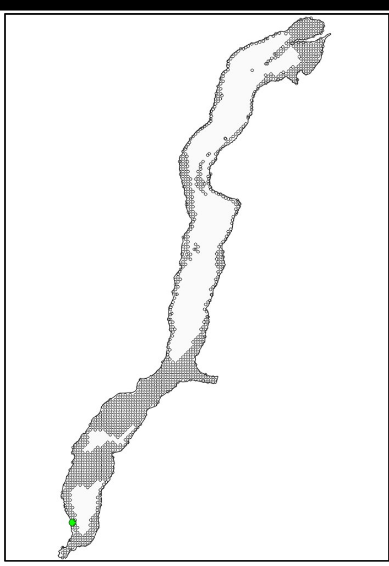
Sago



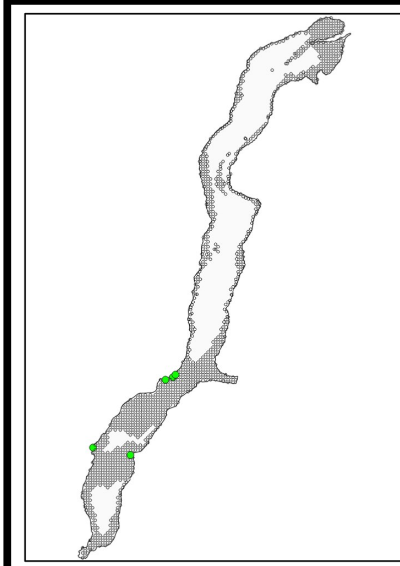
Nutall's Elodea

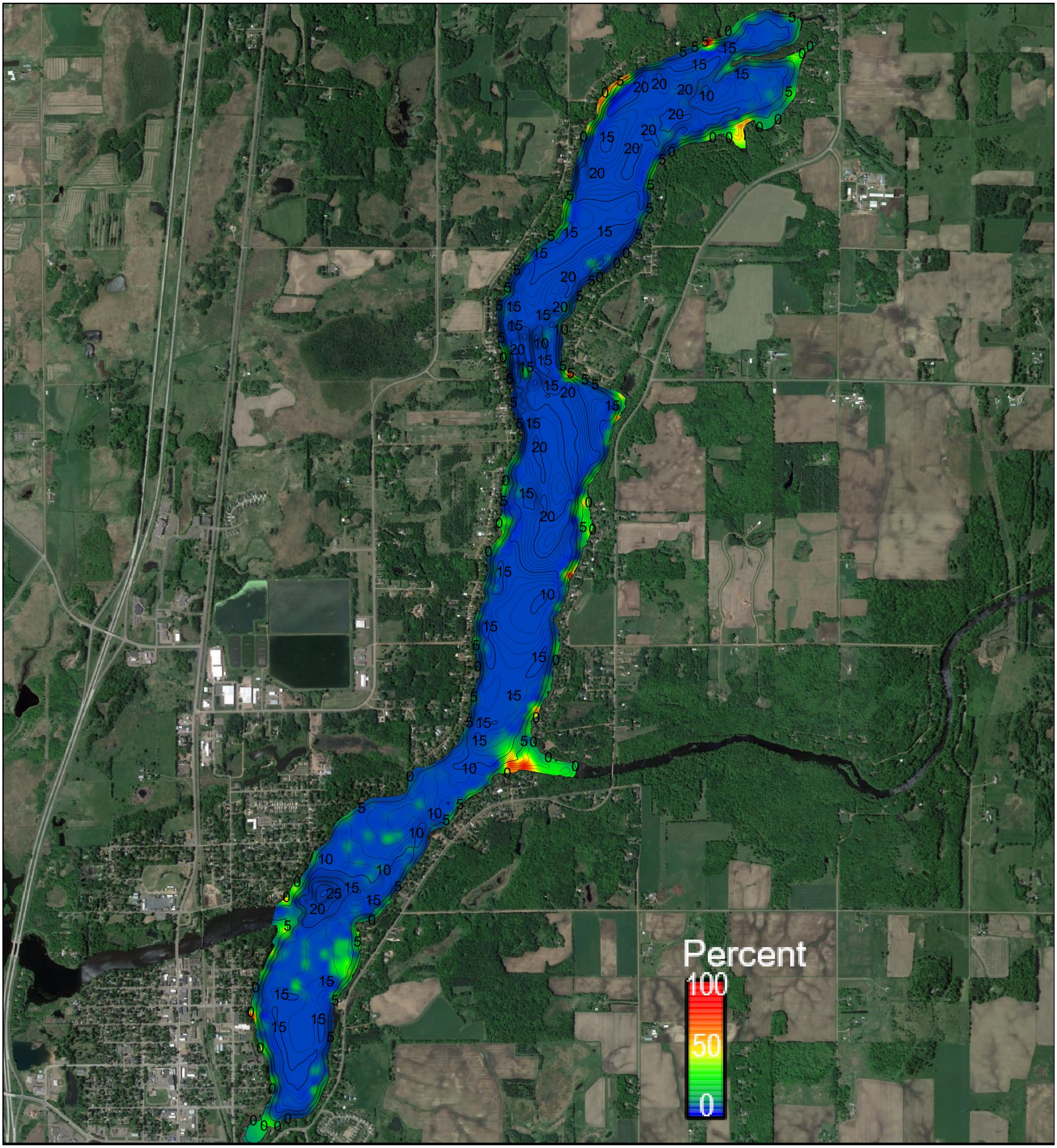


Arum-leaved Arrowhead



Aquatic Mosses





0.5 1 mi

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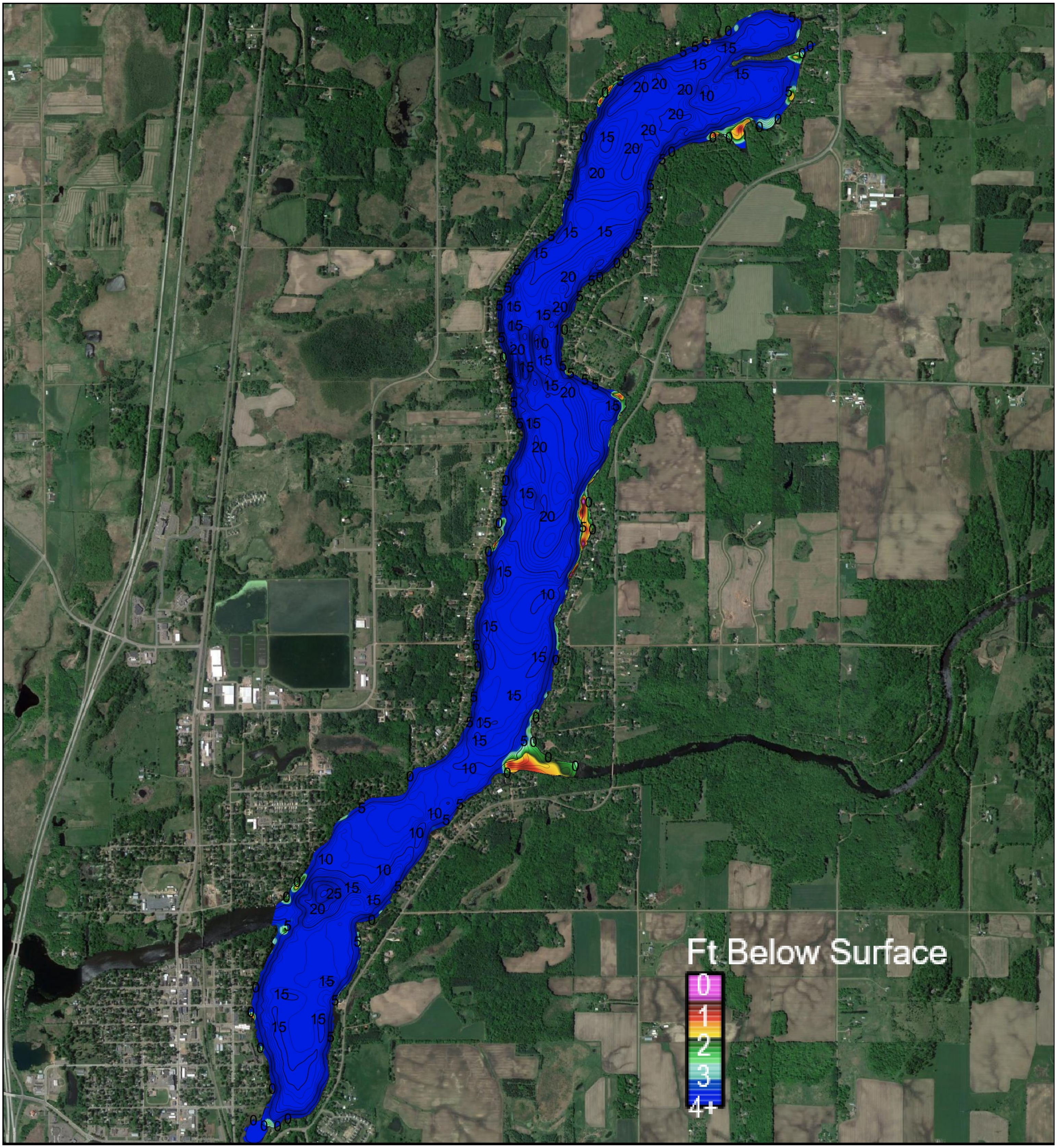
LIMNOpro Aquatic Science

Cross Lake (18015500)
Biovolume (06/21/2021)
Cross Lake Association



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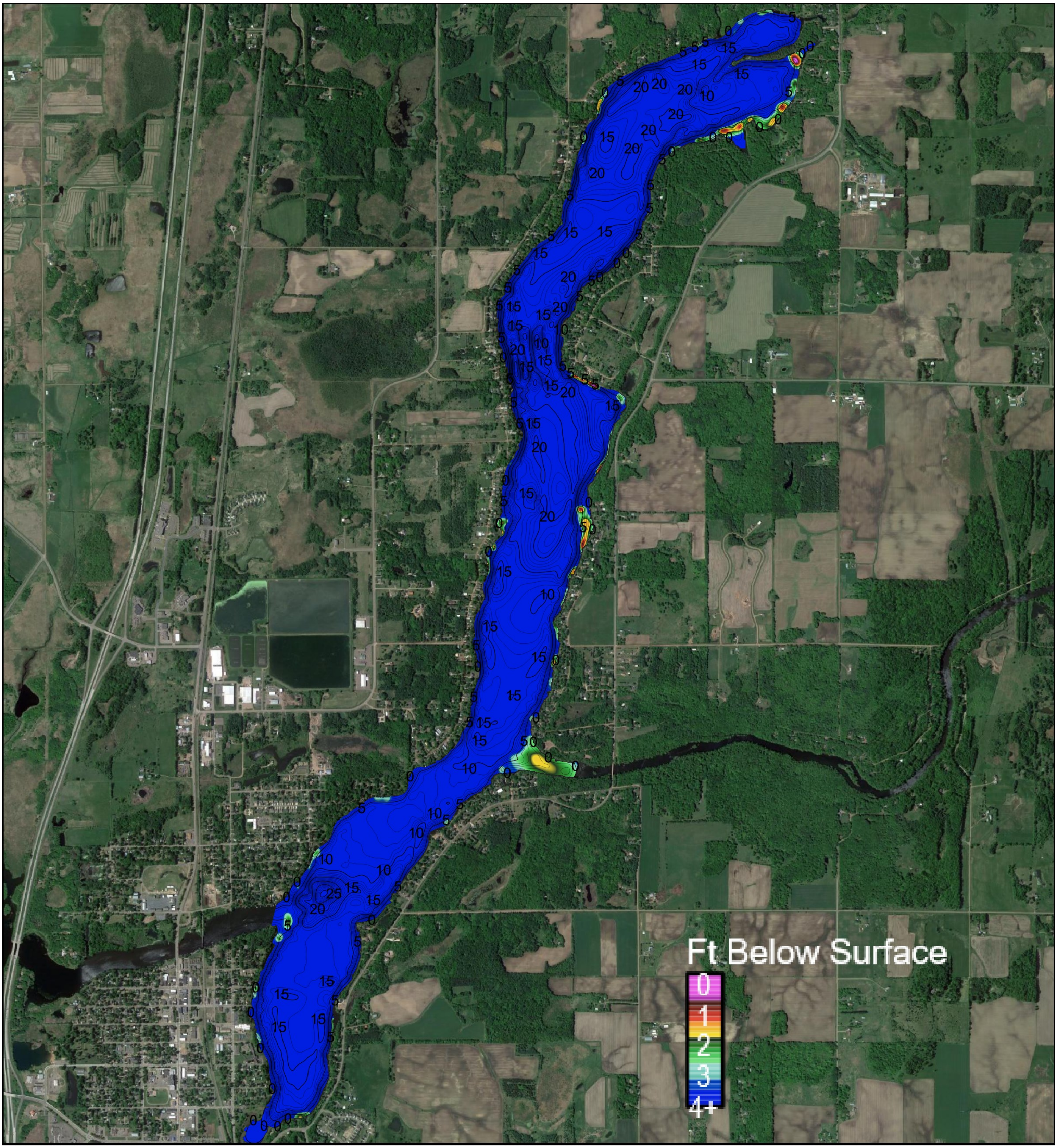
LIMNOpro
Aquatic Science

Cross Lake (18015500)
Canopy Depth (06/21/2021)
Cross Lake Association



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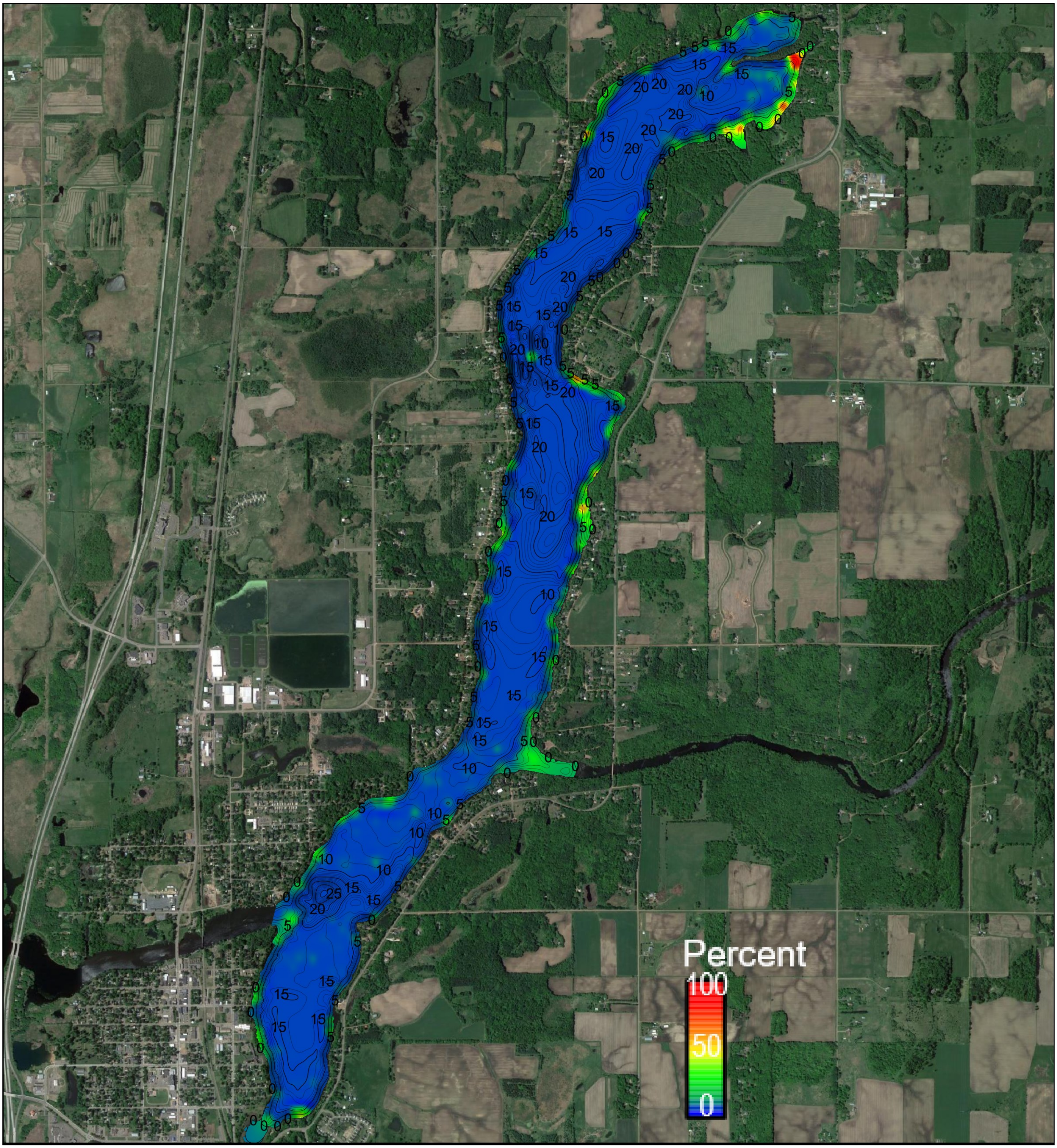
LIMNOpro Aquatic Science

Cross Lake (18015500)
Canopy Depth (08/17/2021)
Cross Lake Association



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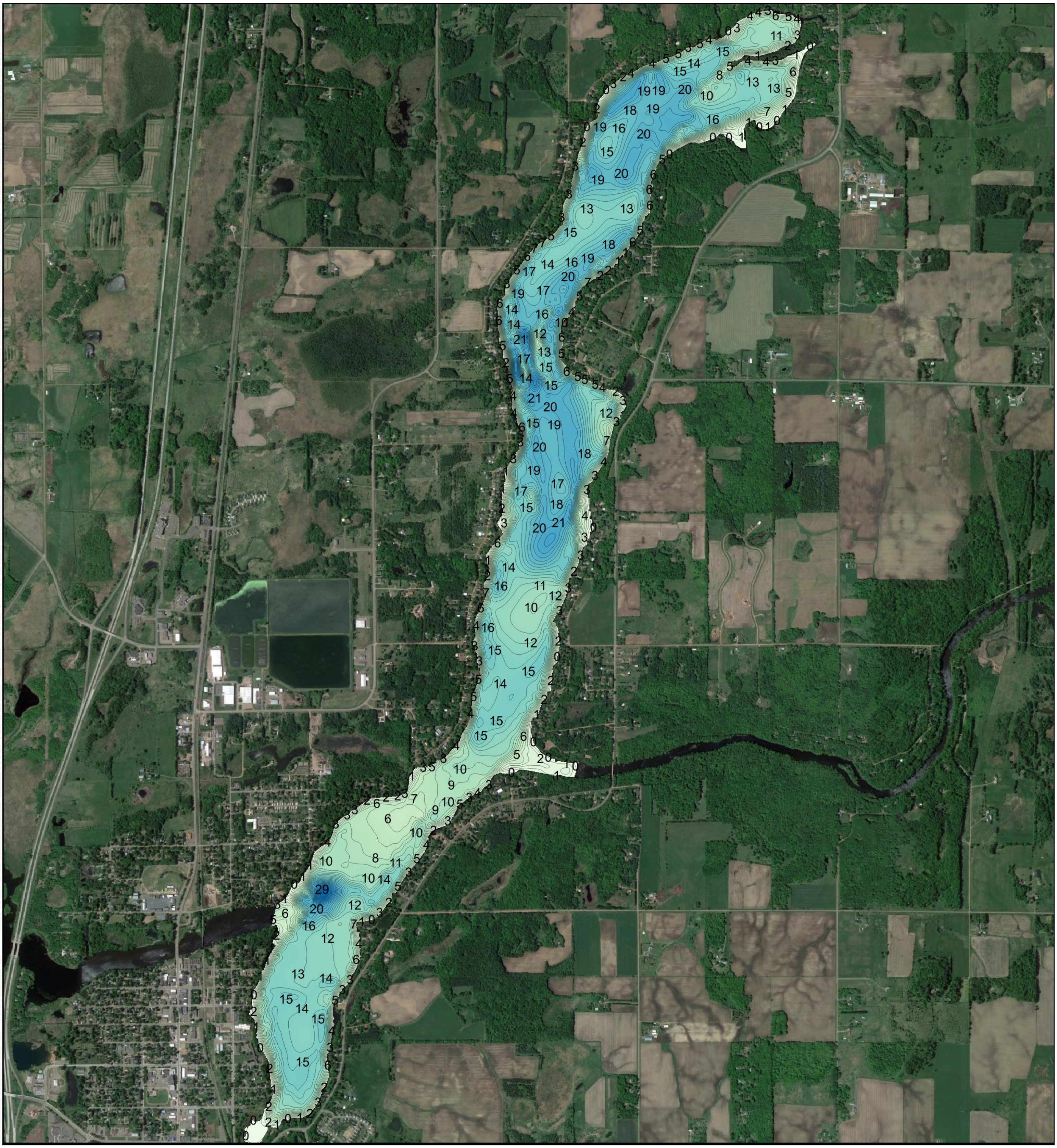
LIMNOpro
Aquatic Science

Cross Lake (18015500)
Biovolume (08/17/2021)
Cross Lake Association



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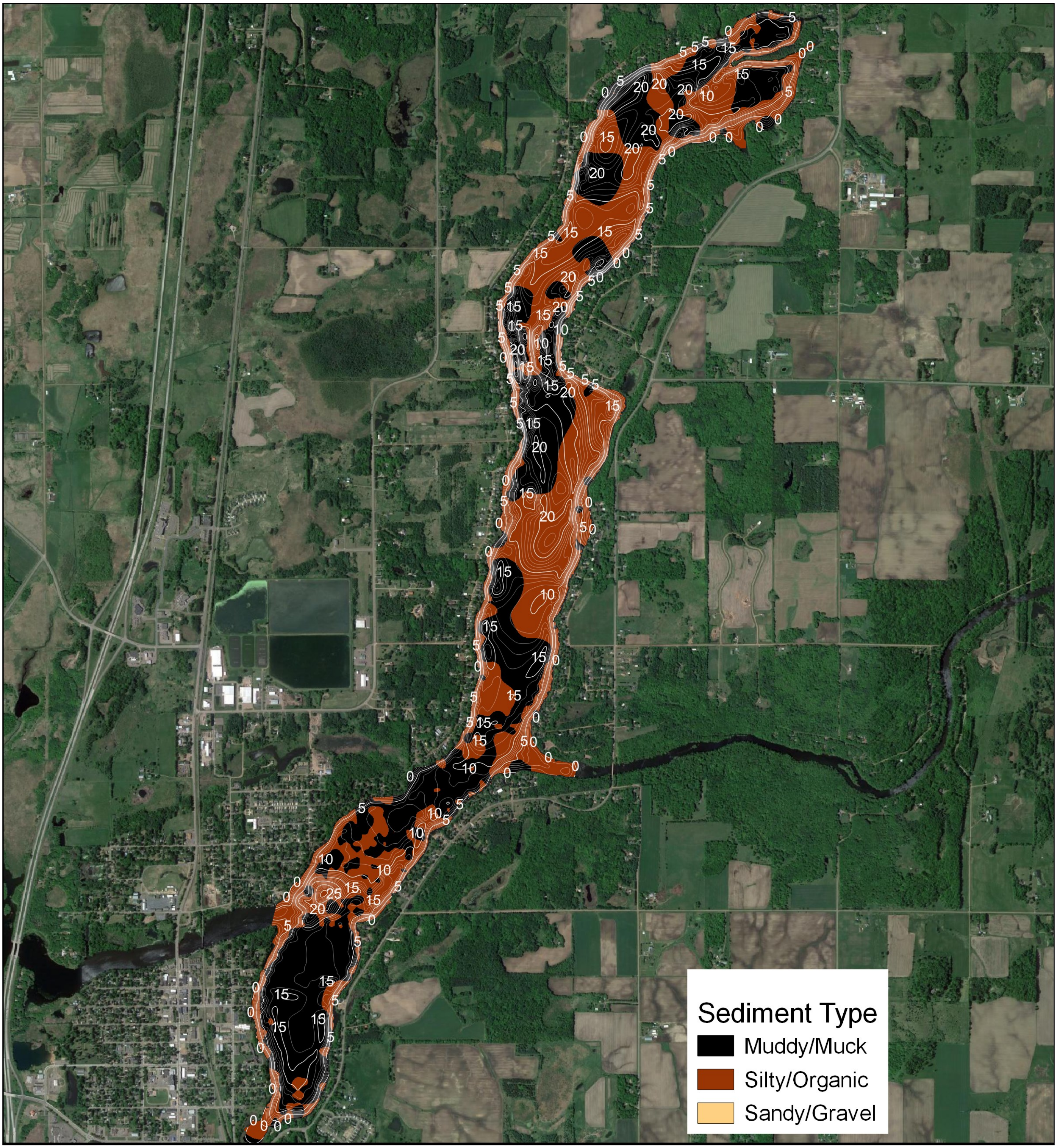
LIMNOpro
Aquatic Science

Cross Lake (18015500)
Bathymetry (06/21/2021)
Cross Lake Association



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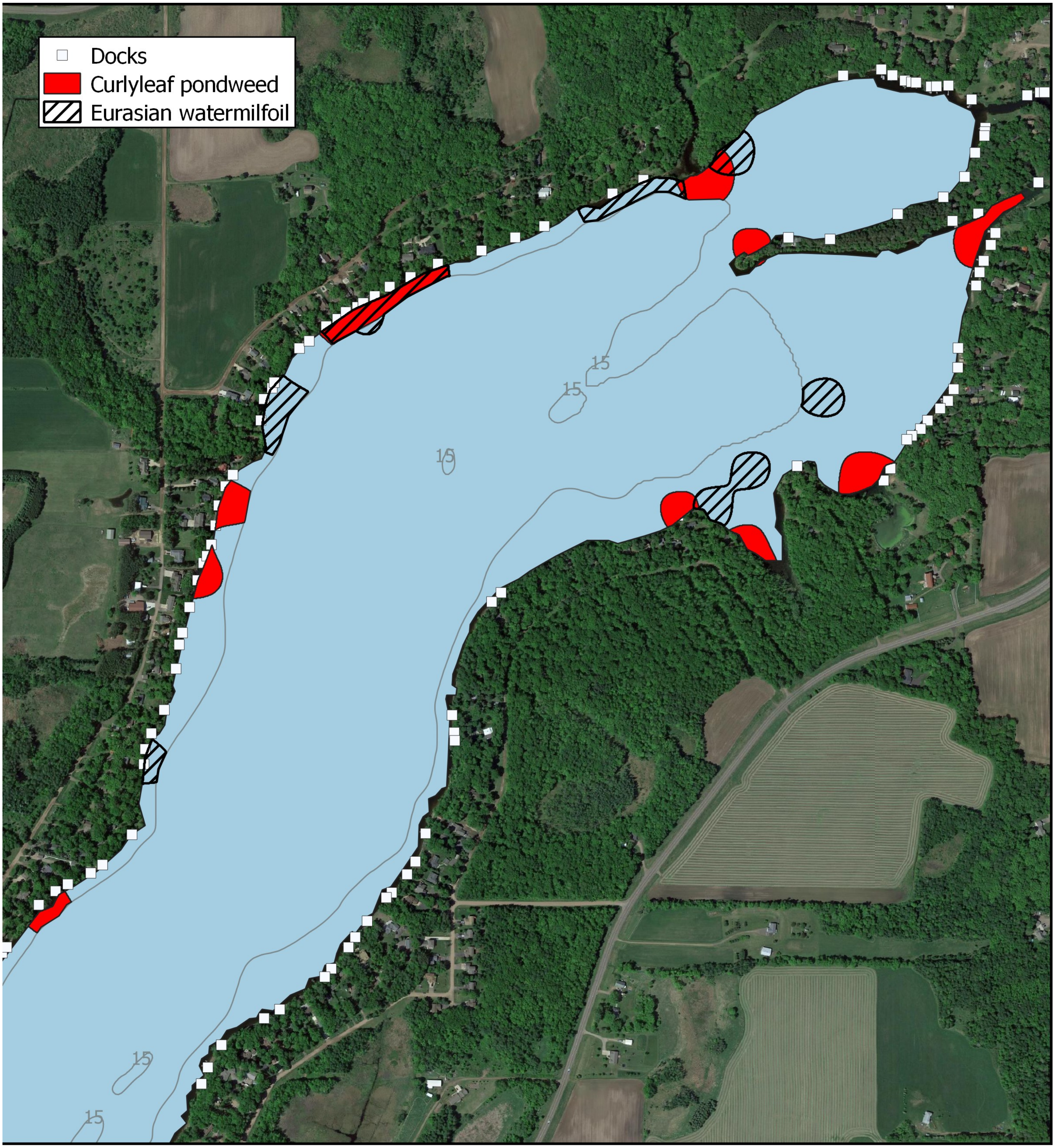
Aquatic Science

Cross Lake (18015500)
Sediment Type
(06/21/21- 08/17/2021)
Cross Lake Association



1 ACRE

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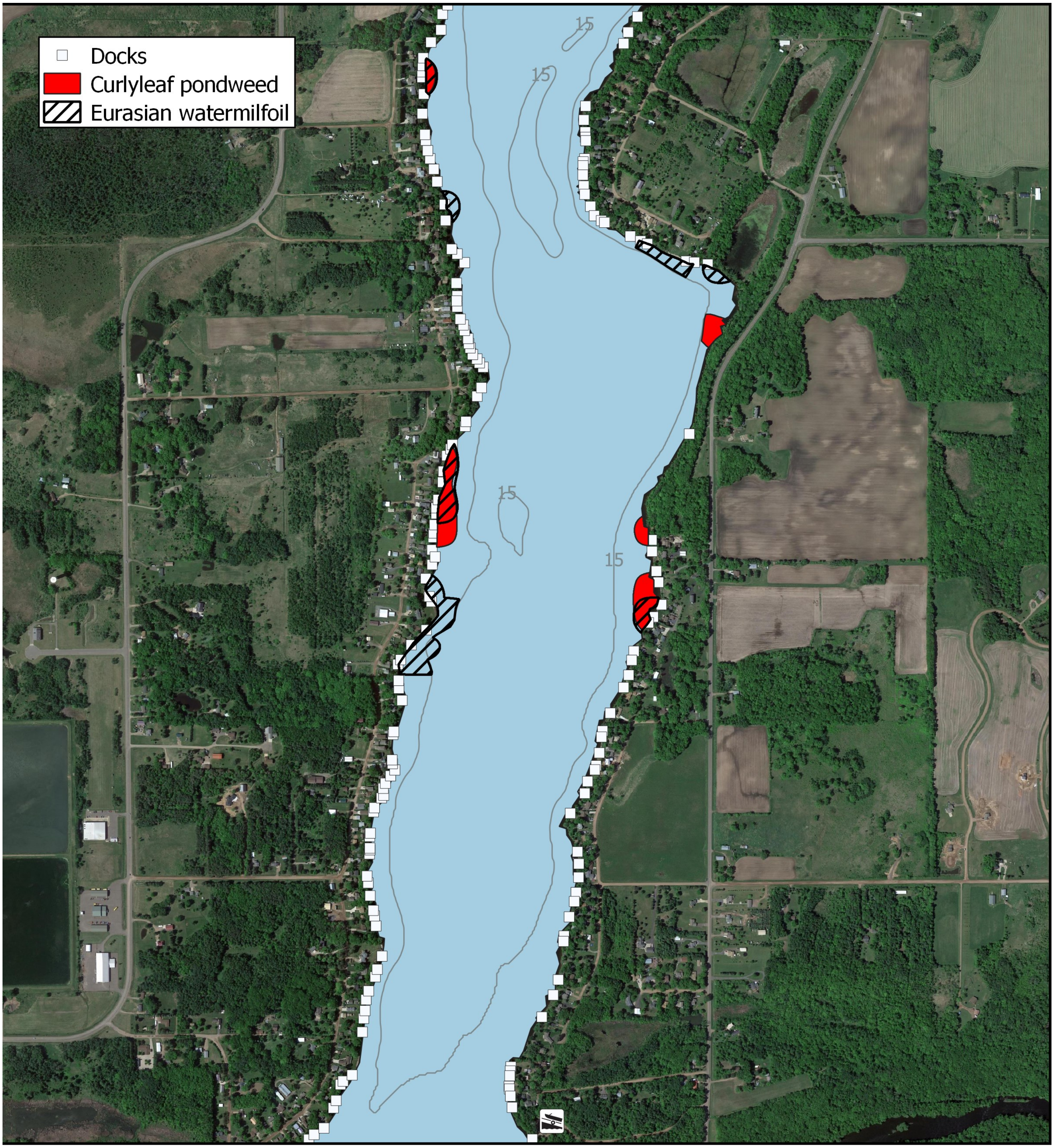
Aquatic Science

Upper Cross Lake (18015500)
Aquatic Invasive Species
Cross Lake Association



1 ACRE

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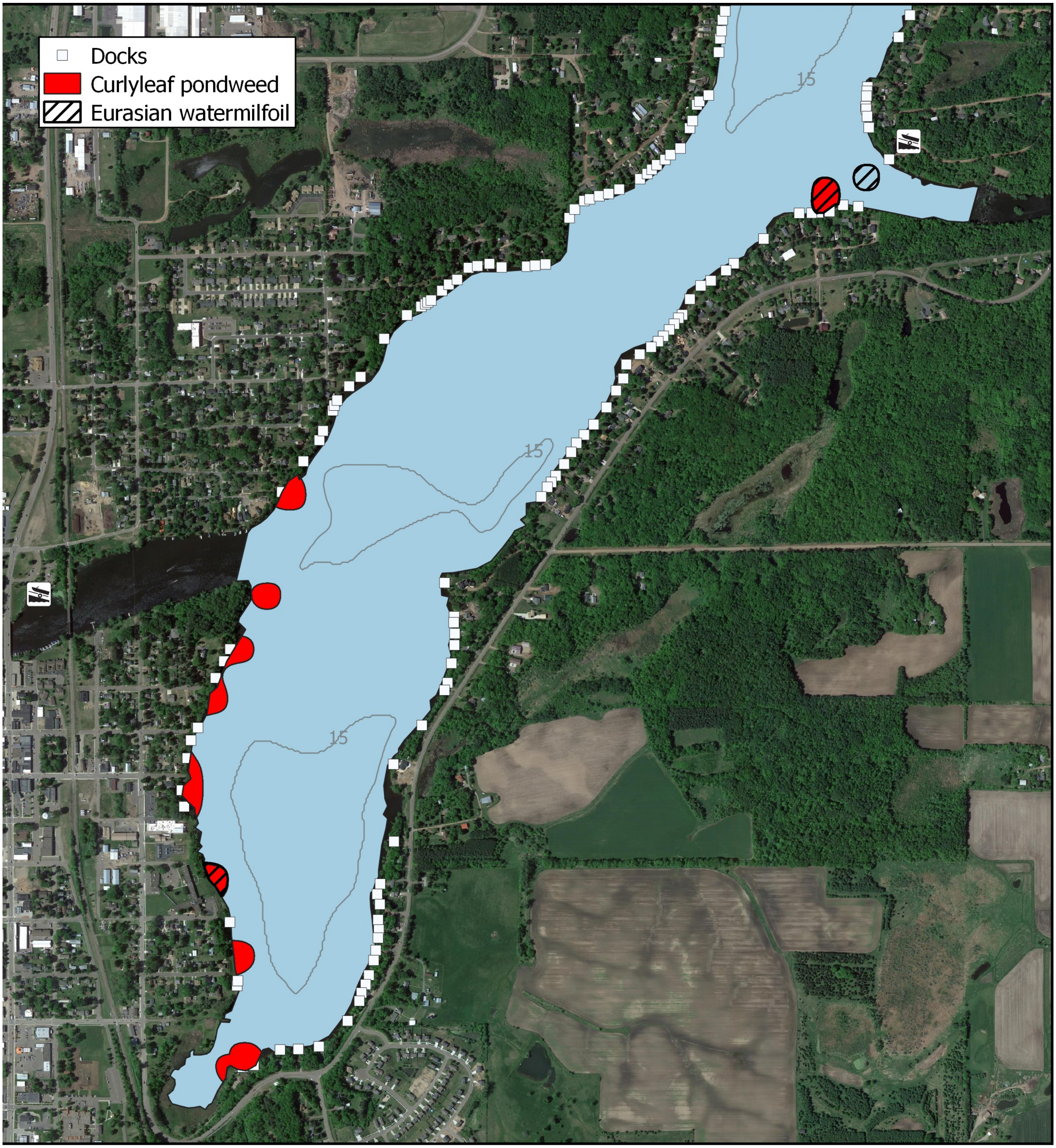
LIMNOpro
Aquatic Science

Middle Cross Lake (18015500)
Aquatic Invasive Species
Cross Lake Association



1 ACRE

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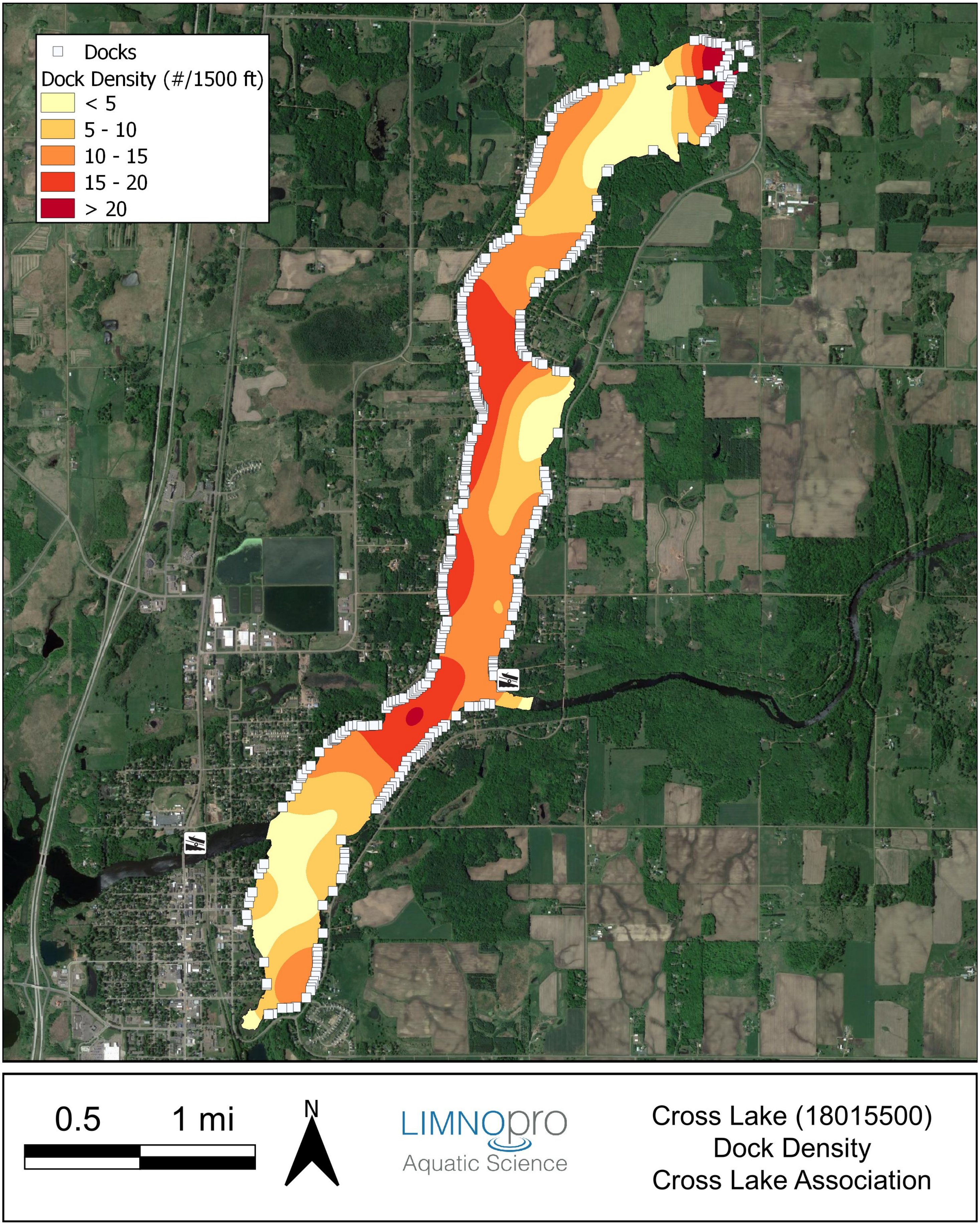
LIMNOpro
Aquatic Science

Lower Cross Lake (18015500)
Aquatic Invasive Species
Cross Lake Association



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Cross Lake (18015500)
Dock Density
Cross Lake Association